

**RADIO SYSTEM REPLACEMENT PROJECT DESIGN BUILD SERVICES
(CONTRACT NO. 1240)**

DOCUMENT 00520: DESIGN-BUILD AGREEMENT

TABLE OF CONTENTS

DOCUMENT 00520: DESIGN-BUILD AGREEMENT 1

DOCUMENT 00520: DESIGN-BUILD AGREEMENT 1

ARTICLE 1 – SCOPE OF WORK2

1.1 CONTRACT DOCUMENTS.....2

1.2 CONTRACTOR’S GENERAL RESPONSIBILITIES2

1.3 COMPLIANCE WITH LAWS3

**1.4 COMPLIANCE WITH BUY AMERICA AND OTHER FEDERAL
PROCUREMENT REQUIREMENTS3**

1.5 NOTICE OF STATUS OF ENVIRONMENTAL REVIEW UNDER CEQA3

ARTICLE 2 - CONTRACT TIME3

ARTICLE 3 – CONTRACT SUM AND PAYMENT4

3. 1 CONSIDERATION AND CONTRACT SUM.....4

3. 2 DEDUCTIONS4

3. 3 PROGRESS PAYMENTS.....4

3.4 PAYMENT DOES NOT CONSTITUTE ACCEPTANCE.....5

3. 5 CERTIFICATION OF AVAILABILITY OF FUNDS BY CONTROLLER5

ARTICLE 4 – PERFORMANCE GUARANTEES6

4. 1 PERFORMANCE GUARANTEES.....6

4.2 REDUCTION IN CONTRACT SUM.....6

4. 3 BONDS6

4.4 INSURANCE.....6

ARTICLE 5 – LABOR REQUIREMENTS AND KEY PERSONNEL6

5. 1 APPLICABLE LAWS AND AGREEMENTS6

5.2 PREVAILING WAGES7

5.3 CONTRACTOR’S PERSONNEL.....7

5.4	SBE REQUIREMENTS.....	7
5.5	KEY PERSONNEL	7
	ARTICLE 6 – INDEMNITY AND LIMITS OF LIABILITY	7
	ARTICLE 7 – RIGHTS AND REMEDIES	7
7.1	GENERAL	7
7.2	NO WAIVER	8
7.3	CITY'S REMEDIES FOR FALSE CLAIMS AND OTHER VIOLATIONS	8
7.4	REMEDIES	8
	ARTICLE 8 – INTERPRETATION OF AGREEMENT	8
8.1	RESOLUTION OF CONFLICTING TERMS	8
8.2	GOVERNING LAW.....	9
	ARTICLE 9 - OPTIONS AND PROCUREMENT	9
9.1	OPTIONS.....	9
9.2	CONTRACTING CONSTRUCTION WORK	9
9.3	THIRD PARTY TECHNOLOGY	9
9.4	CITY IS THIRD PARTY BENEFICIARY.....	9
	ARTICLE 10 – NOTICES TO PARTIES	10
	ARTICLE 11 –CONFIDENTIAL INFORMATION	11
	ARTICLE 12 – SAFETY	11
	ARTICLE 13 – PARTNERING AND CLAIMS	11
	ARTICLE 14 – TERMINATION AND SUSPENSION	11
	ARTICLE 15 - CONTRACTOR'S UNDERSTANDING OF THE WORK.....	11
	DOCUMENT 00530: AGREED SCHEDULE OF COSTS.....	13

DOCUMENT 00520: DESIGN-BUILD AGREEMENT

THIS DESIGN-BUILD AGREEMENT (this "Agreement" or "Contract") for the design, construction, implementation and testing of a replacement radio communications system (the "Replacement Radio System" or "Project") for the San Francisco Municipal Transportation Agency ("SFMTA") is made for the convenience of the parties this 29th day of March, 2012, by and between Harris Corporation, operating by and through its RF Communications Division, located at 221 Jefferson Ridge Parkway, Lynchburg, Virginia 24501(Contractor"), and the City and County of San Francisco, State of California (the "City"), a chartered municipal corporation acting by and through its SFMTA, under and by virtue of the Charter and Administrative Code of the City and County of San Francisco.

RECITALS

WHEREAS, The SFMTA requires a new radio communications system to replace its current radio system, which is outdated, subject to failure, cannot be easily repaired, does not meet the SFMTA's operational needs, and does not integrate with the City's emergency services communications system; and

WHEREAS, The Federal Communications Commission (the "FCC") has informed the SFMTA that as of January 1, 2013, the FCC will require the SFMTA to abandon the radio channels it currently uses and will assign the SFMTA new radio channels that are not compatible with the SFMTA's existing radio communications system; and

WHEREAS, A fully functional Replacement Radio System is critical to the mission and operations of the SFMTA in the delivery of safe and timely public transit, traffic control, and emergency response services, and the object and purpose of this Contract is to obtain a Replacement Radio System that meets the SFMTA's operational requirements; and

WHEREAS, The SFMTA solicited statements of qualifications from vendors possessing the necessary experience and expertise to perform and complete the Project, and based on Contractor's Proposal and statements therein as to Contractor's experience, expertise, understanding of the Project, SFMTA requirements, and price, the SFMTA selected Contractor for award of the Contract; and

WHEREAS, Contractor represents and warrants that it has necessary experience, expertise, personnel and resources to successfully complete the Project for the price and within the time set out in the Contract; and

WHEREAS, approval for this Agreement was obtained when the Civil Service Commission approved Contract number 1240 under Commission resolution PSC #4002-07/08 in July 2007 and August 2009; and

WHEREAS, the SFMTA awarded this Contract to Contractor on the _____ day of _____, 2012, under SFMTA Board of Directors Resolution No. _____, as more fully appears in the formal record of the proceedings of the SFMTA Board of Directors:

NOW, THEREFORE, Contractor promises and agrees, in consideration of the mutual covenants set forth in this Contract and in full knowledge and appreciation of facts and conditions stated in the recitals above (which are material provisions and are incorporated herein), to provide all services to design and construct the Project in accordance with the requirements of the Contract Documents for the Contract Sum and within the Contract Time provided therein, to perform the Work in good and workmanlike manner to the satisfaction of the SFMTA, to prosecute the Work with diligence from day to day to Final Completion, to furnish all design services and construction work, labor and materials to be used in the execution and completion of the Project in accordance with the Contract Documents, and to otherwise fulfill all of Contractor's obligations under the Contract Documents, as and when required under the Contract Documents to the satisfaction of the SFMTA.

Contractor's execution of this Agreement signifies its acceptance of the Contract Time and Contract Sum as being sufficient for completion of the Project, including both design and construction activities, as well as acceptance of all other terms and conditions set out in the Contract Documents.

ARTICLE 1 – SCOPE OF WORK

1.1 CONTRACT DOCUMENTS

Contractor shall provide all Work according to the Contract Documents, which are incorporated into and made a part of this Contract by this reference, and all labor, Equipment, and materials used in providing the Work and incorporated into the Work shall comply with the Contract Documents. The Contract Documents, which comprise the entire agreement between Contractor and the City concerning the Provision of the Work, are defined in the General Conditions (Document 00700) and in the Supplementary Conditions (Document Nos. 00800 et seq.). Any undefined term used in this Agreement shall be given the definition set forth in the General Conditions or in other applicable section of the Agreement.

1.2 CONTRACTOR'S GENERAL RESPONSIBILITIES

Contractor shall provide a complete, turnkey basis, a fully functional, complete and operational Replacement Radio System designed and constructed in accordance with the Contract Documents, including but not limited provision of all investigations, analyses, surveys, engineering, design, procurement, materials, tools, labor, workmanship, construction and erection, installation, testing, Equipment, shipping, subcontractors, subconsultants, material suppliers, permits, licenses, insurance, bonds, fees, taxes, duties, documentation, spare parts, materials for initial operation, security, disposal, startup, testing, cutover, training, manuals, warranties, guarantees, and all incidentals necessary and related to the SFMTA's requirements for the Project. Unless specifically identified as an obligation of the SFMTA or other City agency, where no actor is specified in any Contract Document, the action described shall be the obligation of the Contractor.

1.3 COMPLIANCE WITH LAWS

As more specifically provided in the General Conditions (Document 0700), Contractor shall keep itself fully informed of and shall strictly comply with all Laws. Contractor shall be fully responsible for any and all consequences and damages arising from its failure to comply with any Law.

1.4 COMPLIANCE WITH BUY AMERICA AND OTHER FEDERAL PROCUREMENT REQUIREMENTS

Contractor shall pay particular attention to applicable federal laws governing the use of federal grant monies for procurement, including but not limited to the Buy America rolling stock standards set out in Code of Federal Regulations Part 49, section 661.11 (49 CFR 661.11) and the FTA requirements applicable to end product communications systems as described at Appendix A to 49 CFR 661.3. Contractor shall be liable to and shall indemnify the City for all consequential and incidental damages incurred by the City that arise from Contractor's failure to perform the Contract and procure materials and Equipment for the Project in accordance with federal procurement and contracting requirements. Said consequential damages shall include but are not limited to loss of federal grant funding.

1.5 NOTICE OF STATUS OF ENVIRONMENTAL REVIEW UNDER CEQA

The City is in the process of applying for a categorical exemption through a California Environmental Quality Assurance Act ("CEQA") review process. Phase 4.2 Work will not commence until: (1) the City determines that a CEQA review process is not necessary either by the SFMTA's receipt of categorical exemption; or, (2) by the SFMTA's receipt of a Declaration of Negative Impact ("NegDec"). If a formal CEQA review process is required, and the City approves the Project, Contractor shall incorporate into the Project design any alterations, procedures or alternatives identified and adopted during the CEQA review process. If the City determines in its sole discretion that the Project will not proceed due to potential environmental impacts, the City reserves all rights to suspend all or part of the Project and/or terminate all or part of this Agreement for convenience as set forth in Article 14 of the General Conditions. If the Project is partially or entirely suspended by the City, Contractor shall submit to the SFMTA a proposed revised schedule to perform the remaining Work without delay and mitigate to the greatest extent possible additional costs and delay to the remaining unsuspended Work. Suspension of the Project or Agreement shall be treated as an unavoidable delay to the extent that Contractor is unable to mitigate fully any additional costs arising for such delay.

ARTICLE 2 - CONTRACT TIME

Contractor shall perform the Work under this Contract within the time requirements set out in Section 3.3 and Article 7 of the General Conditions (Document 0700).

ARTICLE 3 – CONTRACT SUM AND PAYMENT

3.1 CONSIDERATION AND CONTRACT SUM

- A. Contractor shall perform the Work in accordance with all requirements and provisions set out in the Contract Documents, and in consideration therefor, the City shall pay Contractor compensation as provided in the General Conditions, Article 9 and the Contract Documents referenced therein.
- B. The total Contract Amount for the Base Work as described in the Contract shall not exceed Eighty Six Million Six Hundred Forty Eight Thousand Fifty Eight Dollars (\$86,648,058) for the Base Work . In addition, the SFMTA reserves the right to exercise the Options described in the Contract Documents for the prices and time limits set out for the Options in Document 530. The SFMTA's exercise of an Option shall increase the Contract Amount for the respective value of said Option listed in Document 530. The price(s) and Contract Amount set forth above will be adjusted during performance or upon Final Completion of the Work, in accordance with the Contract.
- C. Contractor understands and agrees that Contractor shall be solely responsible for providing all resources that may be necessary to provide the Work, and that the City shall have no obligation whatsoever to finance any part of such costs except with respect to those amounts which become due and payable under the terms and conditions of the Contract Documents.

3.2 DEDUCTIONS

Contractor understands and agrees that when, under any provision of the Contract Documents, the City shall charge any sum of money against Contractor, the amount of such charge shall be deducted from the amount of the next succeeding progress estimate, or from any other moneys due or that may become due Contractor on account of the Contract, and the funds will be retained by the City. If upon completion or termination of the Contract, such moneys due Contractor are insufficient to cover the City's charges against it, the City shall have the right to recover the balance from Contractor or its sureties.

3.3 PROGRESS PAYMENTS

Invoices and progress payments shall be administered as provided in Section 9.3 of the General Conditions (Document 0700) and Document 809. The City shall endeavor to make progress payments for undisputed amounts for Work completed by Contractor in accordance with the requirements of this Agreement within fifteen (15) Days, but no later than thirty (30) Days, of receiving a payment request and appropriate documentation including, without limitation, certified payrolls (for construction work) and SFMTA Small

Business Enterprise ("SBE") and San Francisco Human Rights Commission program participation forms.

3.4 PAYMENT DOES NOT CONSTITUTE ACCEPTANCE

The granting of any payment by the City, or the receipt thereof by Contractor, shall in no way constitute or infer acceptance of Work by the City or in any way lessen the liability of Contractor to replace unsatisfactory Work, Equipment, or materials, although the unsatisfactory character of such Work, Equipment or materials may not have been apparent or detected at the time such payment was made. Materials, Equipment, components, or workmanship that does not conform to the requirements of this Agreement may be rejected by the City and in such case must be replaced by Contractor without delay. No charges shall be incurred under this Agreement nor shall any payments become due to Contractor until reports, services, or both, required under this Agreement are received from Contractor and approved by the SFMTA as being in accordance with this Agreement. The City may withhold payment to Contractor in any instance in which Contractor has failed or refused to satisfy any material obligation provided for under this Agreement. In no event shall the City be liable for interest or late charges for any late payments.

3.5 CERTIFICATION OF AVAILABILITY OF FUNDS BY CONTROLLER

This Agreement is subject to the budget and fiscal provisions of the San Francisco Charter. Charges will accrue only after prior written authorization certified by the Controller, and the amount of the City's obligation hereunder shall not at any time exceed the amount certified for the purpose and period stated in such advance authorization. The City's obligation hereunder shall not at any time exceed the amount certified by the Controller for the purpose and period stated in such certification. Except as may be provided by laws governing emergency procedures, officers and employees of the City are not authorized to request, and the City is not required to reimburse Contractor for, commodities or services beyond the agreed upon contract scope of the Work unless the changed scope is authorized by amendment and approved as required by law. Officers and employees of the City are not authorized to offer or promise, nor is the City required to honor, any offered or promised additional funding in excess of the maximum amount of funding for which the Contract is certified without certification of the additional amount by the Controller. The Controller is not authorized to make payments on any contract for which funds have not been certified as available in the budget or by supplemental appropriation. **This Section 3.5 shall control against any other provision of this Contract. Contractor is not authorized to perform Work under this Contract beyond the certified contract funding amount.**

ARTICLE 4 – PERFORMANCE GUARANTEES

4.1 PERFORMANCE GUARANTEES

Contractor warrants and guarantees that the Project will meet the performance specifications and requirements set forth in the Contract Documents. Contractor shall provide a performance bond or a performance bond and warranty and maintenance bond as required under Section 10.2 of the General Conditions (Document 0700) to guarantee to completion and performance of the Project.

4.2 REDUCTION IN CONTRACT SUM

Contractor acknowledges and agrees that if the Project does not meet the performance standards set out in the Contract Documents, the Project shall be of less value to the City. Accordingly, Contractor and the City understand and agree that if the Project when completed fails to meet the performance requirements set out in the Contract Documents, Contractor shall pay to the City the amounts set forth in the Contract Documents or the Contract Sum shall be reduced by those amounts, as provided in the General Conditions (see Section 8.3).

4.3 BONDS

As provided in the Article 10.2 of the General Conditions, Contractor shall provide payment and performance bonds (and if required by the City, a warranty and maintenance bond) to ensure the payment of subcontractors and suppliers and to ensure the performance by Contractor of the Contract.

4.4 INSURANCE

As provided in the General Conditions, Section 10.1, Contractor shall provide insurance in the coverage types and amounts set out therein. The Contractor may propose different insurance products to satisfy the requirements of this section, which the SFMTA may accept or reject in its sole and absolute discretion. Any alternate insurance product must provide the same or better protection to the City.

ARTICLE 5 – LABOR REQUIREMENTS AND KEY PERSONNEL

5.1 APPLICABLE LAWS AND AGREEMENTS

Compensation and working conditions for labor performed or services rendered under this Agreement shall be in accordance with the Contract Documents, the San Francisco Charter, and applicable sections of the San Francisco Administrative Code, including section 6.22(E).

5.2 PREVAILING WAGES

As more specifically set out in Sections 11.1 and 16.11 of the General Conditions, Contractor shall pay any person performing labor that qualifies as construction work under any State law or City ordinance in the provision of the Work under this Contract not less than the highest general prevailing rate of wages as so determined for the Work performed. Contractor shall also ensure that Contractor's subcontractors comply with the said prevailing wage requirement. Contractor shall include, in any contract or subcontract relating to the Work, a requirement that all persons performing labor under such contract or subcontract shall be paid not less than the highest prevailing rate of wages for such labor so performed.

5.3 CONTRACTOR'S PERSONNEL

Work under this Agreement shall be performed only by competent personnel under the supervision of and in the employment of Contractor. Contractor will comply with City's reasonable requests regarding assignment of personnel, but all personnel, including those assigned at the City's request, must be supervised by Contractor. Contractor shall commit adequate resources to complete the Project within the Contract Time.

5.4 SBE REQUIREMENTS

Contractor shall comply with the requirements of the SFMTA's federal contracts Small Business Enterprise subcontracting program, as set out in Appendix 2 of the RFP/RFQ.

5.5 KEY PERSONNEL

As more specifically provided in Section 3.6 of the General Conditions, (Document 0700), Contractor shall assign the Key Personnel, to the Project for the entire term of the Project or for such lesser time as the SFMTA may authorize. Said Key Personnel shall be based and shall work in the local Project Office. Key Personnel are subject to the reassignment and replacement restrictions set out in Section 3.6.5 of the General Conditions.

ARTICLE 6 – INDEMNITY AND LIMITS OF LIABILITY

As set out in the General Conditions, Section 3.20 (Document 0700) and to the maximum extent provided under Law, Contractor shall indemnify and defend the City from all claims and actions arising from Contractor's acts and omissions.

ARTICLE 7 – RIGHTS AND REMEDIES

7.1 GENERAL

The provisions of the Contract Documents shall not limit the duties, obligations, rights and remedies otherwise imposed or available by law or in equity. No action or failure to act shall in any way abridge the rights and obligations of the Parties to the Contract

Documents, or condone a breach thereunder, unless expressly agreed to by the Parties in writing. All remedies provided in the Contract Documents shall be taken and construed as cumulative; that is, in addition to each and every other remedy herein provided, a party shall have any and all equitable and legal remedies that it would in any case have.

7.2 NO WAIVER

No waiver of any breach of any provision of the Contract Documents by one party shall be held to be a waiver by the second party of any other or subsequent breach by one party . The only effective waiver of any contract requirement shall be a waiver in writing that explicitly states the item or right being waived.

7.3 CITY'S REMEDIES FOR FALSE CLAIMS AND OTHER VIOLATIONS

Under San Francisco Administrative Code section 6.22M, Contractor or any Subconsultant, Subcontractor or Supplier who fails to comply with the terms of this Agreement, who violates any provision of Chapter 6 of the Administrative Code or rules and regulations adopted per that Chapter, who submits false claims, or who violates against any governmental entity a civil or criminal law relevant to its ability to perform under or comply with the terms and conditions of the Agreement, may be declared an irresponsible bidder, proposer or unqualified consultant and debarred according to the procedures set forth in San Francisco Administrative Code section 6.80, et seq. Additionally, Contractor or its Subconsultant, Subcontractor or Supplier who submits a false claim may be subject to monetary penalties, investigation, and prosecution as set forth in Administrative Code section 6.80, et seq. Contractor shall include in each subcontract and purchase order for Work a clause incorporating the provisions of this Section 7.3.

7.4 REMEDIES

The remedies available to the City under this Article are cumulative and the exercise of those rights shall in no way impair the City's exercise of any other remedy under local, State or Federal law.

ARTICLE 8 – INTERPRETATION OF AGREEMENT

8.1 RESOLUTION OF CONFLICTING TERMS

The Contract Documents are intended to be read together and integrated as a whole, and shall be construed and interpreted in a manner so as to avoid any conflicts to the extent possible. Supplementary Conditions in the Contract Documents shall not be deemed to be in conflict with these General Conditions or other Contract Documents. It is expressly agreed by and between Contractor and the City that should there be any conflict between the terms of this Agreement and the Proposal of Contractor, this Contract shall control and

nothing herein shall be considered as an acceptance of any terms of the Bid which conflict with this Agreement.

8.2 GOVERNING LAW

The Contract shall be interpreted in accordance with the applicable laws of the State of California and the provisions of the City's Charter and Administrative Code, including but not limited to Chapter 6 of the San Francisco Administrative Code, which are incorporated by this reference as if set forth herein in full. The Contract is also subject to the guidelines and requirements of the Federal Transit Administration ("FTA"), federal Department of Transportation. The SFMTA has not adopted and shall not be bound by Federal Acquisition Regulations ("FAR"), Code of Federal Regulations, Part 48, requirements except to the extent that the FTA so requires.

ARTICLE 9 - OPTIONS AND PROCUREMENT

9.1 OPTIONS

The Agreement contains Additive Options which may be exercised by the SFMTA in its sole and absolute discretion. The SFMTA shall exercise said Options as provided in in the Statement of Work. Where the SFMTA exercises an Additive Option, the Contract Price shall be increased by the amount of that Option as listed in Doc. 530.

9.2 CONTRACTING CONSTRUCTION WORK

The SFMTA reserves the right to self-perform or separately contract with third parties for any elements of Project construction work. Should the City exercise said right, the Contract Sum and scope of Work shall be equitably adjusted.

9.3 THIRD PARTY TECHNOLOGY

As more particularly described in Document 00823 (Software and Technology Procurement), the SFMTA reserves to itself the right to separately procure third party Software and computer equipment, (including but not limited to servers, work stations and personal computers) necessary for the Project. Contractor shall provide all necessary services to install, configure, and integrate said Software and Equipment to the Project and shall warranty said Work.

9.4 CITY IS THIRD PARTY BENEFICIARY

Where Contractor procures for and/or on behalf of the Project services and goods, including but not limited to Software, Equipment, computers, communications equipment, radio sets, Software, and services related to the goods procured, said procurement shall be for the City's benefit. Contractor shall clearly state in all contracts for said procurement(s) that the City is an intended third party beneficiary of said procurement(s) and agreement(s). Contractor shall ensure and said agreements shall specifically provide

that all warranty rights and other guarantees arising from or appurtenant to said procurement(s) shall pass through to the City, and the City shall have the right to demand performance of said warranties and guaranties as if the City had procured said services and goods itself directly.

ARTICLE 10 – NOTICES TO PARTIES

10.1 Unless otherwise indicated elsewhere in the Contract Documents, all communications and notices sent by the Parties may be by U.S. mail, e-mail or by fax, and shall be addressed as follows:

To City: Henry Kim
Project Manager
San Francisco Municipal Transportation Agency
1 South Van Ness Avenue, 3rd floor
San Francisco, CA 94103

Copy to: Shahnam Farhangi
Acting Director of Capital Programs and Construction
San Francisco Municipal Transportation Agency
1 South Van Ness Avenue, 3rd floor
San Francisco, CA 94103
shahnam.farhangi@sfmta.com
415-701-4284

To Contractor: Michelle Babcock
Senior Contract Manager
8105 North Beltline Road
Suite 170
Irving, TX 75063
mbabcock@harris.com
972-550-2341

10.2 From time to time, a Party may designate new address information by notice in writing, delivered to the other Party.

10.3 Contractor may designate in writing a different address to which the City will send payment.

10.4 The delivery to Contractor at the legal address listed above, as it may be amended upon written notice, or the depositing in any post office or post office box regularly maintained by the United States Postal Service in a postage paid wrapper directed to Contractor at such address, of any drawing, notice, letter or other communication shall be deemed legal and sufficient service thereof upon Contractor.

10.5 Any notice of default must be sent by registered mail.

ARTICLE 11 –CONFIDENTIAL INFORMATION

Contractor shall comply with the requirements set out in Document 00830 as to confidentiality and security of information.

ARTICLE 12 – SAFETY

12.1 Contractor shall comply with the safety requirements set out in Article 12 of the General Conditions (Document 00700) and Document 0828 of the Supplementary Conditions.

ARTICLE 13 – PARTNERING AND CLAIMS

13.1 As provided in Article 13 of the General Conditions, Contractor is encouraged to adopt a partnering style of collaborative work to complete the Project within the Contract Time and Contract Sum.

13.2 Contractor shall comply with the requirements for submission of a Contract Claim as set out in Article 13 of the General Conditions, and failure to do shall constitute a waiver of said Contract Claim.

ARTICLE 14 – TERMINATION AND SUSPENSION

This Agreement shall terminate when all obligations required to be performed by Contractor and City under the Agreement has been fulfilled, unless sooner terminated under Article 14 of the General Conditions.

ARTICLE 15 - CONTRACTOR'S INVESTIGATION AND UNDERSTANDING OF THE WORK

Contractor hereby acknowledges that it has read every section, provision and clause in the Contract Documents, has examined the specifications set out in the Design Criteria Package, has examined the locations where the Work is to be done, and has made all inquiries and investigations necessary to enable Contractor to understand thoroughly the intent of all parts of the Contract, and the nature of the Work, and Contractor agrees that it will not hereafter make any claim for compensation, extension of time or other allowance of any sort, based upon or arising out of any alleged misunderstanding by it of any part of the Contract. Contractor further acknowledges that it has toured the Project Sites and has had ample opportunity to investigate the conditions on those Sites that may be discovered with reasonable due diligence. Contractor acknowledges that it has been provided ample opportunity to ask questions of the City and review background and reference documents relevant to the Sites and the Project.

Remainder of this page intentionally left blank.

IN WITNESS WHEREOF, Contractor and the City have hereunto set their hands and seals, and have executed this Agreement in duplicate, the day and year first above written.

<p>CITY</p> <p>Approved: _____</p> <p>Edward D. Reiskin Director of Transportation San Francisco Municipal Transportation Agency</p> <p>San Francisco Municipal Transportation Agency Board of Directors Resolution No. _____ Adopted: _____ Attest: _____ Secretary, SFMTA Board of Directors</p> <p>Approved as to form: DENNIS J. HERRERA City Attorney</p> <p>By: _____ Robert K. Stone Deputy City Attorney Dated: _____</p> <p>0520 Doc. No. n:\ptc\as2012\1000386\00764742.doc 0800 Doc No. n:\ptc\as2012\1000386\00764681.doc 0700 Doc No. n:\ptc\as2012\1000386\00764766.doc</p>	<p>CONTRACTOR:</p> <p>By my signature hereunder, as Contractor, I certify that I have read and understand Section 15.4 in Document 0700, captioned MacBride Principles, the City's statement urging companies doing business in Northern Ireland to move towards resolving employment inequities, encouraging compliance with the MacBride Principles, and urging San Francisco companies to do business with corporations that abide by the MacBride Principles.</p> <p>I further certify that I am aware of the provisions of section 3700 of the Labor Code which require every employer to be insured against liability for workmen's compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the Work of this Contract.</p> <p>I further certify that I have full authority to sign this this Contract and bind the Contractor to this Contract.</p> <p>_____ Paul Greco Vice President, Contracts Harris Corporation RF Communications Division 1680 University Avenue Rochester, New York 14610 Tax ID No. 34-027-6860</p> <p>Dated: _____</p>
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**RADIO SYSTEM REPLACEMENT PROJECT DESIGN BUILD SERVICES
(CONTRACT NO. 1240)**

DOCUMENT 00530: COSTS AND PAYMENT SCHEDULE

Item	Item Description	Method of Payment	Unit Price	Single Payment Amount Upon Completion of The Item*
Phase 4.1 Design Engineering Services				
Scope of Phase 4.1 - Design engineering services for the complete Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) and all other related components as described in Appendix 12 Technical Specifications.				
4.1.1a	Project Mobilization	MS	-	\$1,000,000
4.1.1b-1	Lot #1 - 10 sites (such as Radio Sites, Facilities, underground and vehicles)	MS	-	\$150,000
4.1.1b-2	Lot #2 - 15 sites (such as Radio Sites, Facilities, underground and vehicles)	MS	-	\$225,000
4.1.1b-3	Lot #3 - 25 sites (such as Radio Sites, Facilities, underground and vehicles)	MS	-	\$375,000
4.1.1c	Intermediate Design	MS	-	\$2,841,803
4.1.2a	Contractor's Final Design Submission	MS	-	\$1,000,000
4.1.2b	Final Approval Submission	MS	-	\$1,538,874
Phase 4.2 System Development, Factory Testing, Site Construction				
Scope of Phase 4.2 - Development, customization, configuration, procurement of Stationary Equipment, and fabrication of materials for all equipment and software, and finalization of all test plans and procedures as described in the Design Criteria. Phase 4.2 shall also include construction at all communications sites (above and below ground), installation of in-building transmission lines, component testing, device testing, module testing, and factory acceptance testing of all subsystems.				
4.2.1	Integrated System Test Plan, Test procedures and Cutover Plan	MS	-	\$356,984

Item	Item Description	Method of Payment	Unit Price	Single Payment Amount Upon Completion of The Item*
4.2.2a	Complete Lot #1 Site Construction, at Bernal Heights, Twin Peaks (CRS), Forest Hill, Potrero and Flynn	MS	-	\$1,616,422
4.2.2b	Complete Lot #2 Site Construction, at Cable Car Barn, Scott, MME, Green and South Hill	MS	-	\$1,332,569
4.2.2c	Complete Lot #3 Site Construction, at Presidio, Woods and One Market Plaza	MS	-	\$1,116,979
4.2.2d	Complete Legacy Equipment Removal, Disposal and Site Cleanup at Lenox Way, One Market Plaza, Bernal Heights, B of A at 555 California Street, Forest Hill, underground MUNI stations equipment room, Maintenance facilities and vehicles.	MS	-	\$375,000
4.2.3	Construction Below Ground	MS	-	
4.2.3a	Complete Lot #1 underground construction, at Embarcadero; Montgomery; Powell; Civic Center	MS	-	\$950,000
4.2.3b	Complete Lot #2 underground construction, at Van Ness; Church; Castro; Eureka	MS	-	\$950,000
4.2.3c	Complete Lot #3 construction, at Forest Hill; West Portal; East Portal; Carl Street Substation and Testing	MS	-	\$1,239,084
4.2.4a	Factory Integration	MS	-	\$4,246,794
4.2.4b	Equipment Delivery to SFMTA	MS	-	\$4,246,794

Item	Item Description	Method of Payment	Unit Price	Single Payment Amount Upon Completion of The Item*
4.2.4c	SFMTA's acceptance of the Mini- Fleet Test Report in Phase	MS	-	\$8,493,587
4.2.5a	Factory Acceptance Test - Radio System Test	MS	-	\$375,523
4.2.5b	Factory Acceptance Test - BDA Tunnel Equipment Test	MS	-	\$375,523
4.2.5c	Factory Acceptance Test - CAD/AVL Test	MS	-	\$375,523
4.2.5d	Final Integrated FAT	MS	-	\$1,000,000
Phase 4.3 Equipment Installation, System Configuration and Training Program Planning				
Scope of Phase 4.3 - Delivery, installation, configuration, and testing of all Stationary Equipment at the SFMTA and City sites. The Training Plan shall be finalized, including the Draft Training Schedule, Draft Training Manuals, and Draft Training Agendas.				
4.3.1a	Lot #1: Microwave link to CRS, Potrero, Flynn, Cable Car Barn, Scott, Green, Presidio, MME and Woods	MS	-	\$1,900,000
4.3.1b	Lot #2: Bernal Heights, Forest Hill, CRS and One Market Plaza	MS	-	\$1,400,000
4.3.1c	Lot #3: Lenox Way, 1455 Market Street and CAD/AVL Equipment Install	MS	-	\$1,200,000
4.3.1d	Lot #4: South Hill and Underground Equipment Install	MS	-	\$721,640
4.3.2	Training plan (Final)	MS	-	\$75,654
4.3.3	Training Schedule (Draft)	MS	-	\$75,654
4.3.4	Training Manuals and Agendas (Draft)	MS	-	\$130,843

Item	Item Description	Method of Payment	Unit Price	Single Payment Amount Upon Completion of The Item*
Phase 4.4 Integrated System Testing				
Scope of Phase 4.4 - Includes the remainder of integrated system testing including but not limited to the Radio Coverage Acceptance Test, the Field Performance Test, and the Mini-Fleet Test as described in the Design Criteria for the Project. Phase 4.4 shall also include finalization of all training documentation as described in the Design Criteria.				
4.4.1	Radio Coverage Acceptance Test Report	MS	-	\$878,780
4.4.2	Field Performance Test Report	MS	-	\$913,024
4.4.3	Mini-Fleet Test Report	MS	-	\$347,212
4.4.4	Training Schedule (Final)	MS	-	\$14,121
4.4.5	Training Manuals and Agendas (Final)	MS	-	\$112,961
4.4.6	Database Dictionary and User Manuals	MS	-	\$42,364
Phase 4.5 Training, System Cutover and Availability Demonstration				
Scope of Phase 4.5 - Includes but is not limited to training of SFMTA staff, installation of mobile equipment on SFMTA's fleet of revenue and non-revenue vehicles, and distribution of portable equipment. Phase 4.5 shall also include delivery of all as-built versions of maintenance manuals and as-built system documentation. Phase 4.5 shall conclude with the System Availability Test and submittal of the test report.				
4.5.1	Completion of the training Program	MS	-	\$1,029,786
4.5.2	Installation of Mobile Equipment in all revenue and non revenue vehicles	Unit Price		
4.5.2 a	<i>Configuration A mobile radio</i>	100	\$4,991.94	\$499,194

Item	Item Description	Method of Payment	Unit Price	Single Payment Amount Upon Completion of The Item*
4.5.2 b	<i>Configuration B mobile radio</i>	90	\$6,053.68	\$544,831
4.5.2 c	<i>Configuration C mobile radio</i>	50	\$19,330.97	\$966,549
4.5.2 d	<i>Diesel Hybrid Electric, Orion, 30-foot.</i>	35	\$23,244.43	\$813,555
4.5.2 e	<i>Diesel Hybrid Electric, Orion, 40-foot.</i>	65	\$23,244.43	\$1,510,888
4.5.2 f	<i>Diesel, NABI, 40-foot</i>	55	\$23,244.43	\$1,278,444
4.5.2 g	<i>Diesel, Neoplan, 40-foot</i>	225	\$23,244.43	\$5,229,997
4.5.2 h	<i>Diesel, Neoplan, 60-foot</i>	150	\$23,281.93	\$3,492,290
4.5.2 i	<i>Diesel, Gillig, 40-foot</i>	60	\$23,244.43	\$1,394,666
4.5.2. j	<i>Diesel, NewFlyer, 60-foot</i>	10	\$23,281.93	\$232,819
4.5.2. k	<i>ETI, 40-foot</i>	275	\$23,454.43	\$6,449,968
4.5.2 l	<i>ETI, 60-foot</i>	45	\$23,454.43	\$1,055,449
4.5.2 m	<i>NewFlyer, 60-foot</i>	75	\$23,454.43	\$1,759,082
4.5.2 n	<i>Breda Light Rail Vehicles</i>	160	\$30,582.67	\$4,893,227
4.5.2 o	<i>Light Rail Vehicle Digital Visual and Announcement System</i>	160	\$10,961.83	\$1,753,893
4.5.2 p	<i>St. Louis Car, SEPTA PCC Style</i>	20	\$6,128.68	\$122,574

Item	Item Description	Method of Payment	Unit Price	Single Payment Amount Upon Completion of The Item*
4.5.2 q	<i>Double-Ended PCC Style</i>	10	\$7,403.56	\$74,036
4.5.2 r	<i>Muni PCC 1 (1040) Style</i>	2	\$6,128.68	\$12,257
4.5.2 s	<i>St. Louis Car, NJT Newark PCC Style</i>	12	\$6,128.68	\$73,544
4.5.2 t	<i>Fiat/Breda, Milan PW Style</i>	15	\$6,128.68	\$91,930
4.5.2 u	<i>Vintage Style</i>	15	\$6,128.68	\$91,930
4.5.2 v	<i>Powell Street Style</i>	35	\$2,205.72	\$77,200
4.5.2 w	<i>California Street Style</i>	15	\$2,205.72	\$33,086
4.5.2 x	<i>Cubic Farebox Interface to MTMS</i>	1055	\$616.11	\$650,000
4.5.3	Configuration and distribution of all Portable Equipment	Unit Price		
4.5.3 a	<i>Portable Tier I P25</i>	525	\$2,701.28	\$1,418,172
4.5.3 b	<i>Portable Tier II P25</i>	30	\$2,701.28	\$81,038
4.5.3 c	<i>Portable Tier III P25</i>	20	\$2,872.16	\$57,443
4.5.4	All As Built H/W Documentation, S/W Documentation & Maint. Manuals	LS	-	\$1,769,267
4.5.5	Deliv. Of all Program Source Code; execution of S/W Escrow Agreement	LS	-	\$772,284
4.5.6	System Availability Test Report and Punchlist Items	MS	-	\$2,660,322

Item	Item Description	Method of Payment	Unit Price	Single Payment Amount Upon Completion of The Item*
Two years of Warranty Support for MTMS and PSVRN				
W1	First Quarter of First Year Warranty	LS	-	\$242,914
W2	Second Quarter of First Year Warranty	LS	-	\$242,914
W3	Third Quarter of First Year Warranty	LS	-	\$242,914
W4	Forth Quarter of First Year Warranty	LS	-	\$242,914
W5	First Quarter of Second Year Warranty	LS	-	\$242,914
W6	Second Quarter of Second Year Warranty	LS	-	\$242,914
W7	Third Quarter of Second Year Warranty	LS	-	\$242,914
W8	Forth Quarter of Second Year Warranty	LS	-	\$242,914
Base System Spare Parts				
Base System Spare Parts		Unit Price	-	\$896,313
Optional Services Items				
Optional Services Items		Lump Sum or Unit Price	-	Per Agreed Schedule of Costs
Allowance				\$925,000

Item	Item Description	Method of Payment	Unit Price	Single Payment Amount Upon Completion of The Item*
Grand Total - Base Bid				\$86,648,058
*	Assume all work is completed as described in Design Criteria package. Where there are discrepancies between Part 1 and Part 2 in terms of dollar amounts, Part 1 shall govern.			

Cost Summary

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
Phase 4.1 Design Engineering Services					
Scope - Design engineering services for the complete Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) and all other related components as described in Appendix 12 Technical Specifications.					
1	4.1.1 - Intermediate (65%) Design	-	LS	-	\$4,591,803
2	4.1.2 - Final (100%) Design	-	LS	-	\$2,538,874
3	Total Phase 4.1				\$7,130,677
Phase 4.2 - System Development, Factory Testing, Site Construction					
Scope - Development, customization, configuration, procurement of Stationary Equipment, and fabrication of materials for all equipment and software, and finalization of all test plans and procedures as described in the Design Criteria. Phase 4.2 shall also include construction at all communications sites (above and below ground), installation of in-building transmission lines, component testing, device testing, module testing, and factory acceptance testing of all subsystems.					
4	4.2.1 - Integrated System Test Plan, Test Procedures, and Cutover Plan.	-	LS	-	\$356,984
5	4.2.2 - Site Construction Above Ground	Worksheet A - Construction, Line 16			\$4,440,970

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
6	4.2.3 - Installation and testing of all in-building/below ground transmission lines.	Worksheet A - Construction, Line 26			\$3,139,084
7	4.2.4 - Procurement of Stationary Equipment.	Worksheet B -Stationary Equip., Line 10			\$16,987,174
8	4.2.5 - Factory Acceptance Testing including all pre-requisite testing.	-	MS	-	\$2,126,568
9	Total Phase 4.2				\$27,050,779
Phase 4.3 - Equipment Installation, System Configuration, and Training Program Planning					
Scope - Delivery, installation, configuration, and testing of all Stationary Equipment at the SFMTA and City sites. The Training Plan shall be finalized, including the Draft Training Schedule, Draft Training Manuals, and Draft Training Agendas.					
10	4.3.1 - Installation, configuration, and functional testing of all Stationary Equipment at all City sites	Worksheet B -Stationary Equip., Line 19			\$5,396,640
11	4.3.2 - Training Plan (Final)	-	LS	-	\$75,654
12	4.3.3 - Training Schedule (Draft)	-	LS	-	\$75,654
13	4.3.4 - Training Manuals and Agendas (Draft)	-	LS	-	\$130,843

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
14	Total Phase 4.3				\$5,678,791
Phase 4.4 - Integrated System Testing					
Scope - Includes the remainder of integrated system testing including but not limited to the Radio Coverage Acceptance Test, the Field Performance Test, and the Mini-Fleet Test as described in the Design Criteria for the Project. Phase 4.4 shall also include finalization of all training documentation as described in the Design Criteria.					
15	Phase 4.4.1 - Radio Coverage Acceptance Test Report	-	LS	-	\$878,780
16	Phase 4.4.2 - Field Performance Test Report	-	LS	-	\$913,024
17	Phase 4.4.3 - Mini-Fleet Test Report	-	LS	-	\$347,212
18	Phase 4.4.4 - Training Schedule (Final)	-	LS	-	\$14,121
19	Phase 4.4.5 - Training manuals and agendas (Final)	-	LS	-	\$112,961
20	Phase 4.4.6 - Database Dictionary and User Manuals	-	LS	-	\$42,364
21	Total Phase 4.4				\$2,308,462
Phase 4.5 - Training, System Cutover, and Availability Demonstration					

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
Scope - Includes but is not limited to training of SFMTA staff, installation of mobile equipment on SFMTA’s fleet of revenue and non-revenue vehicles, and distribution of portable equipment. Phase 4.5 shall also include delivery of all as-built versions of maintenance manuals and as-built system documentation. Phase 4.5 shall conclude with the System Availability Test and submittal of the test report.					
22	Phase 4.5.1 - Completion of the training program	-	LS	-	\$1,029,786
23	Phase 4.5.2 - Installation of mobile equipment in all revenue and non-revenue vehicles	Worksheet C - Subscriber Equip, Line 33			\$33,101,421
24	Phase 4.5.3 - Configuration and distribution of all portable equipment	Worksheet C - Subscriber Equip, Line 4			\$1,556,651
25	Phase 4.5.4 - All As-Built H/W documentation, S/W documentation, and Maint. Manuals	-	LS	-	\$1,769,267
26	Phase 4.5.5 - Deliv. of all Program Source Code; execution of the S/W Escrow Agreement	-	LS	-	\$772,284
27	Phase 4.5.6 - System Availability Test report		MS		\$2,660,322
28	Total Phase 4.5				\$40,889,731
29	Total Cost - Complete MTMS and PSVRN Systems (sum of lines 3, 9, 14, 21, and 28)				\$83,058,440

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
Warranty					
30	Two (2) years of Warranty Support for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with six (6) 800 MHz MTMS data/voice channels and nine (9) 700 MHz P-25 compliant PSVRN voice channels (See Document 00835 Warranty and Maintenance).	1	LS	\$1,943,310.55	\$1,943,311
31	Intentionally Left Blank				
32	Total Warranty				\$1,943,311
Base System Spare Parts					
33	Total Spare Parts			Worksheet D - Spare Parts, Line 16	\$896,313
Allowance Items					
34	Allowance for use by the City to address unforeseen site construction and fixed-equipment installation issues. Work shall be ordered in writing by the Engineer by means of a written Change Order. No extra work shall be performed or expenses incurred that have not been authorized by a written change order. Work that has not been so authorized will not be paid for.	-	LS	-	\$250,000

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
35	Allowance for use by the City to address unforeseen vehicle equipment installation issues. Work shall be ordered in writing by the Engineer by means of a written Change Order. No extra work shall be performed or expenses incurred that have not been authorized by a written change order. Work that has not been so authorized will not be paid for.	-	LS	-	\$250,000
36	Allowance for use by the City to address other issues including reimbursable expenses, community relations, traffic control, or other services. Work shall be ordered in writing by the Engineer by means of a written Change Order. No extra work shall be performed or expenses incurred that have not been authorized by a written change order. Work that has not been so authorized will not be paid for.	-	LS	-	\$250,000
36a	Grand Total - Base Bid				\$86,648,063
Optional Services Items					
34	Total Optional Services Items	Worksheet E - Options, Line 25			\$21,864,701
Allowance Items					

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
35	Grand Total – Complete MTMS and PSVRN Systems, Two (2) Year Warranty, Spare Parts and allowances(line 38)				\$108,512,764
Optional Services Items(sum of lines 29, 32, 33, and 34)					
<i>Note 1: Total Payment upon completion of Phase 4.3 shall not exceed Thirty Seven Percent (37%) of Line #39 Grand Total</i>					
<i>Note 2: Total Payment upon completion of Phase 4.4 shall not exceed Sixty Percent (60%) of Line #39 Grand Total</i>					

Worksheet A - Construction					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
Above Ground Construction					
1	For Line 1, Worksheet B Stationary Equipment, Construction at the Bernal Heights prime communications site, including all other interim network locations required to connect to the facility.	1	LS	\$313,741.32	\$313,741.32
2	For Line 1, Worksheet B Stationary Equipment, Construction at the Forest Hill communications site.	1	LS	\$793,101.51	\$793,101.51
3	For Line 1, Worksheet B Stationary Equipment, Construction at the CRS Twin Peaks communications site.	1	LS	\$421,280.00	\$421,280.00
4	For Line 1, Worksheet B Stationary Equipment, Construction at the One Market Plaza communications site.	1	LS	\$897,710.75	\$897,710.75
5	For Line 1, Worksheet B Stationary Equipment, Construction at the South Hill communications site.	1	LS	\$984,812.07	\$984,812.07
6	Intentionally Left Blank				

Worksheet A - Construction					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
7	Construction at the Lenox Way Operations Control Center communications site. Add Interoperability Gateway	1	LS	\$121,724.00	\$121,724.00
8	Intentionally Left Blank				
9	For Line 2, Worksheet B Stationary Equipment, construction at the Bernal Heights communications site, including all other interim network locations required to connect to the facility.	-	LS	-	
10	For Line 2, Worksheet B Stationary Equipment, construction at the Forest Hill communications site.	-	LS	-	
11	For Line 2, Worksheet B Stationary Equipment, construction at the CRS Twin Peaks communications site.	-	LS	-	
12	For Line 2, Worksheet B Stationary Equipment, construction at the One Market Plaza communications site.	-	LS	-	
13	For Line 2, Worksheet B Stationary Equipment, construction at the South Hill communications site.	-	LS	-	
14	Intentionally Left Blank				

Worksheet A - Construction					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
15	Construction at all SFMTA vehicle maintenance facilities including Scott, Cable Car, Potrero, Woods, Muni Metro East, Green, Presidio, and Flynn Divisions.	1	LS	\$908,599.88	\$908,599.88
	Potrero				\$105,946.64
	Muni Metro East				\$96,105.91
	Presidio				\$115,191.72
	Green				\$146,548.75
	Woods				\$107,352.46
	Flynn				\$107,352.46
	Cable Car Barn				\$119,111.35
	Scott				\$110,990.93
16	Total Above Ground Construction				\$4,440,969.52
In-Building/Below-Ground Construction					

Worksheet A - Construction					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
17	For Line 1, Worksheet B Stationary Equipment, Construction for in-building communications equipment in all underground rail tunnels, and platforms, with the exception of radiating transmission line.	1	LS	\$1,050,286.00	\$1,050,286.00
18	See worksheet E Line 26	-	LS	-	
19	For Line 1, Worksheet B Stationary Equipment, Construction for in-building communications equipment in all surface street tunnels, with the exception of radiating transmission line.	-	LS	-	
20	For Line 2, Worksheet B Stationary Equipment, Construction for in-building communications equipment in all surface street tunnels, with the exception of radiating transmission line.	-	LS	-	
21	Supply, installation, and testing of radiating transmission line throughout all underground rail tunnels, platforms, and storage tracks.	1	LS	\$2,088,798.00	\$2,088,798.00
22	Intentionally Left Blank				
23	Intentionally Left Blank				

Worksheet A - Construction					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
24	Intentionally Left Blank				
25	Intentionally Left Blank				
26	Total In-Building/Below-Ground Construction				\$3,139,084.00

Worksheet B – Stationary Equipment					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
Stationary Equipment Procurement					
1	<p>Procurement of all fixed-end equipment and material for a complete Multimodal Transit Management System (MTMS) including six (6) 800 MHz MTMS transit data/voice channels and nine (9) P-25 compliant PSVRN 700 MHz voice channels. Includes equipment and material for all surface street tunnels, underground rail tunnels, platforms, fixed guide ways, vehicle maintenance facilities, and all other associated components.</p> <p>****Note: Do not include supply of radiating transmission line throughout all surface street tunnels, underground rail tunnels, platforms, and storage tracks. This cost for this is allocated on Worksheet A. Do not include individual line items listed below.</p>				
	P25 Network Switch & RSM				\$1,445,696
	Secondary RSM				\$237,439
	P25 Simulcast Equipment				\$200,046
	ISSI Server & Software				\$301,088
	CAD/AVL Network Equipment				\$3,132,453
	Logging Recorder				\$236,000

Worksheet B – Stationary Equipment					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
	Network Security Servers/Firewalls				\$1,067,082
	Desktop Stations/Tunnel Alarm Radios (Qty 30)				\$223,029
	Microwave				\$193,753
	DC Power Equipment				\$363,494
	System Equipment				\$7,400,080
P25 Site Equipment					
	9 P25 Base Stations				\$367,172
	Common Simulcast Equipment				\$74,963
	Intermodulation Study				\$33,906
Open Sky Equipment					
	3 Open Sky Base Stations				\$206,078
	Open Sky Licenses				\$61,451

Worksheet B – Stationary Equipment					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
	Antenna Equipment				\$78,625
	Security Router, Switch, Interface Equip				\$43,149
	CRS Site Total				\$865,344
P25 Site Equipment					
	9 P25 Base Stations				\$367,172
	Common Simulcast Equipment				\$75,695
	Intermodulation Study				\$33,906
	Antenna Equipment				\$78,625
	Security Router, Switch, Interface Equip				\$43,149
	Forest Hills Site Total				\$598,547
P25 Site Equipment					
	9 P25 Base Stations				\$367,172

Worksheet B – Stationary Equipment					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
	Common Simulcast Equipment				\$75,695
	Intermodulation Study				\$33,906
Open Sky Equipment					
	3 Open Sky Base Stations				\$206,078
	Open Sky Licenses				\$61,451
	Antenna Equipment				\$78,625
	Security Router, Switch, Interface Equip				\$43,149
	South Hill Site Total				\$866,077
P25 Site Equipment					
	9 P25 Base Stations				\$367,172
	Common Simulcast Equipment				\$75,463
	Intermodulation Study				\$33,906

Worksheet B – Stationary Equipment					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
Open Sky Equipment					
	3 Open Sky Base Stations				\$206,078
	Open Sky Licenses				\$61,451
	Antenna Equipment				\$78,625
	Security Router, Switch, Interface Equip				\$43,149
	One Market Plaza Site Total				\$865,845
Open Sky Equipment					
	1 Open Sky Base Stations				\$68,693
	Open Sky Licenses				\$20,484
	Antenna Equipment				\$6,798
	Security Router, Interface Equip				\$13,274
	Bernal Heights Site Total				\$109,249

Worksheet B – Stationary Equipment					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
	13 Dispatch Consoles				\$780,926
	Security Router, Interface Equip				\$19,768
	1455 Mkt Site Total				\$800,694
Vehicle Yard Equipment					
	12 RDL-3000 Sector Control Radios				\$182,556
	ClearviewPRO Network Server and Lics.				\$279,036
	17 Cisco Switches with Layer 3 routing				\$102,988
	Power Supplies, Modules				\$35,158
	21 Dispatch Consoles				\$1,261,496
	Vehicle Yards Site Total				\$1,861,234
	Site Equipment				\$5,966,990
	Underground Equipment				\$3,620,104

Worksheet B – Stationary Equipment					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
	12 BDA's; 24 Remote Repeater Units;				
	Antenna Kits; Combiners; Couplers				
Total Stationary Equipment Procurement					\$16,987,174
Stationary Equipment Installation, Configuration, and Testing					
2	Installation, configuration, and testing of all fixed-end equipment and material for a complete Multimodal Transit Management System (MTMS) including six (6) 800 MHz MTMS transit data/voice channels and nine (9) P-25 compliant PSVRN 700 MHz voice channels. Includes equipment and material for all surface street tunnels, underground rail tunnels, platforms, fixed guide ways, vehicle maintenance facilities, and all other associated components.				
Per Site					
	Bernal Heights				\$56,940.00
	Forest Hill				\$227,759.30
	CRS				\$398,578.78
	One Market Plaza				\$512,458.43

Worksheet B – Stationary Equipment					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
	South Hill				\$284,699.13
	Lenox Way				\$56,939.83
Per OCC					
	1455 Market Street				\$1,178,654.00
	CAD/AVL Equipment Install				\$1,479,059.71
	Microwave Link to CRS				\$130,961.00
	Underground Equipment Install - Headend Equip, Wallmount BDA's, Antennas				\$585,854.43
Per Yard					
	Potrero				\$56,522.17
	Muni Metro East				\$51,272.17
	Presidio				\$61,454.39

Worksheet B – Stationary Equipment					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
	Green				\$78,183.26
	Woods				\$57,272.17
	Flynn				\$57,272.17
	Cable Car Barn				\$63,545.50
	Scott				\$59,213.28
	Total Stationary Equipment Installation, Configuration, and Testing				\$5,396,639.75

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
Portable Subscriber Units								
1	Supply and programming of Portable Tier I P25 compliant equipment for transit and PSVRN users, including antenna and battery (see Appendix 12 Section 2.7).	525	EA	\$2,620.28	\$81.00	\$2,701	\$1,418,169	Harris P7300 radio
2	Supply and programming of Portable Tier II P25 compliant equipment for transit and PSVRN users, including antenna and battery (see Appendix 12 Section 2.7).	30	EA	\$2,620.28	\$81.00	\$2,701	\$81,038	Harris P7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
3	Supply and programming of Portable Tier III P25 compliant equipment for transit and PSVRN users, including antenna and battery (see Appendix 12 Section 2.7).	20	EA	\$2,791.16	\$81.00	\$2,872	\$57,443	Harris P7300 radio
4	Total Portable Subscriber Units				\$1,556,651			
Non-Revenue Vehicle Equipment and Installation								
5	Supply, installation, and SFMTA acceptance of mobile equipment in non-revenue vehicles, "Configuration A" (see Appendix 12, Section 3.2).	100	EA	\$4,398.59	\$593.37	\$4,992	\$499,196	Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
6	Supply, installation, and SFMTA acceptance of mobile equipment in non-revenue vehicles, "Configuration B" (see Appendix 12, Section 3.2).	90	EA	\$5,122.83	\$930.87	\$6,054	\$544,832	Harris M7300 radio
7	Supply, installation, and SFMTA acceptance of mobile equipment in non-revenue vehicles, "Configuration C" (see Appendix 12, Section 3.2).	50	EA	\$18,056.05	\$1,274.92	\$19,331	\$966,549	
7a	CAD/AVL on-board equipment			\$8,783.79	\$253.47			ACS Equipment
7b	Mobile Radio			\$3,918.48	\$1,021.45			Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
7c	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				MAR
7d	Bulk Data Transfer on-board equipment - Radio			\$2,756.07				Harris 4.9GHz radio
8	Total Non-Revenue Vehicle Equipment and Installation						\$2,010,576	
Revenue Vehicle Equipment and Installation								

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
9	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS equipment (see Appendix 12 Section 3.2) in motor coaches of type: Diesel Hybrid Electric, Orion, 30-foot.	35	EA	\$21,789.64	\$1,454.80	\$23,244	\$813,555	
9a	CAD/AVL on-board equipment			\$12,639.44	\$137.10			ACS Equipment
9b	Mobile Radio			\$3,796.42	\$1,317.70			Harris M7300 radio
9c	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
9d	Bulk Data Transfer on-board equipment			\$2,756.07				Harris 4.9GHz radio
10	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS equipment (see Appendix 12 Section 3.2) in motor coaches of type: Diesel Hybrid Electric, Orion, 40-foot.	65	EA	\$21,789.64	\$1,454.80	\$23,244	\$1,510,888	
10a	CAD/AVL on-board equipment			\$12,639.44	\$137.10			ACS Equipment
10b	Mobile Radio			\$3,796.42	\$1,317.70			Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
10c	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				MAR
10d	Bulk Data Transfer on-board equipment			\$2,756.07				Harris 4.9GHz radio
11	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS equipment (see Appendix 12 Section 3.2) in motor coaches of type: Diesel, NABI, 40-foot.	55	EA	\$21,789.64	\$1,454.80	\$23,244	\$1,278,444	
11a	CAD/AVL on-board equipment			\$12,639.44	\$137.10			ACS Equipment
11b	Mobile Radio			\$3,796.42	\$1,317.70			Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
11c	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				MAR
11d	Bulk Data Transfer on-board equipment			\$2,756.07				Harris 4.9GHz radio
12	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS equipment (see Appendix 12 Section 3.2) in motor coaches of type: Diesel, Neoplan, 40-foot.	225	EA	\$21,789.64	\$1,454.80	\$23,244	\$5,229,999	
12a	CAD/AVL on-board equipment			\$12,639.44	\$137.10			ACS Equipment
12b	Mobile Radio			\$3,796.42	\$1,317.70			Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
12c	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				MAR
12d	Bulk Data Transfer on-board equipment			\$2,756.07				Harris 4.9GHz radio
13	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS equipment (see Appendix 12 Section 3.2) in motor coaches of type: Diesel, Neoplan, 60-foot.	150	EA	\$21,789.64	\$1,492.30	\$23,282	\$3,492,291	
13a	CAD/AVL on-board equipment			\$12,639.44	\$137.10			ACS Equipment
13b	Mobile Radio			\$3,796.42	\$1,355.20			Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
13c	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				MAR
13d	Bulk Data Transfer on-board equipment			\$2,756.07				Harris 4.9GHz radio
14	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS equipment (see Appendix 12 Section 3.2) in motor coaches of type: Diesel, Gillig, 40-foot.	60	EA	\$21,789.64	\$1,454.80	\$23,244	\$1,394,666	
14a	CAD/AVL on-board equipment			\$12,639.44	\$137.10			ACS Equipment
14b	Mobile Radio			\$3,796.42	\$1,317.70			Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				MAR
	Bulk Data Transfer on-board equipment			\$2,756.07				Harris 4.9GHz radio
15	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS equipment (see Appendix 12 Section 3.2) in motor coaches of type: Diesel, NewFlyer, 60-foot.	10	EA	\$21,789.64	\$1,492.30	\$23,282	\$232,819	
	CAD/AVL on-board equipment			\$12,639.44	\$137.10			ACS Equipment
	Mobile Radio			\$3,796.42	\$1,355.20			Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				MAR
	Bulk Data Transfer on-board equipment			\$2,756.07				Harris 4.9GHz radio
16	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in electric trolley coaches of type: ETI, 40-foot.	275	EA	\$21,789.64	\$1,664.80	\$23,454	\$6,449,970	
	CAD/AVL on-board equipment			\$12,639.44	\$137.10			ACS Equipment
	Mobile Radio			\$3,796.42	\$1,527.70			Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				MAR
	Bulk Data Transfer on-board equipment			\$2,756.07				Harris 4.9GHz radio
17	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in electric trolley coaches of type: ETI, 60-foot.	45	EA	\$21,789.64	\$1,664.80	\$23,454	\$1,055,450	
	CAD/AVL on-board equipment			\$12,639.44	\$137.10			ACS Equipment
	Mobile Radio			\$3,796.42	\$1,527.70			Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				MAR
	Bulk Data Transfer on-board equipment			\$2,756.07				Harris 4.9GHz radio
18	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in electric trolley coaches of type: NewFlyer, 60-foot.	75	EA	\$21,789.64	\$1,664.80	\$23,454	\$1,759,083	
	CAD/AVL on-board equipment			\$12,639.44	\$137.10			ACS Equipment
	Mobile Radio			\$3,796.42	\$1,527.70			Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				MAR
	Bulk Data Transfer on-board equipment			\$2,756.07				Harris 4.9GHz radio
19	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in Breda Light Rail Vehicles.	160	EA	\$27,569.67	\$3,013.00	\$30,583	\$4,893,228	
	CAD/AVL on-board equipment			\$18,175.35	\$247.80			ACS Equipment
	Mobile Radio			\$4,040.54	\$2,765.20			Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
	Bulk Data Transfer on-board equipment - Mobile Access Router			\$2,597.71				MAR
	Bulk Data Transfer on-board equipment			\$2,756.07				Harris 4.9GHz radio
20	Supply, installation, and SFMTA acceptance of the Interim Light Rail Vehicle Digital Visual and Announcement System (see Appendix 12, Section 3, Appendix 22, and Appendix 23 Section 10).	160	EA		\$10,961.83	\$10,962	\$1,753,893	

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
21	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: St. Louis Car, SEPTA PCC Style.	20	EA	\$5,122.83	\$1,005.87	\$6,129	\$122,574	Harris M7300 radio
22	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: Double-Ended PCC Style.	10	EA	\$6,397.70	\$1,005.87	\$7,404	\$74,036	Harris M7300 radio with two control heads

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
23	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: Muni PCC 1 (1040) Style.	2	EA	\$5,122.83	\$1,005.87	\$6,129	\$12,257	Harris M7300 radio
24	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: St. Louis Car, NJT Newark PCC Style.	12	EA	\$5,122.83	\$1,005.87	\$6,129	\$73,544	Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
25	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: Fiat/Breda, Milan PW Style.	15	EA	\$5,122.83	\$1,005.87	\$6,129	\$91,930	Harris M7300 radio
26	Supply, installation, and SFMTA acceptance of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: Vintage Style.	15	EA	\$5,122.83	\$1,005.87	\$6,129	\$91,930	Harris M7300 radio

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
27	Supply, installation, and SFMTA acceptance of AVL equipment (see Appendix 12 Section 3.2) in Cable Cars of type: Powell Street Style.	35	EA		\$2,205.72	\$2,206	\$77,200	Install only
28	Supply, installation, and SFMTA acceptance of AVL equipment (see Appendix 12 Section 3.2) in Cable Cars of type: California Street Style.	15	EA		\$2,205.72	\$2,206	\$33,086	Install only
29	TransLink On-Board Interface to MTMS (Revenue Vehicles, see Appendix 12, Section 3)	1229	EA	Removed from Requirements				

Worksheet C: Subscriber Equipment Detail								
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot , MS = Milestone								
Item No.	Item Description	Estimated Quantity	Unit	Equipment (Unit Price)	Services (Unit Price)	Total Unit Price	Total Amount	Description of Equipment
30	Cubic Farebox Interface to MTMS (Revenue Vehicles, see Appendix 12, Section 3)	1	LS	\$650,000.00		\$650,000	\$650,000	
31	Traffic Signal Priority Equipment, Vehicle Subsystem (see Appendix 12 Section 3.2.28) (Part of TSP On-Board Equip Option)	20	EA	\$ -	\$ -	\$ -	\$ -	See Optional Pricing
32	Total Revenue Vehicle Equipment and Installation						\$31,090,844	
33	Total Non-Revenue and Revenue Vehicle Equipment and Installation (Line #8 Plus Line #32)					\$ -	\$33,101,421	

Worksheet D – Spare Parts					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
1	Mobile Voice Radio	44	EA	\$3,796.42	\$167,042.26
2	Mobile Data Radio (if applicable)				
3	Mobile Data Terminal	40	EA	\$3,103.83	\$124,153.36
4	Vehicle Logic Unit	36	EA	\$5,411.81	\$194,825.28
5	On-Board Electronic Sign	50	EA		CFE
6	On-Board Public Address Amplifier	36	EA	\$397.93	\$14,325.39
7	Complete set of revenue vehicle hardware including all equipment, cables, connectors, and brackets (assume for Transit Bus, 40 ft.)	6	EA	\$12,667.83	\$76,006.95
8	Complete set of revenue vehicle hardware including all equipment, cables, connectors, and brackets, Light Rail Vehicle	2	EA	\$30,111.37	\$60,222.75

Worksheet D – Spare Parts					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
9	Complete set of non-revenue vehicle hardware including all equipment, cables, connectors, and brackets (assume for sedan)	3	EA	\$8,950.54	\$26,851.61
10	Dispatch Voice Radio Console, including all hardware, software, and applicable software licenses.	2	EA	\$52,901.89	\$105,803.78
11	Dispatch CAD/AVL Console, including all hardware, software, and applicable software licenses.	3	EA	\$12,844.13	\$38,532.38
12	CAD/AVL software license, read-only	5	EA	\$7,160.42	\$35,802.10
13	Portable Radio, Tier I, P25 compliant, including antenna and battery	16	EA	\$2,620.28	\$41,924.40
14	Portable Radio, Tier II, P25 compliant, including antenna and battery	2	EA	\$2,620.28	\$5,240.55
15	Portable Radio, Tier III, P25 compliant, including antenna and battery	2	EA	\$2,791.16	\$5,582.33
16	Total Spare Parts				\$896,313.13

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
1	Over the Air Programming for portable radios (see Appendix 12 Section 2.17) VALID FOR 365 DAYS FROM NTP				
2	Over the Air Re-keying for portable radios (see Appendix 12 Section 2.17) VALID FOR 365 DAYS FROM NTP	50	EA	\$685.00	\$34,250.00
2a	KMF Server required for OTAP VALID FOR 365 DAYS FROM NTP	1	LS	\$85,472.23	\$85,472.23
3	Encryption – Subscriber to Subscriber (see Appendix 12 Section 2.17) VALID FOR 365 DAYS FROM NTP	50	EA	\$671.25	\$33,562.50
4	Intrinsically safe portable radio, Tier II (see Appendix 12 Section 2.17) VALID FOR 365 DAYS FROM NTP	25	EA	\$2,689.44	\$67,236.09

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
5	Automatic Passenger Counting System Interface (see Appendix 12 Section 3.3) VALID FOR 180 DAYS FROM NTP	250	EA	\$398.39	\$99,597.26
6	Track Layout and Turnaround Layer (see Appendix 12 Section 3.3) VALID FOR 180 DAYS FROM NTP	1	LS	\$192,891.35	\$192,891.35
7	Headway Control (see Appendix 12 Section 3.3) VALID FOR 180 DAYS FROM NTP	1	LS	\$499,481.09	\$499,481.09
8	“Crush-Load” Detection with Wheelchair Priority Pickup (see Appendix 12 Section 3.3) VALID FOR 180 DAYS FROM NTP	1	LS	\$223,753.01	\$223,753.01
9	Capture Vehicle Load Using Real-Time Automatic Passenger Count Input (see Appendix 12 Section 3.3) VALID FOR 180 DAYS FROM NTP	250	EA	\$57.44	\$14,361.20

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
10	Predictive Arrival and Departure Information System (see Appendix 12 Section 3.3) VALID FOR 180 DAYS FROM NTP	390	LS	\$3,018.90	\$1,177,371.18
11	Predictive Subsystem and Web Services API (see Appendix 12 Section 3.3) VALID FOR 180 DAYS FROM NTP	1	LS	\$154,313.08	\$154,313.08
12	Mobile Dispatch Computers (see Appendix 12 Section 3.3) VALID FOR 365 DAYS FROM NTP	30	EA	\$11,226.78	\$336,803.47
13	MTMS Development Environment (see Appendix 12 Section 3.3) VALID FOR 180 DAYS FROM NTP	1	EA	\$65,320.59	\$65,320.59
14	Yard Management System for 995 vehicles (see Appendix 12 Section 3.3) at the following vehicle maintenance facilities - Potrero, Muni Metro East, Presidio, Green, Woods, Flynn, and Islais Creek (planned) VALID FOR 180 DAYS FROM NTP	995	EA	\$4,271.70	\$4,250,344.89

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
15	Construction at Lenox Way Operations Control Center - Added Dispatch Furniture & Qty 5 Dispatch Workstations; VALID FOR 180 DAYS FROM NTP	1	LS	\$1,335,761.51	\$1,335,761.51
16	Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with six (6) 800 MHz MTMS data/voice channels and nine (9) 700 MHz P-25 compliant PSVRN voice channels. – Year 1 VALID FOR 365 DAYS FROM NTP	1	LS	\$1,112,146.86	\$1,112,146.86
17	Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with six (6) 800 MHz MTMS data/voice channels and nine (9) 700 MHz P-25 compliant PSVRN voice channels. – Year 2 VALID FOR 365 DAYS FROM NTP	1	LS	\$1,163,030.44	\$1,163,030.44

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
18	Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with six (6) 800 MHz MTMS data/voice channels and nine (9) 700 MHz P-25 compliant PSVRN voice channels. – Year 3 VALID FOR 365 DAYS FROM NTP	1	LS	\$1,216,269.93	\$1,216,269.93
19	Three (3) Year Extended Support Program for nine (9) additional P-25 compliant 700 MHz PSVRN voice channels. – Year 1 (See Document 00835 Warranty and Maintenance). VALID FOR 365 DAYS FROM NTP	1	LS	\$157,437.27	\$157,437.27
20	Three (3) Year Extended Support Program for nine (9) additional P-25 compliant 700 MHz PSVRN voice channels. – Year 2 (See Document 00835 Warranty and Maintenance). VALID FOR 365 DAYS FROM NTP	1	LS	\$163,734.74	\$163,734.74

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
21	Three (3) Year Extended Support Program for nine (9) additional P-25 compliant 700 MHz PSVRN voice channels. – Year 3 (See Document 00835 Warranty and Maintenance). VALID FOR 365 DAYS FROM NTP	1	LS	\$170,284.03	\$170,284.03
22	Logging Recorder: Additional "Hindsight-P25/OpenSky Recorder Assistant" licenses for Exacom logging recorder for remote viewing of the recorder only. VALID FOR 180 DAYS FROM NTP	1	LS	\$12,475.00	\$12,475.00
23	Logging Recorder: Upgrade from Exacom fault-tolerant to Exacom redundant logging recorder. Equipment only cost. VALID FOR 180 DAYS FROM NTP	1	LS	\$50161.95	\$50,161.95
24	Logging Recorder: Enable Recording of Encrypted Call on Exacom VALID FOR 180 DAYS FROM NTP	1	LS	\$14,996.25	\$14,996.25

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
25	Logging Recorder: A turnkey NICE logging recorder installation with 3rd party storage and server hardware VALID FOR 180 DAYS FROM NTP	1	LS	\$818,300.01	\$818,300.01
26	Islais Creek Site Work/Data Equipment/Console VALID FOR 180 DAYS FROM NTP	1	LS	\$120,092.00	\$120,092.00
27	Kirkland Yard Site Work/Data Equipment/Console VALID FOR 180 DAYS FROM NTP	1	LS	\$120,092.00	\$120,092.00
28	Supply, installation, and testing of radiating transmission line throughout the Stockton Tunnel VALID FOR 180 DAYS FROM NTP	1	LS	\$593,791.75	\$593,791.75
29	Supply, installation, and testing of radiating transmission line throughout the Yerba Buena Tunnel VALID FOR 180 DAYS FROM NTP	1	LS	\$623,726.36	\$623,726.36

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
30	Supply, installation, and testing of radiating transmission line throughout the Broadway Tunnel VALID FOR 180 DAYS FROM NTP	1	LS	\$665,715.86	\$665,715.86
31	Supply, installation, and testing of radiating transmission line throughout the MacArthur Tunnel VALID FOR 180 DAYS FROM NTP	1	LS	\$638,692.85	\$638,692.85
32	BDA for Cable Car Barn VALID FOR 180 DAYS FROM NTP	1	LS	\$327,879.41	\$327,879.41
33	Traffic Signal Priority Pilot System VALID FOR 45 DAYS FROM NTP	1	LS	\$850,631.09	\$850,631.09
33a	- Traffic Signal Priority 6 intersection pilot with management server and construction	1	LS	\$616,459.00	
33b	- Traffic Signal Priority System - D4 Protocol	1	LS	\$175,717.50	

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
33c	- TSP Onboard Equipment - Full On Board (Qty 20 Vehicles)	20	LS	\$58,454.59	
34	South Hill Tower Replacement VALID FOR 90 DAYS FROM NTP	1	LS	\$114,720.00	\$114,720.00
35	312 Strand Fiber Option for Market Street Tunnel VALID FOR 90 DAYS FROM NTP	1	LS	\$774,690.00	\$774,690.00
36	PERS Option VALID FOR 90 DAYS FROM NTP	1	LS	\$4,061,867.78	\$4,061,867.78
36a	- Procurement of equipment for eight (8) additional 700 MHz P-25 compliant PSVRN channels. PERS	1	LS	\$1,916,250.00	
36b	- Installation, configuration, and testing of all equipment for eight (8) additional 700 MHz P-25 compliant PSVRN channels at all RF sites. PERS	1	LS	\$300,584.00	

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
36c	- Tunnel equipment for eight (8) additional 700 MHz P-25 compliant PSVRN channels in all underground rail tunnels and platforms with the exception of radiating transmission line. PERS	1	LS	\$287,879.00	
36d	- Install Tunnel equipment for eight (8) additional 700 MHz P-25 compliant PSVRN channels in all underground rail tunnels and platforms with the exception of radiating transmission line. PERS	1	LS	\$285,503.50	
36e	- Two (2) years of Warranty Support for eight (8) additional 700 MHz P-25 compliant PSVRN voice channels (See Document 00835 Warranty and Maintenance). PERS	1	LS	\$284,505.00	
36f	- PERS Professional Services	1	LS	\$987,146.28	
37	McLaren Park Clean-Up VALID FOR 365 DAYS FROM NTP	1	LS	\$25,500.00	\$25,500.00

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
38	NextBus System Interface VALID FOR 90 DAYS FROM NTP	1	LS	\$47,582.00	\$47,582.00
39	MTMS Option Transit Safe VALID FOR 90 DAYS FROM NTP	1	LS	\$61,177.00	\$61,177.00
40	MTMS Option Translink Interface VALID FOR 90 DAYS FROM NTP	1	LS	\$96,947.00	\$96,947.00
OPTIONAL DEDUCTIONS					
41	SFMTA provided fiber to feed the West End of Sunset Tunnel VALID FOR 90 DAYS FROM NTP	1	LS	\$(94,500.00)	\$(94,500.00)
42	SFMTA provided fiber to feed the East End of Sunset Tunnel VALID FOR 90 DAYS FROM NTP	1	LS	\$(94,500.00)	\$(94,500.00)
43	SFMTA to Increase Available Work Hours for Tunnel Installation VALID FOR 90 DAYS FROM NTP	1	LS	\$(337,500.00)	\$(337,500.00)

Worksheet E - Optional Services Items					
*****Note: Option prices shall cover all costs of the option work only and shall not include Base work. Option prices shall include all associated costs including design engineering and markups for overhead and profit.					
LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone					
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Total Amount
44	SFMTA provided Logging Recorder VALID FOR 90 DAYS FROM NTP	1	LS	\$(181,260.00)	\$(181,260.00)
Total Options					\$21,864,701.00

Fix End Equipment

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
1	1455 Market Street - Network Switching Center					
1.2	Network Switching Center					
1.2.1	Server, Network Switch (NSS), Primary	LS	1	\$390,423.07	\$390,423.07	Service, SyBase Software License, NSS, Harris SW licenses
1.2.2	Server, Regional VIDA Manager (RVM)	LS	1	\$91,635.00	\$91,635.00	Service, SyBase Sftwr License, RNM/CNM
1.2.3	Printer, Laser, Black/White, NSC	LS	1	\$690.15	\$690.15	
1.2.4	Server, Regional Site Mgr Professional	LS	1	\$55,125.00	\$55,125.00	License, Sql 2008 Enterprise Edition
1.2.5	Printer, Color Laser, 110V	LS	1	\$2,325.00	\$2,325.00	
1.2.6	Server, Transcoder	LS	1	\$46,901.25	\$46,901.25	
1.2.7	P25iP Simulcast Control Point System	LS	1	\$184,373.57	\$184,373.57	
1.2.8	Server,iSSI Gateway	LS	1	\$277,500.00	\$277,500.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
1.2.9	Router, Cisco, 2911, AC, Sec, w/Ether Switch	LS	1	\$7,250.00	\$7,250.00	
1.2.10	EthrSwth, L2, SM, 23FE, 1 GE, Cisco, SM-ES2-24	LS	1	\$2,200.00	\$2,200.00	
1.2.11	Router, Cisco ASR1001, AC Pwr,iP Bs, AdvIP	LS	1	\$77,150.00	\$77,150.00	
1.2.12	Switch, Cisco 3560X-48T-S, 48 Port	LS	1	\$18,500.00	\$18,500.00	
1.2.13	Server, Dell R610, SUMS Automation server	LS	1	\$13,050.00	\$13,050.00	
1.2.14	Cisco ASA5510	LS	1	\$11,850.00	\$11,850.00	
1.2.15	Unitrends DPU 720	LS	1	\$32,966.50	\$32,966.50	
1.2.16	Server, Dell R610, Active Directory Server	LS	1	\$17,011.00	\$17,011.00	
1.2.17	HIDS	LS	217	\$120.34	\$26,113.78	
1.2.18	LogLogic ST, for 3 year retention	LS	1	\$310,618.00	\$310,618.00	
1.2.19	LogLogic SEM	LS	1	\$36,611.00	\$36,611.00	

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
1.2.20	Quest 2-Factor VPN	LS	1	\$36,611.00	\$36,611.00	
1.2.21	IDS, SourceFire DC1000	LS	1	\$53,351.00	\$53,351.00	
1.2.22	IDS, SourceFire 3D2500	LS	1	\$80,917.00	\$80,917.00	
1.2.23	CiscoWorks	LS	1	\$13,050.00	\$13,050.00	
1.17	Radio Consoles					
1.17.1	Computer, MaestroIP, UNA Dispatch	EA	33	\$39,000.00	\$1,287,000.00	Total System Consoles. See Equipment Listing Attachment #3
1.17.2	Monitor, 19in Touch Capable	EA	33	\$1,143.75	\$37,743.75	
1.17.3	Speaker, Semi Rugged	EA	66	\$330.00	\$21,780.00	
1.17.4	Footswitch, Dual	EA	33	\$371.25	\$12,251.25	
1.17.5	Microphone, Gooseneck	EA	33	\$431.25	\$14,231.25	
1.17.6	License, Vocoder	EA	33	\$75.00	\$2,475.00	
1.17.7	Adapter, 6 Wire Jackbox to Headset	EA	33	\$592.50	\$19,552.50	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
1.17.8	Feature, C3 Gateway	EA	33	\$6,483.75	\$213,963.75	
1.17.9	Headset, Ear Bud Style	EA	25	\$461.25	\$11,531.25	
1.17.10	Headset, Over-the-Head Style	EA	25	\$461.25	\$11,531.25	
1.18	Logging Recorder					
1.18.1	Hindsight-Net XPlus/G2" Archival Digital Logging Recorder System with P25 and OpenSky-VNICintegration	LS	1	\$181,260.00	\$181,260.00	
1.18.2	120 Mixed-Ch Recorder w/DVD	LS	1	incl. above	incl. above	
1.18.3	Raid 5 Array Hard Drive	LS	1	incl. above	incl. above	
1.18.4	P25 PhaseIIinterface Module	LS	1	incl. above	incl. above	
1.18.5	OpenSky-VNICinterface Module	LS	1	incl. above	incl. above	
1.18.6	Recorder Assistant Playback License (optional)	LS	12	\$1,039.58	\$12,475.00	
1.18.7	Recording of AES encrypted voice (optional)	LS	1	\$24,993.75	\$24,993.75	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
1.18.8	Redundant Logging Recorder (optional)	LS	1	\$57,262.50	\$57,262.50	
2	Central Radio Station - Network Switching Center (Backup)					
2.1	Network Switching Center (Backup)					
2.1.1	Server, Network Switch (NSS), Secondary	LS	1	\$86,912.25	\$86,912.25	Service, SyBase Software License, NSS
2.1.2	Server, Regional VIDA Manager (RVM)	LS	1	\$91,635.00	\$91,635.00	Service, SyBase Sftwr License, RNM/CNM
2.1.3	Printer, Laser, Black/White, NSC	LS	1	\$690.15	\$690.15	
2.1.4	Server, Regional Site Mgr Professional	LS	1	\$55,125.00	\$55,125.00	License, Sql 2008 Enterprise Edition
2.1.5	Printer, Color Laser, 110V	LS	1	\$2,325.00	\$2,325.00	
2.1.6	Server, Transcoder	LS	1	\$2,325.00	\$2,325.00	
2.1.7	Router, Cisco, 2911, AC, Sec, w/EtherSwitch	LS	1	\$7,250.00	\$7,250.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
2.1.8	EthrSwth, L2, SM, 23FE, 1 GE, Cisco, SM-ES2-24	LS	1	\$2,200.00	\$2,200.00	
2.1.9	Router, Cisco ASR1001, AC Pwr,iP Bs, AdvIP	LS	1	\$77,150.00	\$77,150.00	
2.1.10	Switch, Cisco 3560X-48T-S, 48 Port	LS	1	\$18,500.00	\$18,500.00	
2.1.11	Cisco ASA5510	LS	1	\$11,850.00	\$11,850.00	
2.1.12	Unitrends DPU 720	LS	1	\$32,966.50	\$32,966.50	
2.1.13	Server, Dell R610, Active Directory Server	LS	1	\$17,011.00	\$17,011.00	
2.1.14	IDS, SourceFire 3D2500	LS	1	\$80,917.00	\$80,917.00	
3	Lenox Way					
	System Equipment,interop Gateway	LS	1	\$2,400.00	\$2,400.00	
	Service, P25 Vocoder License	LS	12	\$11.25	\$135.00	
	Software, UAC GWB	LS	1	\$75.00	\$75.00	
	Chassis, 4-Slotinteroperability Gateway	LS	1	\$11,812.50	\$11,812.50	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Power Supply, AC, 4-Slot Gateway Chassis	LS	1	\$1,537.50	\$1,537.50	
	Module, DVU, UAC, interoperability Gateway	LS	3	\$7,462.50	\$22,387.50	
	Cable, Ethernet, 6ft	LS	3	\$20.25	\$60.75	
	Cable, Audio, 4-Slot Chassis GWB, 10ft	LS	12	\$36.75	\$441.00	
	Panel, Filler	LS	3	\$116.25	\$348.75	
	Manual, instal, 4-Slot, intrperabilty Gtwy	LS	1	\$48.75	\$48.75	
	Rack, Open, 86in, Extra Deep	LS	1	\$1,537.50	\$1,537.50	
	Outlet Strip, 120VAC	LS	1	\$120.00	\$120.00	
	Router, 2921, AC, Security, w/Ether Switch	LS	1	\$8,769.00	\$8,769.00	
4a	CRS Site Equipment P25 Equipment					
	Simulcast, Common Equipment, P25T, MASTR V	LS	1	\$37,050.00	\$37,050.00	
	Network Sentry, P25 Simulcast	LS	1	\$25,901.25	\$25,901.25	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Kit, Cable, GPS Tx Site Common Equip	LS	1	\$82.50	\$82.50	
	Outlet Strip, 120VAC	LS	8	\$120.00	\$960.00	
	Power Supply, 120VAC, 60Hz, 12/24VDC	LS	1	\$701.25	\$701.25	
	Rack, Open, 86in, Extra Deep	LS	1	\$1,537.50	\$1,537.50	
	Fan, 120VAC, Extra Deep Cabinet	LS	1	\$637.50	\$637.50	
	Antenna, 1575.42MHz, Set	LS	2	\$405.00	\$810.00	
	Filter, Surge Protector, 800-2500MHz	LS	2	\$175.00	\$350.00	
	Cable, GPS Antenna, 50ft	LS	2	\$265.00	\$530.00	
	Cable, GPS Antenna, 50ft	LS	2	\$265.00	\$530.00	
	Station, MASTR V, P25T, 700MHz	LS	9	\$37,600.83	\$338,407.50	
	Router, 2921, AC, Security, w/Ether Switch	LS	2	\$8,769.00	\$17,538.00	
	Switch, Cisco 3560v2, DC	LS	2	\$9,723.68	\$19,447.36	
	Interface Card, 2-port 3rd Gen Wan	LS	1	\$2,784.00	\$2,784.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
4b	CRS Site Equipment Open Sky Base Stations					
	Station, SkyMASTR, 800MHz, 100W	LS	3	\$63,311.25	\$189,933.75	
4c	CRS Site Equipment Antenna Equipment					
	CRS M/C, Combiners, TTA, Base	LS	1	\$36,765.00	\$36,765.00	
	Omni, 9 dB gain, 4 deg. elect downtilt	LS	3	\$2,667.75	\$8,003.25	
	Power Sensor, 403-1000MHz	LS	2	\$477.00	\$954.00	
	Cable, RF Sensor, 30ft	LS	2	\$103.50	\$207.00	
	Tape, Vapor-Wrap, 3in, 50 ft Roll	LS	2	\$27.00	\$54.00	
	Kit, Antenna Side Mount, ASPR614	LS	3	\$450.00	\$1,350.00	
	Amplifier, Towertop, 806-824MHz, Test Port	LS	1	\$3,753.00	\$3, 53.00	
	Cable, 6ft, NM/NM, Jumper For 1/2in	LS	4	\$94.50	\$378.00	
	Connector, N Female, 1 5/8 Coax	LS	4	\$144.00	\$576.00	
	Kit, Grounding, W Gnd Lug, For 1 5/8in Ca	LS	8	\$31.50	\$252.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Cable, Coaxial, 1 5/8in, Low Loss Foam	LS	600	\$6.30	\$3,780.00	
	Kit, Coax Hoisting Grip, 1 5/8in	LS	4	\$49.50	\$198.00	
	Kit, Hanger, 1 5/8in Cable, Qty 10	LS	18	\$36.00	\$648.00	
	Kit, Angle Adapter, Qty 10	LS	18	\$76.50	\$1,377.00	
	Kit, Feedthru Boot, 1-5/8in	LS	2	\$22.50	\$45.00	
	Connector, N Female, For 7/8in Coax	LS	2	\$36.00	\$72.00	
	Kit, Grounding, CellFlex 7/8in 60in	LS	4	\$40.50	\$162.00	
	Cable, Coaxial, 7/8in, Low Loss Foam	LS	300	\$2.93	\$877.50	
	Kit, Hoisting Grip, 7/8in Cable	LS	2	\$27.00	\$54.00	
	Kit, Hanger, 7/8in Cable, Qty 10	LS	9	\$36.00	\$324.00	
	Kit, Angle Adapter, Qty 10	LS	9	\$76.50	\$688.50	
	Kit, Feedthru Boot, 7/8in	LS	1	\$27.00	\$27.00	
	Cable, Coaxial, 1/2in Superflex	LS	415	\$2.48	\$1,027.13	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Connector, N Male, 1/2in Coax	LS	9	\$36.00	\$324.00	
	Connector, N Female, 1/2in Coax	LS	3	\$40.50	\$121.50	
	Filter, 800-900MHz, N Male, Flange Mt, 750W	LS	2	\$216.00	\$432.00	
	Surge Port, 400-1200MHz, N-M to N-F, Flange	LS	1	\$189.00	\$189.00	
	Load, 50 Ohm, 1Watt, BNC	LS	5	\$9.00	\$45.00	
	Connector, BNC-M, 1/4in Coax, Shrink Sleeve	LS	19	\$76.50	\$1,453.50	
	Connector, N Male, Right Angle	LS	19	\$40.50	\$769.50	
	Connector, N Male, 1/2in Coax	LS	19	\$36.00	\$684.00	
	Cable, Coaxial, 1/4in Cellflex	LS	285	\$1.76	\$500.18	
	Surge Port, 400-1200 MHz, N-M to N-F, Flange	LS	1	\$189.00	\$189.00	
	Kit, Grounding, W Gnd Lug, For 1/2in Cable	LS	4	\$27.00	\$108.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Kit, Hoisting Grip, 1/2in Cable	LS	2	\$27.00	\$54.00	
	Kit, Hanger, 1/2in Cable	LS	18	\$27.00	\$486.00	
	Kit, Angle Adapter, Qty 10	LS	18	\$76.50	\$1,377.00	
	Kit, Feedthru, 1/2in Cable	LS	1	\$49.50	\$49.50	
	Cable, Coaxial, 1/2in, Low Loss Foam	LS	300	\$9.00	\$2,700.00	
	Connector, N Male, 1/2in Coax, Rapid Fit	LS	2	\$36.00	\$72.00	
	Cable, Coaxial, 1/4in Cellflex	LS	40	\$1.76	\$70.20	
	Cabinet, 83in, Extra Deep	LS	2	\$4,410.00	\$8,820.00	
	Power Strip, 110VAC, 2X20A Brkr, 2-Cbl, 6Pos	LS	2	\$360.00	\$720.00	
5a	Forest Hill Site Equipment P25 Equipment					
	Simulcast, Common Equipment, P25T, MASTR V	LS	1	\$37,050.00	\$37,050.00	
	Network Sentry, P25 Simulcast	LS	1	\$25,901.25	\$25,901.25	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Kit, Cable, GPS Tx Site Common Equip	LS	1	\$82.50	\$82.50	
	Outlet Strip, 120VAC	LS	8	\$120.00	\$960.00	
	Power Supply, 120VAC, 60Hz, 12/24VDC	LS	1	\$701.25	\$701.25	
	Rack, Open, 86in, Extra Deep	LS	1	\$2,212.57	\$2,212.57	
	Fan, 120VAC, Extra Deep Cabinet	LS	1	\$637.50	\$637.50	
	Antenna, 1575.42 MHz, Set	LS	2	\$405.00	\$810.00	
	Filter, Surge Protector, 800-2500MHz	LS	2	\$175.00	\$350.00	
	Cable, GPS Antenna, 50ft	LS	2	\$265.00	\$530.00	
	Cable, GPS Antenna, 50ft	LS	2	\$265.00	\$530.00	
	Station, MASTR V, P25T, 700MHz	LS	9	\$37,600.83	\$338,407.50	
	Router, 2921, AC, Security, w/Ether Switch	LS	2	\$8,769.00	\$17,538.00	
	Switch, Cisco 3560v2, DC	LS	2	\$9,723.68	\$19,447.36	
	Interface Card, 2-port 3rd Gen Wan	LS	1	\$2,784.00	\$2,784.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
5c	Forest Hill Site Equipment Antenna Equipment					
	Forest Hill, M/C, Combiners, TTA	LS	1	\$27,571.25	\$27,571.25	
	Omni, 9 dB gain, 4 deg. elect downtilt	LS	3	\$2,667.75	\$8,003.25	
	Power Sensor, 403-1000 MHz	LS	1	\$477.00	\$477.00	
	Cable, RF Sensor, 30ft	LS	1	\$103.50	\$103.50	
	Tape, Vapor-Wrap, 3in, 50 ft Roll	LS	1	\$27.00	\$27.00	
	Kit, Antenna Side Mount, ASPR614	LS	2	\$450.00	\$900.00	
	Amplifier, Towertop, 806-824MHz, Test Port	LS	1	\$3,753.00	\$3,753.00	
	Cable, 6ft, NM/NM, Jumper For 1/2in	LS	3	\$94.50	\$283.50	
	Connector, N Female, 1 5/8 Coax	LS	2	\$144.00	\$288.00	
	Kit, Grounding, W Gnd Lug, For 1 5/8in Ca	LS	3	\$31.50	\$94.50	
	Cable, Coaxial, 1 5/8in, Low Loss Foam	LS	200	\$6.30	\$1,260.00	
	Kit, Coax Hoisting Grip, 1 5/8in	LS	1	\$49.50	\$49.50	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Kit, Hanger, 1 5/8in Cable, Qty 10	LS	5	\$36.00	\$180.00	
	Kit, Angle Adapter, Qty 10	LS	5	\$76.50	\$382.50	
	Kit, Feedthru Boot, 1-5/8in	LS	1	\$22.50	\$22.50	
	Connector, N Female, For 7/8in Coax	LS	2	\$36.00	\$72.00	
	Kit, Grounding, CellFlex 7/8in 60in	LS	3	\$40.50	\$121.50	
	Cable, Coaxial, 7/8in, Low Loss Foam	LS	200	\$2.93	\$585.00	
	Kit, Hoisting Grip, 7/8in Cable	LS	1	\$27.00	\$27.00	
	Kit, Hanger, 7/8in Cable, Qty 10	LS	5	\$36.00	\$180.00	
	Kit, Angle Adapter, Qty 10	LS	5	\$76.50	\$382.50	
	Kit, Feedthru Boot, 7/8in	LS	1	\$27.00	\$27.00	
	Cable, Coaxial, 1/2in Superflex	LS	235	\$2.48	\$581.63	
	Connector, N Male, 1/2in Coax	LS	6	\$36.00	\$216.00	
	Connector, N Female, 1/2in Coax	LS	2	\$40.50	\$81.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Filter, 800-900MHz, N Male, Flange Mt, 750W	LS	1	\$216.00	\$216.00	
	Surge Port, 400-1200MHz, N-M to N-F, Flange	LS	1	\$189.00	\$189.00	
	Load, 50 Ohm, 1Watt, BNC	LS	7	\$9.00	\$63.00	
	Connector, BNC-M, 1/4in Coax, Shrink Sleeve	LS	9	\$76.50	\$688.50	
	Connector, N Male, 1/2in Coax	LS	9	\$36.00	\$324.00	
	Connector, N Male, 1/2in Coax	LS	9	\$36.00	\$324.00	
	Cable, Coaxial, 1/4in Cellflex	LS	135	\$1.76	\$236.93	
	Surge Port, 400-1200MHz, N-M to N-F, Flange	LS	1	\$189.00	\$189.00	
	Kit, Grounding, W Gnd Lug, For 1/2in Cable	LS	3	\$27.00	\$81.00	
	Kit, Hoisting Grip, 1/2in Cable	LS	1	\$27.00	\$27.00	
	Kit, Hanger, 1/2in Cable	LS	10	\$27.00	\$270.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Kit, Angle Adapter, Qty 10	LS	10	\$76.50	\$765.00	
	Kit, Feedthru, 1/2in Cable	LS	1	\$49.50	\$49.50	
	Cable, Coaxial, 1/2in, Low Loss Foam	LS	200	\$9.00	\$1,800.00	
	Connector, N Male, 1/2in Coax, Rapid Fit	LS	2	\$36.00	\$72.00	
	Cable, Coaxial, 1/4in Cellflex	LS	40	\$1.76	\$70.20	
	Power Sensor, 403-1000MHz	LS	1	\$477.00	\$477.00	
	Cable, RF Sensor, 30ft	LS	1	\$103.50	\$103.50	
	Tape, Vapor-Wrap, 3in, 50 ft Roll	LS	1	\$27.00	\$27.00	
	Kit, Antenna Side Mount, ASPR614	LS	2	\$450.00	\$900.00	
	Cable, 6ft, NM/NM, Jumper For 1/2in	LS	3	\$94.50	\$283.50	
	Connector, N Female, 1 5/8 Coax	LS	2	\$144.00	\$288.00	
	Kit, Grounding, W Gnd Lug, For 1 5/8in Ca	LS	3	\$31.50	\$94.50	
	Cable, Coaxial, 1 5/8in, Low Loss Foam	LS	200	\$6.30	\$1,260.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Kit, Coax Hoisting Grip, 1 5/8in	LS	1	\$49.50	\$49.50	
	Kit, Hanger, 1 5/8in Cable, Qty 10	LS	5	\$36.00	\$180.00	
	Kit, Angle Adapter, Qty 10	LS	5	\$76.50	\$382.50	
	Kit, Feedthru Boot, 1-5/8in	LS	1	\$22.50	\$22.50	
	Connector, N Female, For 7/8in Coax	LS	2	\$36.00	\$72.00	
	Kit, Grounding, CellFlex 7/8in 60in	LS	3	\$40.50	\$121.50	
	Cable, Coaxial, 7/8in, Low Loss Foam	LS	200	\$2.93	\$585.00	
	Kit, Hoisting Grip, 7/8in Cable	LS	1	\$27.00	\$27.00	
	Kit, Hanger, 7/8in Cable, Qty 10	LS	5	\$36.00	\$180.00	
	Kit, Angle Adapter, Qty 10	LS	5	\$76.50	\$382.50	
	Kit, Feedthru Boot, 7/8in	LS	1	\$27.00	\$27.00	
	Cable, Coaxial, 1/2in Superflex	LS	235	\$2.48	\$581.63	
	Connector, N Male, 1/2in Coax	LS	6	\$36.00	\$216.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Connector, N Female, 1/2in Coax	LS	2	\$40.50	\$81.00	
	Filter, 800-900MHz, N Male, Flange Mt, 750W	LS	1	\$216.00	\$216.00	
	Surge Port, 400-1200MHz, N-M to N-F, Flange	LS	1	\$189.00	\$189.00	
	Load, 50 Ohm, 1Watt, BNC	LS	7	\$9.00	\$63.00	
	Connector, BNC-M, 1/4in Coax, Shrink Sleeve	LS	9	\$76.50	\$688.50	
	Connector, N Male, 1/2in Coax	LS	9	\$36.00	\$324.00	
	Connector, N Male, 1/2in Coax	LS	9	\$36.00	\$324.00	
	Cable, Coaxial, 1/4in Cellflex	LS	135	\$1.76	\$236.93	
	Cabinet, 83in, Extra Deep	LS	2	\$4,410.00	\$8, 820.00	
	Power Strip, 110VAC, 2X20A Brkr, 2-Cbl, 6Pos	LS	2	\$360.00	\$720.00	
6a	South Hill Site Equipment P25 Equipment					

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Simulcast, Common Equipment, P25T, MASTR V	LS	1	\$37,050.00	\$37,050.00	
	Network Sentry, P25 Simulcast	LS	1	\$25,901.25	\$25,901.25	
	Kit, Cable, GPS Tx Site Common Equip	LS	1	\$82.50	\$82.50	
	Outlet Strip, 120VAC	LS	8	\$120.00	\$960.00	
	Power Supply, 120VAC, 60Hz, 12/24VDC	LS	1	\$701.25	\$701.25	
	Rack, Open, 86in, Extra Deep	LS	1	\$2,212.57	\$2,212.57	
	Fan, 120VAC, Extra Deep Cabinet	LS	1	\$637.50	\$637.50	
	Antenna, 1575.42MHz, Set	LS	2	\$405.00	\$810.00	
	Filter, Surge Protector, 800-2500MHz	LS	2	\$175.00	\$350.00	
	Cable, GPS Antenna, 50ft	LS	2	\$265.00	\$530.00	
	Cable, GPS Antenna, 50ft	LS	2	\$265.00	\$530.00	
	Station, MASTR V, P25T, 700MHz	LS	9	\$37,600.83	\$338,407.50	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Router, 2921, AC, Security, w/Ether Switch	LS	2	\$8,769.00	\$17,538.00	
	Switch, Cisco 3560v2, DC	LS	2	\$9,723.68	\$19,447.36	
	Interface Card, 2-port 3rd Gen Wan	LS	1	\$2,784.00	\$2,784.00	
6b	South Hill Site Equipment Open Sky Base Stations					
	Station, SkyMASTR, 800MHz, 100W	LS	2	\$63,311.25	\$126,622.50	
6c	South Hill Site Equipment Antenna Equipment					
	South Hill Site TTA, M/C, Combiners, Base	LS	1	\$32,148.75	\$32,148.75	
	Directional Antenna	LS	3	\$3,746.25	\$11,238.75	
	Power Sensor, 403-1000MHz	LS	2	\$477.00	\$954.00	
	Cable, RF Sensor, 30ft	LS	2	\$103.50	\$207.00	
	Tape, Vapor-Wrap, 3in, 50 ft Roll	LS	2	\$27.00	\$54.00	
	Kit, Antenna Side Mount, ASPR614	LS	3	\$450.00	\$1,350.00	
	Cable, 6ft, NM/NM, Jumper For 1/2in	LS	4	\$94.50	\$378.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Connector, N Female, 1 5/8 Coax	LS	4	\$144.00	\$576.00	
	Kit, Grounding, W Gnd Lug, For 1 5/8in Ca	LS	6	\$31.50	\$189.00	
	Cable, Coaxial, 1 5/8in, Low Loss Foam	LS	300	\$6.30	\$1,890.00	
	Kit, Coax Hoisting Grip, 1 5/8in	LS	2	\$49.50	\$99.00	
	Kit, Hanger, 1 5/8in Cable, Qty 10	LS	8	\$36.00	\$288.00	
	Kit, Angle Adapter, Qty 10	LS	8	\$76.50	\$612.00	
	Kit, Feedthru Boot, 1-5/8in	LS	2	\$22.50	\$45.00	
	Connector, N Female, For 7/8in Coax	LS	2	\$36.00	\$72.00	
	Kit, Grounding, CellFlex 7/8in 60in	LS	3	\$40.50	\$121.50	
	Cable, Coaxial, 7/8in, Low Loss Foam	LS	150	\$2.93	\$438.75	
	Kit, Hoisting Grip, 7/8in Cable	LS	1	\$27.00	\$27.00	
	Kit, Hanger, 7/8in Cable, Qty 10	LS	4	\$36.00	\$144.00	
	Kit, Angle Adapter, Qty 10	LS	4	\$76.50	\$306.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Kit, Feedthru Boot, 7/8in	LS	1	\$27.00	\$27.00	
	Cable, Coaxial, 1/2in Superflex	LS	400	\$2.48	\$990.00	
	Connector, N Male, 1/2in Coax	LS	9	\$36.00	\$324.00	
	Connector, N Female, 1/2in Coax	LS	3	\$ 40.50	\$121.50	
	Filter, 800-900MHz, N Male, Flange Mt, 750W	LS	2	\$216.00	\$432.00	
	Surge Port, 400-1200MHz, N-M to N-F, Flange	LS	1	\$189.00	\$189.00	
	Load, 50 Ohm, 1Watt, BNC	LS	6	\$9.00	\$54.00	
	Connector, BNC-M, 1/4in Coax, Shrink Sleeve	LS	18	\$76.50	\$1,377.00	
	Connector, N Male, Right Angle	LS	18	\$40.50	\$729.00	
	Connector, N Male, 1/2in Coax	LS	18	\$36.00	\$648.00	
	Cable, Coaxial, 1/4in Cellflex	LS	270	\$1.76	\$473.85	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Surge Port, 400-1200MHz, N-M to N-F, Flange	LS	1	\$189.00	\$189.00	
	Kit, Grounding, W Gnd Lug, For 1/2in Cable	LS	3	\$27.00	\$81.00	
	Kit, Hoisting Grip, 1/2in Cable	LS	1	\$27.00	\$27.00	
	Kit, Hanger, 1/2in Cable	LS	8	\$27.00	\$216.00	
	Kit, Angle Adapter, Qty 10	LS	8	\$76.50	\$612.00	
	Kit, Feedthru, 1/2in Cable	LS	1	\$49.50	\$49.50	
	Cable, Coaxial, 1/2in, Low Loss Foam	LS	150	\$9.00	\$1,350.00	
	Connector, N Male, 1/2in Coax, Rapid Fit	LS	2	\$36.00	\$72.00	
	Cable, Coaxial, 1/4in Cellflex	LS	40	\$1.76	\$70.20	
	Cabinet, 83in, Extra Deep	LS	2	\$4,410.00	\$8,820.00	
	Power Strip, 110VAC, 2X20A Brkr, 2-Cbl, 6Pos	LS	2	\$360.00	\$720.00	
7a	One Market Plaza Site Equipment P25 Equipment					

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Simulcast, Common Equipment, P25T, MASTR V	LS	1	\$37,050.00	\$37,050.00	
	Network Sentry, P25 Simulcast	LS	1	\$25,901.25	\$25,901.25	
	Kit, Cable, GPS Tx Site Common Equip	LS	1	\$82.50	\$82.50	
	Outlet Strip, 120VAC	LS	8	\$120.00	\$960.00	
	Power Supply, 120VAC, 60Hz, 12/24VDC	LS	1	\$701.25	\$701.25	
	Rack, Open, 86in, Extra Deep	LS	1	\$2,212.57	\$2,212.57	
	Fan, 120VAC, Extra Deep Cabinet	LS	1	\$637.50	\$637.50	
	Antenna, 1575.42MHz, Set	LS	2	\$405.00	\$810.00	
	Filter, Surge Protector, 800-2500MHz	LS	2	\$68.01	\$136.01	
	Cable, GPS Antenna, 50ft	LS	2	\$265.00	\$530.00	
	Cable, GPS Antenna, 50ft	LS	2	\$265.00	\$530.00	
	Station, MASTR V, P25T, 700MHz	LS	9	\$37,600.83	\$338,407.50	

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Router, 2921, AC, Security, w/Ether Switch	LS	2	\$8,769.00	\$17,538.00	
	Switch, Cisco 3560v2, DC	LS	2	\$9,723.68	\$19,447.36	
	Interface Card, 2-port 3rd Gen Wan	LS	1	\$2,784.00	\$2,784.00	
7b	One Market Plaza Site Equipment Open Sky Base Stations					
	Station, SkyMASTR, 800MHz, 100W	LS	3	\$63,311.25	\$189,933.75	
7c	One Market Plaza Site Equipment Antenna Equipment					
	One Mkt. Plaza M/C, Combiners, TTA, Base	LS	1	\$29,881.25	\$29,881.25	
	Directional Antenna	LS	2	\$1,469.25	\$2,938.50	
	Omni, 9 dB gain, 4 deg. elect downtilt	LS	2	\$3,746.25	\$7,492.50	
	Power Sensor, 403-1000MHz	LS	3	\$477.00	\$1,431.00	
	Cable, RF Sensor, 30ft	LS	3	\$103.50	\$310.50	
	Tape, Vapor-Wrap, 3in, 50 ft Roll	LS	2	\$27.00	\$54.00	
	Kit, Antenna Side Mount, ASPR614	LS	4	\$450.00	\$1,800.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Cable, 6ft, NM/NM, Jumper For 1/2in	LS	5	\$94.50	\$472.50	
	Connector, N Female, 1 5/8 Coax	LS	6	\$144.00	\$864.00	
	Kit, Grounding, W Gnd Lug, For 1 5/8in Ca	LS	9	\$31.50	\$283.50	
	Cable, Coaxial, 1 5/8in, Low Loss Foam	LS	600	\$6.30	\$3,780.00	
	Kit, Coax Hoisting Grip, 1 5/8in	LS	3	\$49.50	\$148.50	
	Kit, Hanger, 1 5/8in Cable, Qty 10	LS	15	\$36.00	\$540.00	
	Kit, Angle Adapter, Qty 10	LS	15	\$76.50	\$1,147.50	
	Kit, Feedthru Boot, 1-5/8in	LS	3	\$22.50	\$67.50	
	Connector, N Female, For 7/8in Coax	LS	2	\$36.00	\$72.00	
	Kit, Grounding, CellFlex 7/8in 60in	LS	3	\$40.50	\$121.50	
	Cable, Coaxial, 7/8in, Low Loss Foam	LS	200	\$2.93	\$585.00	
	Kit, Hoisting Grip, 7/8in Cable	LS	1	\$27.00	\$27.00	
	Kit, Hanger, 7/8in Cable, Qty 10	LS	5	\$36.00	\$180.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Kit, Angle Adapter, Qty 10	LS	5	\$76.50	\$382.50	
	Kit, Feedthru Boot, 7/8in	LS	1	\$27.00	\$27.00	
	Cable, Coaxial, 1/2in Superflex	LS	445	\$2.48	\$1,101.38	
	Connector, N Male, 1/2in Coax	LS	12	\$36.00	\$432.00	
	Connector, N Female, 1/2in Coax	LS	4	\$40.50	\$162.00	
	Filter, 800-900MHz, N Male, Flange Mt, 750W	LS	3	\$216.00	\$648.00	
	Surge Port, 400-1200MHz, N-M to N-F, Flange	LS	1	\$189.00	\$189.00	
	Load, 50 Ohm, 1Watt, BNC	LS	5	\$9.00	\$45.00	
	Connector, BNC-M, 1/4in Coax, Shrink Sleeve	LS	19	\$76.50	\$1,453.50	
	Connector, N Male, Right Angle	LS	19	\$40.50	\$769.50	
	Connector, N Male, 1/2in Coax	LS	19	\$36.00	\$684.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Cable, Coaxial, 1/4in Cellflex	LS	285	\$1.76	\$500.18	
	Surge Port, 400-1200MHz, N-M to N-F, Flange	LS	1	\$189.00	\$189.00	
	Kit, Grounding, W Gnd Lug, For 1/2in Cable	LS	3	\$27.00	\$81.00	
	Kit, Hoisting Grip, 1/2in Cable	LS	1	\$27.00	\$27.00	
	Kit, Hanger, 1/2in Cable	LS	10	\$27.00	\$270.00	
	Kit, Angle Adapter, Qty 10	LS	10	\$76.50	\$765.00	
	Kit, Feedthru, 1/2in Cable	LS	1	\$49.50	\$49.50	
	Cable, Coaxial, 1/2in, Low Loss Foam	LS	200	\$9.00	\$1,800.00	
	Connector, N Male, 1/2in Coax, Rapid Fit	LS	2	\$36.00	\$72.00	
	Cable, Coaxial, 1/4in Cellflex	LS	40	\$1.76	\$70.20	
	Cabinet, 83in, Extra Deep	LS	2	\$4,410.00	\$8,820.00	
	Power Strip, 110VAC, 2X20A Brkr, 2-Cbl, 6Pos	LS	2	\$360.00	\$720.00	

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
8b	Bernal Heights Site Equipment Open Sky Base Stations					
	Station, SkyMASTR, 800MHz, 100W	LS	1	\$63,311.25	\$63,311.25	
	Router, Cisco, 2911, AC, Sec, w/EtherSwitch	LS	1	\$7,250.00	\$7,250.00	
	EthrSwth, L2, SM, 23FE, 1 GE, Cisco, SM-ES2-24	LS	1	\$2,200.00	\$2,200.00	
	Interface Card, 2-port 3rd Gen Wan	LS	1	\$2,784.00	\$2,784.00	
8c	Bernal Heights Site Equipment Antenna Equipment					
	BHeights Duplexer	LS	1	\$1,156.25	\$1,156.25	
	Ant for OS Fill Site	LS	1	\$584.38	\$584.38	
	Kit, Antenna Side Mount, ASPR614	LS	2	\$450.00	\$900.00	
	Cable, 6ft, NM/NM, Jumper For 1/2in	LS	3	\$94.50	\$283.50	
	Connector, N Male, 1/2in Coax	LS	6	\$36.00	\$216.00	
	Connector, N Female, 1/2in Coax	LS	2	\$40.50	\$81.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Cable, Coaxial, 1/2in Superflex	LS	60	\$2.48	\$148.50	
	Tape, Vapor-Wrap, 3in, 50 ft Roll	LS	1	\$27.00	\$27.00	
	Kit, Angle Adapter, Qty 10	LS	10	\$76.50	\$765.00	
	Filter, 800-900MHz, N Male, Flange Mt, 750W	LS	1	\$216.00	\$216.00	
	Surge Port, 400-1200MHz, N-M to N-F, Flange	LS	1	\$189.00	\$189.00	
	Cable, Coaxial, 7/8in, Low Loss Foam	LS	350	\$ 2.93	\$1,023.75	
	Connector, N Female, For 7/8in Coax	LS	2	\$36.00	\$72.00	
	Kit, Grounding, CellFlex 7/8in 60in	LS	4	\$40.50	\$162.00	
	Kit, Hoisting Grip, 7/8in Cable	LS	2	\$27.00	\$54.00	
	Kit, Hanger, 7/8in Cable, Qty 10	LS	10	\$36.00	\$360.00	
	Kit, Feedthru Boot, 7/8in	LS	1	\$27.00	\$27.00	
9	Cable Car Facility Equipment					

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Industrial Switch with Layer 3 Routing	LS	1	\$5,583.50	\$5,583.50	
	120 VAC -industrial Switch Power Supply	LS	1	\$276.25	\$276.25	
	Rugged SFP - 100FX transceiver module	LS	2	\$192.50	\$385.00	
	4inch Red 6-Digit 110ViP Clock Front Bezel with Surface Mount.	LS	1	\$931.25	\$931.25	
10	Flynn Facility Equipment					
	4.9 GHz Sector Control Radio	LS	2	\$10,000.00	\$20,000.00	
	4.9 GHz Sector Control Radio Extended Warranty	LS	2	\$180.00	\$360.00	
	4.9 GHz Sector Control Power Supply	LS	2	\$50.00	\$100.00	
	4.9 GHz Sector Control Radio Pole Mount	LS	2	\$97.50	\$195.00	
	100BaseT to 100BaseFX media converter	LS	2	\$242.50	\$485.00	
	Antenna, Omni, Vehicle, 18Deg, 5.5dBi, Type N	LS	4	\$241.20	\$964.80	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Cable, Power, 2Pin, Sealed, 300ft	LS	2	\$544.50	\$1,089.00	
	Cable, Fo, Outdoor,iP67, LC-LC Duplex 300ft	LS	2	\$1,114.20	\$2,228.40	
	Surge Protector, Coax, Type N, 4.9GHz	LS	4	\$81.00	\$324.00	
	Surge Protector, DC, Wire, 27VDC	LS	2	\$244.80	\$489.60	
	Cable, Fiber, Lc Duplex, 5 M, Gray	LS	2	\$54.00	\$108.00	
	Assy Kit, Rackmnt, Fo Distrib, 1 Site	LS	2	\$311.00	\$622.00	
	10ft of 1/2" Superflex NM-NM FSJ4-50B Coax Jumper Cable	LS	4	\$128.88	\$515.52	
	ANDREW Grounding Kit 1/4" and 3/8"	LS	24	\$23.38	\$561.12	
	Industrial Switch with Layer 3 Routing	LS	1	\$5,583.50	\$5,583.50	
	120 VAC -industrial Switch Power Supply	LS	1	\$276.25	\$276.25	
	Rugged SFP - 100FX transceiver module	LS	2	\$192.50	\$385.00	

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	4inch Red 6-Digit 110ViP Clock Front Bezel with Surface Mount.	LS	1	\$931.25	\$931.25	
	Hardned router/switch for yards	LS	1	\$1,500.00	\$1,500.00	
11	Geneva Car House Facility Equipment					
	4.9 GHz Sector Control Radio	LS	1	\$10,000.00	\$10,000.00	
	4.9 GHz Sector Control Radio Extended Warranty	LS	1	\$180.00	\$180.00	
	4.9 GHz Sector Control Power Supply	LS	1	\$50.00	\$50.00	
	4.9 GHz Sector Control Radio Pole Mount	LS	1	\$97.50	\$97.50	
	100BaseT to 100BaseFX media converter	LS	1	\$242.50	\$242.50	
	Antenna, Omni, Vehical, 18Deg, 5.5dBi, Type N	LS	2	\$241.20	\$482.40	
	Cable, Power, 2Pin, Sealed, 300ft	LS	1	\$544.50	\$544.50	
	Cable, Fo, Outdoor,iP67, LC-LC Duplex 300ft	LS	1	\$1,114.20	\$1,114.20	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Surge Protector, Coax, Type N, 4.9GHz	LS	2	\$81.00	\$162.00	
	Surge Protector, DC, Wire, 27VDC	LS	1	\$244.80	\$244.80	
	Cable, Fiber, Lc Duplex, 5 M, Gray	LS	1	\$54.00	\$54.00	
	Assy Kit, Rackmnt, Fo Distrib, 1 Sitee	LS	1	\$311.00	\$311.00	
	10ft of 1/2" Superflex NM-NM FSJ4-50B Coax Jumper Cable	LS	2	\$128.88	\$257.76	
	ANDREW Grounding Kit 1/4" and 3/8"	LS	12	\$23.38	\$280.56	
	Industrial Switch with Layer 3 Routing	LS	2	\$5,583.50	\$11,167.00	
	120 VAC -industrial Switch Power Supply	LS	2	\$276.25	\$552.50	
	Rugged SFP - 100FX transceiver module	LS	4	\$192.50	\$770.00	
	Hardned router/switch for yards	LS	1	\$1,500.00	\$1,500.00	
12	Green Annex Facility Equipment					
	4.9 GHz Sector Control Radio	LS	1	\$10,000.00	\$10,000.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	4.9 GHz Sector Control Radio Extended Warranty	LS	1	\$180.00	\$180.00	
	4.9 GHz Sector Control Power Supply	LS	1	\$50.00	\$50.00	
	4.9 GHz Sector Control Radio Pole Mount	LS	1	\$97.50	\$97.50	
	100BaseT to 100BaseFX media converter	LS	1	\$242.50	\$242.50	
	Antenna, Omni, Vehical, 18Deg, 5.5dBi, Type N	LS	2	\$241.20	\$482.40	
	Cable, Power, 2Pin, Sealed, 300ft	LS	1	\$544.50	\$544.50	
	Cable, Fo, Outdoor,iP67, LC-LC Duplex 300ft	LS	1	\$1, 114.20	\$1, 114.20	
	Surge Protector, Coax, Type N, 4.9GHz	LS	2	\$81.00	\$162.00	
	Surge Protector, DC, Wire, 27VDC	LS	1	\$244.80	\$244.80	
	Cable, Fiber, Lc Duplex, 5 M, Gray	LS	1	\$54.00	\$54.00	
	Assy Kit, Rackmnt, Fo Distrib, 1 Sitee	LS	1	\$311.00	\$311.00	

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	10ft of 1/2" Superflex NM-NM FSJ4-50B Coax Jumper Cable	LS	2	\$128.88	\$257.76	
	ANDREW Grounding Kit 1/4" and 3/8"	LS	12	\$23.38	\$280.56	
	Industrial Switch with Layer 3 Routing	LS	2	\$5,583.50	\$11,167.00	
	120 VAC -industrial Switch Power Supply	LS	2	\$276.25	\$552.50	
	Rugged SFP - 100FX transceiver module	LS	4	\$192.50	\$770.00	
	4inch Red 6-Digit 110ViP Clock Front Bezel with Surface Mount.	LS	1	\$931.25	\$931.25	
	Hardned router/switch for yards	LS	1	\$1,500.00	\$1,500.00	
13	Muni Metro East Facility Equipment					
	4.9 GHz Sector Control Radio	LS	3	\$10,000.00	\$30,000.00	
	4.9 GHz Sector Control Radio Extended Warranty	LS	3	\$180.00	\$540.00	
	4.9 GHz Sector Control Power Supply	LS	3	\$50.00	\$150.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	4.9 GHz Sector Control Radio Pole Mount	LS	3	\$97.50	\$292.50	
	100BaseT to 100BaseFX media converter	LS	3	\$242.50	\$727.50	
	Antenna, Omni, Vehical, 18Deg, 5.5dBi, Type N	LS	6	\$241.20	\$1,447.20	
	Cable, Power, 2Pin, Sealed, 300ft	LS	3	\$544.50	\$1,633.50	
	Cable, Fo, Outdoor,iP67, LC-LC Duplex 300ft	LS	3	\$1,114.20	\$3,342.60	
	Surge Protector, Coax, Type N, 4.9GHz	LS	6	\$81.00	\$486.00	
	Surge Protector, DC, Wire, 27VDC	LS	3	\$244.80	\$734.40	
	Cable, Fiber, Lc Duplex, 5 M, Gray	LS	3	\$54.00	\$162.00	
	Assy Kit, Rackmnt, Fo Distrib, 1 Sitee	LS	3	\$311.00	\$933.00	
	10ft of 1/2" Superflex NM-NM FSJ4-50B Coax Jumper Cable	LS	6	\$128.88	\$773.28	
	ANDREW Grounding Kit 1/4" and 3/8"	LS	36	\$23.38	\$841.68	

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Industrial Switch with Layer 3 Routing	LS	4	\$5,583.50	\$22,334.00	
	120 VAC -industrial Switch Power Supply	LS	4	\$276.25	\$1,105.00	
	Rugged SFP - 100FX transceiver module	LS	8	\$192.50	\$1,540.00	
	4inch Red 6-Digit 110ViP Clock Front Bezel with Surface Mount.	LS	1	\$931.25	\$931.25	
	Hardned router/switch for yards	LS	1	\$1,500.00	\$1,500.00	
14	Potrero Facility Equipment					
	4.9 GHz Sector Control Radio	LS	1	\$10,000.00	\$10,000.00	
	4.9 GHz Sector Control Radio Extended Warranty	LS	1	\$180.00	\$180.00	
	4.9 GHz Sector Control Power Supply	LS	1	\$50.00	\$50.00	
	4.9 GHz Sector Control Radio Pole Mount	LS	1	\$97.50	\$97.50	
	100BaseT to 100BaseFX media converter	LS	1	\$242.50	\$242.50	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Antenna, Omni, Vehical, 18Deg, 5.5dBi, Type N	LS	2	\$241.20	\$482.40	
	Cable, Power, 2Pin, Sealed, 300ft	LS	1	\$544.50	\$544.50	
	Cable, Fo, Outdoor,iP67, LC-LC Duplex 300ft	LS	1	\$1,114.20	\$1,114.20	
	Surge Protector, Coax, Type N, 4.9GHz	LS	2	\$81.00	\$162.00	
	Surge Protector, DC, Wire, 27VDC	LS	1	\$244.80	\$244.80	
	Cable, Fiber, Lc Duplex, 5 M, Gray	LS	1	\$54.00	\$54.00	
	Assy Kit, Rackmnt, Fo Distrib, 1 Sitee	LS	1	\$311.00	\$311.00	
	10ft of 1/2" Superflex NM-NM FSJ4-50B Coax Jumper Cable	LS	2	\$128.88	\$257.76	
	ANDREW Grounding Kit 1/4" and 3/8"	LS	12	\$23.38	\$280.56	
	Industrial Switch with Layer 3 Routing	LS	2	\$5,583.50	\$11,167.00	
	120 VAC -industrial Switch Power Supply	LS	2	\$276.25	\$552.50	

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Rugged SFP - 100FX transceiver module	LS	4	\$192.50	\$770.00	
	4inch Red 6-Digit 110ViP Clock Front Bezel with Surface Mount.	LS	1	\$931.25	\$931.25	
	Hardned router/switch for yards	LS	1	\$1,500.00	\$1,500.00	
15	Presidio Facility Equipment					
	4.9 GHz Sector Control Radio	LS	1	\$10,000.00	\$10,000.00	
	4.9 GHz Sector Control Radio Extended Warranty	LS	1	\$180.00	\$180.00	
	4.9 GHz Sector Control Power Supply	LS	1	\$50.00	\$50.00	
	4.9 GHz Sector Control Radio Pole Mount	LS	1	\$97.50	\$97.50	
	100BaseT to 100BaseFX media converter	LS	1	\$242.50	\$242.50	
	Antenna, Omni, Vehical, 18Deg, 5.5dBi, Type N	LS	2	\$241.20	\$482.40	
	Cable, Power, 2Pin, Sealed, 300ft	LS	1	\$544.50	\$544.50	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Cable, Fo, Outdoor,iP67, LC-LC Duplex 300ft	LS	1	\$1,114.20	\$1,114.20	
	Surge Protector, Coax, Type N, 4.9GHz	LS	2	\$81.00	\$162.00	
	Surge Protector, DC, Wire, 27VDC	LS	1	\$244.80	\$244.80	
	Cable, Fiber, Lc Duplex, 5 M, Gray	LS	1	\$54.00	\$54.00	
	Assy Kit, Rackmnt, Fo Distrib, 1 Sitee	LS	1	\$311.00	\$311.00	
	10ft of 1/2" Superflex NM-NM FSJ4-50B Coax Jumper Cable	LS	2	\$128.88	\$257.76	
	ANDREW Grounding Kit 1/4" and 3/8"	LS	12	\$23.38	\$280.56	
	Industrial Switch with Layer 3 Routing	LS	2	\$5,583.50	\$11,167.00	
	120 VAC -industrial Switch Power Supply	LS	2	\$276.25	\$552.50	
	Rugged SFP - 100FX transceiver module	LS	4	\$192.50	\$770.00	
	4inch Red 6-Digit 110ViP Clock Front Bezel with Surface Mount.	LS	1	\$931.25	\$931.25	

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Hardned router/switch for yards	LS	1	\$1,500.00	\$1,500.00	
16	Scott Facility Equipment					
	4.9 GHz Sector Control Radio	LS	1	\$10,000.00	\$10,000.00	
	4.9 GHz Sector Control Radio Extended Warranty	LS	1	\$180.00	\$180.00	
	4.9 GHz Sector Control Power Supply	LS	1	\$50.00	\$50.00	
	4.9 GHz Sector Control Radio Pole Mount	LS	1	\$97.50	\$97.50	
	100BaseT to 100BaseFX media converter	LS	1	\$242.50	\$242.50	
	Antenna, Omni, Vehical, 18Deg, 5.5dBi, Type N	LS	2	\$241.20	\$482.40	
	Cable, Power, 2Pin, Sealed, 300ft	LS	1	\$544.50	\$544.50	
	Cable, Fo, Outdoor,iP67, LC-LC Duplex 300ft	LS	1	\$1,114.20	\$1,114.20	
	Surge Protector, Coax, Type N, 4.9GHz	LS	2	\$81.00	\$162.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Surge Protector, DC, Wire, 27VDC	LS	1	\$244.80	\$244.80	
	Cable, Fiber, Lc Duplex, 5 M, Gray	LS	1	\$54.00	\$54.00	
	Assy Kit, Rackmnt, Fo Distrib, 1 Sitee	LS	1	\$311.00	\$311.00	
	10ft of 1/2" Superflex NM-NM FSJ4-50B Coax Jumper Cable	LS	2	\$128.88	\$257.76	
	ANDREW Grounding Kit 1/4" and 3/8"	LS	12	\$23.38	\$280.56	
	Industrial Switch with Layer 3 Routing	LS	1	\$5,583.50	\$5,583.50	
	120 VAC -industrial Switch Power Supply	LS	1	\$276.25	\$276.25	
	Rugged SFP - 100FX transceiver module	LS	2	\$192.50	\$385.00	
	Hardned router/switch for yards	LS	1	\$1,500.00	\$1,500.00	
17	Woods Facility Equipment					
	4.9 GHz Sector Control Radio	LS	2	\$10,000.00	\$20,000.00	
	4.9 GHz Sector Control Radio Extended Warranty	LS	2	\$180.00	\$360.00	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	4.9 GHz Sector Control Power Supply	LS	2	\$50.00	\$100.00	
	4.9 GHz Sector Control Radio Pole Mount	LS	2	\$97.50	\$195.00	
	100BaseT to 100BaseFX media converter	LS	2	\$242.50	\$485.00	
	Antenna, Omni, Vehical, 18Deg, 5.5dBi, Type N	LS	4	\$241.20	\$964.80	
	Cable, Power, 2Pin, Sealed, 300ft	LS	2	\$544.50	\$1,089.00	
	Cable, Fo, Outdoor,iP67, LC-LC Duplex 300ft	LS	2	\$1,114.20	\$2,228.40	
	Surge Protector, Coax, Type N, 4.9GHz	LS	4	\$81.00	\$324.00	
	Surge Protector, DC, Wire, 27VDC	LS	2	\$244.80	\$489.60	
	Cable, Fiber, Lc Duplex, 5 M, Gray	LS	2	\$54.00	\$108.00	
	Assy Kit, Rackmnt, Fo Distrib, 1 Sitee	LS	2	\$311.00	\$622.00	
	10ft of 1/2" Superflex NM-NM FSJ4-50B Coax Jumper Cable	LS	4	\$128.88	\$515.52	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	ANDREW Grounding Kit 1/4" and 3/8"	LS	24	\$23.38	\$561.12	
	Industrial Switch with Layer 3 Routing	LS	3	\$5,583.50	\$16,750.50	
	120 VAC -industrial Switch Power Supply	LS	3	\$276.25	\$828.75	
	Rugged SFP - 100FX transceiver module	LS	6	\$192.50	\$1,155.00	
	4inch Red 6-Digit 110ViP Clock Front Bezel with Surface Mount.	LS	1	\$931.25	\$931.25	
	4.9 GHz Subscriber Radio	LS	1	\$1,625.00	\$1,625.00	
	4.9 GHz Sector Control Radio Extended Warranty	LS	1	\$180.00	\$180.00	
	4.9 GHz Sector Control Power Supply	LS	1	\$50.00	\$50.00	
	4.9 GHz Sector Control Radio Pole Mount	LS	1	\$97.50	\$97.50	
	Antenna, Omni, 16Deg, 8dBi, Type N	LS	2	\$158.40	\$316.80	
	Cable, Power, 2Pin, Sealed, 100ft	LS	1	\$198.00	\$198.00	
	Cable, Cat5E, Outdr, Shielded w/Drain, 100	LS	1	\$274.50	\$274.50	

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Surge Protector, Coax, Type N, 4.9GHz	LS	1	\$81.00	\$81.00	
	Surge Protector, DC, Wire, 27VDC	LS	1	\$244.80	\$244.80	
	Surge Protector, Cat5E, RJ45, Data	LS	1	\$238.50	\$238.50	
	10ft of 1/2" Superflex NM-NM FSJ4-50B Coax Jumper Cable	LS	1	\$128.88	\$128.88	
	ANDREW Grounding Kit 1/4" and 3/8"	LS	6	\$23.38	\$140.28	
	Hardned router/switch for yards	LS	1	\$1,500.00	\$1,500.00	
	Total Harris Equipment				\$7,202,596.49	
	Sales Tax				\$612,220.70	
	Grand Total with Tax				\$7,814,817.19	

Subcontractor Fix End Equipment

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.3.0	Geographically separated MTMS primary fixed end system (1.3 - 1.15)		LS	\$ 1,166,809.83	\$ 1,166, 809.83
1.3	ORBCAD Application Cluster - 2 Servers				
1.3.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above
1.3.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above
1.3.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above
1.3.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above
1.3.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above
1.3.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above
1.3.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above
1.3.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above
1.3.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.3.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above
1.3.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above
1.3.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	4	incl. above	incl. above
1.3.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above
1.3.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above
1.3.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above
1.4	Active SQL Cluster - 2 Servers				
1.4.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above
1.4.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above
1.4.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above
1.4.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above
1.4.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.4.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above
1.4.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above
1.4.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above
1.4.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above
1.4.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above
1.4.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above
1.4.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	4	incl. above	incl. above
1.4.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above
1.4.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above
1.4.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above
1.5	LTDB SQL Cluster - 2 Servers				
1.5.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.5.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above
1.5.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above
1.5.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above
1.5.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above
1.5.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above
1.5.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above
1.5.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above
1.5.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above
1.5.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above
1.5.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above
1.5.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	4	incl. above	incl. above
1.5.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.5.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above
1.5.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above
1.6	Shared SAN				
1.6.1	HP P2000 G3 MSA FC Dual Cntrl SFF Array	LS	1	incl. above	incl. above
1.6.2	HP 146GB 6G SAS 10K 2.5in DP ENT HDD	LS	20	incl. above	incl. above
1.6.3	Factoryintegrated	LS	20	incl. above	incl. above
1.6.4	HPinstallation and Startup Service	LS	1	incl. above	incl. above
1.6.5	HP MSAinstall SVC	LS	1	incl. above	incl. above
1.6.6	HP 5m Multi-mode OM2 LC/LC FC Cable	LS	2	incl. above	incl. above
1.6.7	HP P2000 Snapshot 512 Software E-LTU	LS	1	incl. above	incl. above
1.6.8	HP P2000 Remote Snap Software E-LTU	LS	1	incl. above	incl. above
1.6.9	HP 16A High Voltage Modular PDU	LS	2	incl. above	incl. above
1.6.10	HP 8/24 Base 16-ports Enabled SAN Switch	LS	2	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.6.11	U.S. - English localization	LS	1	incl. above	incl. above
1.6.12	HP 3y Support Plus 24 SVC	LS	1	incl. above	incl. above
1.6.13	MSA2000 G3 support	LS	1	incl. above	incl. above
1.6.14	P2000 Snapshot 512 SW LTU SW Support	LS	1	incl. above	incl. above
1.6.15	P2000 Remote Snap SW LTU SW Support	LS	1	incl. above	incl. above
1.6.16	HP B-Series 8/8 and 8/24 Switch Support	LS	1	incl. above	incl. above
1.6.17	HP 3.6m C19 Nema L6-20P NA/JP Pwr Crd	LS	2	incl. above	incl. above
1.6.18	HPInstallation Service	LS	1	incl. above	incl. above
1.6.19	ProLiant Add On Optionsinstallation SVC	LS	4	incl. above	incl. above
1.6.20	LowEnd SAN/Edge Switch/HAFMinstallation	LS	1	incl. above	incl. above
1.6.21	HP MSA2000 SWinstallation	LS	2	incl. above	incl. above
1.6.22	HP 15m Multi-mode OM3 LC/LC FC Cable	LS	16	incl. above	incl. above
1.6.23	HP 8Gb Shortwave B-series FC SFP+ 1 Pack	LS	16	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.7	Reports Server				
1.7.1	windows large san dl380g7 x 1	LS	1	incl. above	incl. above
1.7.2	HP DL380G7 SFF CTO Chassis	LS	1	incl. above	incl. above
1.7.3	HP E5640 DL380G7 FIO Kit	LS	1	incl. above	incl. above
1.7.4	HP E5640 DL380G7 Kit	LS	1	incl. above	incl. above
1.7.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	6	incl. above	incl. above
1.7.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	2	incl. above	incl. above
1.7.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	1	incl. above	incl. above
1.7.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	1	incl. above	incl. above
1.7.9	HP 512MB Flash Backed Write Cache	LS	1	incl. above	incl. above
1.7.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	2	incl. above	incl. above
1.7.11	HP NC360T PCIe DP Gig Adptr	LS	1	incl. above	incl. above
1.7.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
	Fibre Channel				
1.7.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	2	incl. above	incl. above
1.7.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	1	incl. above	incl. above
1.7.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	1	incl. above	incl. above
1.8	MDC (Citrix) Server Farm - 4 Servers				
1.8.1	windows large san dl380g7 x 1	LS	4	incl. above	incl. above
1.8.2	HP DL380G7 SFF CTO Chassis	LS	4	incl. above	incl. above
1.8.3	HP E5640 DL380G7 FIO Kit	LS	4	incl. above	incl. above
1.8.4	HP E5640 DL380G7 Kit	LS	4	incl. above	incl. above
1.8.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	24	incl. above	incl. above
1.8.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	8	incl. above	incl. above
1.8.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	4	incl. above	incl. above
1.8.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	4	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.8.9	HP 512MB Flash Backed Write Cache	LS	4	incl. above	incl. above
1.8.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	8	incl. above	incl. above
1.8.11	HP NC360T PCIe DP Gig Adptr	LS	4	incl. above	incl. above
1.8.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	8	incl. above	incl. above
1.8.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	8	incl. above	incl. above
1.8.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	4	incl. above	incl. above
1.8.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	4	incl. above	incl. above
1.9	DCC Server - 2 Servers				
1.9.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
1.9.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
1.9.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
1.9.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.9.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above
1.10	GTRMD Server - 2 Servers				
1.10.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
1.10.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
1.10.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
1.10.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above
1.10.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above
1.11	Domain Controller Servers - 2 Servers				
1.11.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
1.11.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
1.11.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
1.11.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above
1.11.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.12	SNMP Server - 1 Server				
1.12.1	HP DL360G7 E5640 1P Performance US Svr	LS	1	incl. above	incl. above
1.12.2	HP E5640 DL360 G7 Processor	LS	1	incl. above	incl. above
1.12.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	3	incl. above	incl. above
1.12.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	1	incl. above	incl. above
1.12.5	Proliant Server DL36x HW Supp	LS	1	incl. above	incl. above
1.13	DIS Servers				
1.13.1	HP ML350 g6 SFF Tower Server	LS	9	incl. above	incl. above
1.13.2	HPiLO advanced server license with 24x7 technical support and updates	LS	9	incl. above	incl. above
1.13.3	Proliant Server DL36x HW Supp	LS	9	incl. above	incl. above
1.14	CAD Network Equipment				
1.14.1	Cisco 24 Port Gigabit switch withiP base functionality	LS	2	incl. above	incl. above
1.14.2	Cisco Redundant power supply for 24 port Lan base	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.14.3	Cisco Redundant power supply cable	LS	2	incl. above	incl. above
1.14.4	Cisco SmartNet warranty for 3750X switches, 1 yr	LS	6	incl. above	incl. above
1.14.5	Cisco 4 port 1GBinterface for 3750x	LS	2	incl. above	incl. above
1.15	Server Racks - HP 10642 42U				
1.15.1	HP 10642 42U Shock Rack Pallet	LS	2	incl. above	incl. above
1.15.2	HP 1U 10pk Universal Filler Panel	LS	2	incl. above	incl. above
1.15.3	HP Rack 9000/ Rack 10000 Grounding Kit	LS	2	incl. above	incl. above
1.15.4	HP 24A Low Voltage US/JP Modular PDU	LS	4	incl. above	incl. above
1.15.5	HP 10K Graphite Metallic 42U Side Panel	LS	2	incl. above	incl. above
1.15.6	Avocent Autoview 3200 digital KVM overIP	LS	2	incl. above	incl. above
1.15.7	HPiP KVMinterface adapter	LS	24	incl. above	incl. above
1.15.8	Avocent Console, 17"	LS	2	incl. above	incl. above
1.15.9	14' CAT5e cable, patch	LS	60	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.16	CAD/AVL Dispatch Workstation				
1.16.1	Intel® Xeon® W3530 2.80 8MB/1066 QC CPU	EA	58	\$ 12,104.09	\$702,037.22
1.16.2	Intel® Core™ 2 Duo E8400 3.00 GHz, 6MB Cache, 1333 MHz FSB	LS		incl. above	incl. above
1.16.3	Integrated 4-channel SAS 3Gb/s controller with RAID 0, 1, 0+1 capability	LS		incl. above	incl. above
1.16.4	160GB SAS 3Gb/s NCQ (7200 RPM)	LS		incl. above	incl. above
1.16.5	4GB (4x1GB) DDR3-1333 ECC RAM	LS		incl. above	incl. above
1.16.6	16X DVD+/-RM SuperMulti Drive	LS		incl. above	incl. above
1.16.7	USB Standard Keyboard	LS		incl. above	incl. above
1.16.8	HP USB optical scroll mouse	LS		incl. above	incl. above
1.16.9	Integratedintel Audio	LS		incl. above	incl. above
1.16.10	Integrated 10/100/1000 Gigabit PCIe	LS		incl. above	incl. above
1.16.11	nVidia NVS295 256MB PCIe Video Card	LS		incl. above	incl. above
1.16.12	HP 19' LCD Widescreen LCD	EA	116	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.2.0	Geographically separated MTMS hot standby system (2.2 - 2.15)		LS	\$ 1,237,194.21	\$ 1,237,194.21
2.2	Backup ORBCAD Application Cluster - 2 Servers				
2.2.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above
2.2.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above
2.2.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above
2.2.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above
2.2.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above
2.2.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above
2.2.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above
2.2.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above
2.2.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above
2.2.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above
2.2.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.2.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	4	incl. above	incl. above
2.2.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above
2.2.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above
2.2.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above
2.3	Backup Active SQL Cluster - 2 Servers				
2.3.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above
2.3.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above
2.3.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above
2.3.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above
2.3.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above
2.3.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above
2.3.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.3.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above
2.3.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above
2.3.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above
2.3.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above
2.3.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	4	incl. above	incl. above
2.3.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above
2.3.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above
2.3.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above
2.4	Backup LTDB SQL Cluster - 2 Servers				
2.4.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above
2.4.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above
2.4.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.4.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above
2.4.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above
2.4.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above
2.4.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above
2.4.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above
2.4.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above
2.4.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above
2.4.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above
2.4.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	4	incl. above	incl. above
2.4.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above
2.4.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above
2.4.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.5	BackupSAN				
2.5.1	HP P2000 G3 MSA FC Dual Cntrl SFF Array	LS	1	incl. above	incl. above
2.5.2	HP 146GB 6G SAS 10K 2.5in DP ENT HDD	LS	20	incl. above	incl. above
2.5.3	Factoryintegrated	LS	20	incl. above	incl. above
2.5.4	HPinstallation and Startup Service	LS	1	incl. above	incl. above
2.5.5	HP MSAinstall SVC	LS	1	incl. above	incl. above
2.5.6	HP 5m Multi-mode OM2 LC/LC FC Cable	LS	2	incl. above	incl. above
2.5.7	HP P2000 Snapshot 512 Software E-LTU	LS	1	incl. above	incl. above
2.5.8	HP P2000 Remote Snap Software E-LTU	LS	1	incl. above	incl. above
2.5.9	HP 16A High Voltage Modular PDU	LS	2	incl. above	incl. above
2.5.10	HP 8/24 Base 16-ports Enabled SAN Switch	LS	2	incl. above	incl. above
2.5.11	U.S. - English localization	LS	1	incl. above	incl. above
2.5.12	HP 3y Support Plus 24 SVC	LS	1	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.5.13	MSA2000 G3 support	LS	1	incl. above	incl. above
2.5.14	P2000 Snapshot 512 SW LTU SW Support	LS	1	incl. above	incl. above
2.5.15	P2000 Remote Snap SW LTU SW Support	LS	1	incl. above	incl. above
2.5.16	HP B-Series 8/8 and 8/24 Switch Support	LS	1	incl. above	incl. above
2.5.17	HP 3.6m C19 Nema L6-20P NA/JP Pwr Crd	LS	2	incl. above	incl. above
2.5.18	HPInstallation Service	LS	1	incl. above	incl. above
2.5.19	ProLiant Add On Optionsinstallation SVC	LS	4	incl. above	incl. above
2.5.20	LowEnd SAN/Edge Switch/HAFMInstallation	LS	1	incl. above	incl. above
2.5.21	HP MSA2000 SWInstallation	LS	2	incl. above	incl. above
2.5.22	HP 15m Multi-mode OM3 LC/LC FC Cable	LS	16	incl. above	incl. above
2.5.23	HP 8Gb Shortwave B-series FC SFP+ 1 Pack	LS	16	incl. above	incl. above
2.6	Backup Reports Server				
2.6.1	windows large san dl380g7 x 1	LS	1	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.6.2	HP DL380G7 SFF CTO Chassis	LS	1	incl. above	incl. above
2.6.3	HP E5640 DL380G7 FIO Kit	LS	1	incl. above	incl. above
2.6.4	HP E5640 DL380G7 Kit	LS	1	incl. above	incl. above
2.6.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	6	incl. above	incl. above
2.6.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	2	incl. above	incl. above
2.6.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	1	incl. above	incl. above
2.6.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	1	incl. above	incl. above
2.6.9	HP 512MB Flash Backed Write Cache	LS	1	incl. above	incl. above
2.6.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	2	incl. above	incl. above
2.6.11	HP NC360T PCIe DP Gig Adptr	LS	1	incl. above	incl. above
2.6.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	2	incl. above	incl. above
2.6.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.6.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	1	incl. above	incl. above
2.6.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	1	incl. above	incl. above
2.7	Backup DCC Server - 2 Servers				
2.7.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
2.7.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
2.7.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
2.7.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above
2.7.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above
2.8	Backup GTRMD Server - 2 Servers				
2.8.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
2.8.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
2.8.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
2.8.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.8.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above
2.9	Backup Domain Controller Servers - 2 Servers				
2.9.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
2.9.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
2.9.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
2.9.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above
2.9.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above
2.10	Backup MDC (Citrix) Server Farm - 4 Servers				
2.10.1	HP DL380 G7 X5670 Perf US Svr	LS	4	incl. above	incl. above
2.10.2	HP 2GB 2Rx8 PC3-10600R-9 Kit	LS	12	incl. above	incl. above
2.10.3	HP 146GB 6G SAS 15K 2.5in DP ENT HDD	LS	16	incl. above	incl. above
2.10.4	HP 82E 8Gb Dual-port PCI-e FC HBA	LS	4	incl. above	incl. above
2.10.5	HP NC360T PCIe Dp Gigabit Server Adapter	LS	4	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.10.6	HPiLO Adv 1-Svrincl 1yr TS&U SW	LS	4	incl. above	incl. above
2.10.7	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	4	incl. above	incl. above
2.10.8	HP 3y 24x7 SW Support	LS	4	incl. above	incl. above
2.10.9	HPiLO AdvPack NonBL SW Support	LS	4	incl. above	incl. above
2.11	Backup SmartTraveler Server - Signs (Option)				
2.11.1	windows large san dl380g7 x 1	LS	1	incl. above	incl. above
2.11.2	HP DL380G7 SFF CTO Chassis	LS	1	incl. above	incl. above
2.11.3	HP E5640 DL380G7 FIO Kit	LS	1	incl. above	incl. above
2.11.4	HP E5640 DL380G7 Kit	LS	1	incl. above	incl. above
2.11.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	6	incl. above	incl. above
2.11.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	2	incl. above	incl. above
2.11.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	1	incl. above	incl. above
2.11.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	1	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.11.9	HP 512MB Flash Backed Write Cache	LS	1	incl. above	incl. above
2.11.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	2	incl. above	incl. above
2.11.11	HP NC360T PCIe DP Gig Adptr	LS	1	incl. above	incl. above
2.11.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	2	incl. above	incl. above
2.11.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	2	incl. above	incl. above
2.11.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	1	incl. above	incl. above
2.11.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	1	incl. above	incl. above
2.12	Backup SmartTraveler Server - Web (Option)				
2.12.1	windows large san dl380g7 x 1	LS	1	incl. above	incl. above
2.12.2	HP DL380G7 SFF CTO Chassis	LS	1	incl. above	incl. above
2.12.3	HP E5640 DL380G7 FIO Kit	LS	1	incl. above	incl. above
2.12.4	HP E5640 DL380G7 Kit	LS	1	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.12.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	6	incl. above	incl. above
2.12.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	2	incl. above	incl. above
2.12.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	1	incl. above	incl. above
2.12.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	1	incl. above	incl. above
2.12.9	HP 512MB Flash Backed Write Cache	LS	1	incl. above	incl. above
2.12.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	2	incl. above	incl. above
2.12.11	HP NC360T PCIe DP Gig Adptr	LS	1	incl. above	incl. above
2.12.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	2	incl. above	incl. above
2.12.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	2	incl. above	incl. above
2.12.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	1	incl. above	incl. above
2.12.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	1	incl. above	incl. above
2.13	Backup SmartTraveler Server - SMS (Option)				

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.13.1	windows large san dl380g7 x 1	LS	1	incl. above	incl. above
2.13.2	HP DL380G7 SFF CTO Chassis	LS	1	incl. above	incl. above
2.13.3	HP E5640 DL380G7 FIO Kit	LS	1	incl. above	incl. above
2.13.4	HP E5640 DL380G7 Kit	LS	1	incl. above	incl. above
2.13.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	6	incl. above	incl. above
2.13.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	2	incl. above	incl. above
2.13.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	1	incl. above	incl. above
2.13.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	1	incl. above	incl. above
2.13.9	HP 512MB Flash Backed Write Cache	LS	1	incl. above	incl. above
2.13.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	2	incl. above	incl. above
2.13.11	HP NC360T PCIe DP Gig Adptr	LS	1	incl. above	incl. above
2.13.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax
2.13.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	2	incl. above	incl. above
2.13.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	1	incl. above	incl. above
2.13.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	1	incl. above	incl. above
2.14	Backup CAD Network Equipment				
2.14.1	Cisco 24 Port Gigabit switch withiP base functionality	LS	2	incl. above	incl. above
2.14.2	Cisco Redundant power supply for 24 port Lan base	LS	2	incl. above	incl. above
2.14.3	Cisco Redundant power supply cable	LS	2	incl. above	incl. above
2.14.4	Cisco SmartNet warranty for 3750X switches, 1 yr	LS	6	incl. above	incl. above
2.14.5	Cisco 4 port 1GBinterface for 3750x	LS	2	incl. above	incl. above
2.15	Server Racks - HP 10642 42U				
2.15.1	HP 10642 42U Shock Rack Pallet	LS	2	incl. above	incl. above
2.15.2	HP 1U 10pk Universal Filler Panel	LS	2	incl. above	incl. above
2.15.3	HP Rack 9000/ Rack 10000 Grounding Kit	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.15.4	HP 24A Low Voltage US/JP Modular PDU	LS	4	incl. above	incl. above
2.15.5	HP 10K Graphite Metallic 42U Side Panel	LS	2	incl. above	incl. above
2.15.6	Avocent Autoview 3200 digital KVM overIP	LS	2	incl. above	incl. above
2.15.7	HPiP KVMinterface adapter	LS	24	incl. above	incl. above
2.15.8	Avocent Console, 17"	LS	2	incl. above	incl. above
2.15.9	14' CAT5e cable, patch	LS	60	incl. above	incl. above
3	Underground Stationary Equipment		1	\$ 3,620,104.00	\$ 3, 620,104.00
	12 BDA's; 24 Remote Repeater Units; Antenna Kits; Combiners; Couplers			included above	included above
4	Microwave, DC Power and Other Misc Equipment		1	\$ 1,659,839.94	\$ 1,659,839.94
	Total Subcontractor Equipment				\$ 8,385,985.20
	Sales Tax				\$712,808.74
	Grand Total with Tax				\$ 9,098,793.94

Subcontractor Fix End Equipment

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax
1.3.0	Geographically separated MTMS primary fixed end system (1.3 - 1.15)		LS	\$ 1,166,809.83	\$ 1,166, 809.83
1.3	ORBCAD Application Cluster - 2 Servers				
1.3.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above
1.3.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above
1.3.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above
1.3.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above
1.3.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above
1.3.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above
1.3.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above
1.3.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above
1.3.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above
1.3.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.3.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above
1.3.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	4	incl. above	incl. above
1.3.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above
1.3.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above
1.3.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above
1.4	Active SQL Cluster - 2 Servers				
1.4.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above
1.4.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above
1.4.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above
1.4.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above
1.4.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above
1.4.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax
1.4.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above
1.4.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above
1.4.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above
1.4.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above
1.4.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above
1.4.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	4	incl. above	incl. above
1.4.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above
1.4.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above
1.4.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above
1.5	LTDB SQL Cluster - 2 Servers				
1.5.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above
1.5.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.5.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above
1.5.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above
1.5.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above
1.5.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above
1.5.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above
1.5.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above
1.5.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above
1.5.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above
1.5.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above
1.5.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	4	incl. above	incl. above
1.5.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above
1.5.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.5.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above
1.6	Shared SAN				
1.6.1	HP P2000 G3 MSA FC Dual Cntrl SFF Array	LS	1	incl. above	incl. above
1.6.2	HP 146GB 6G SAS 10K 2.5in DP ENT HDD	LS	20	incl. above	incl. above
1.6.3	Factoryintegrated	LS	20	incl. above	incl. above
1.6.4	HPinstallation and Startup Service	LS	1	incl. above	incl. above
1.6.5	HP MSAinstall SVC	LS	1	incl. above	incl. above
1.6.6	HP 5m Multi-mode OM2 LC/LC FC Cable	LS	2	incl. above	incl. above
1.6.7	HP P2000 Snapshot 512 Software E-LTU	LS	1	incl. above	incl. above
1.6.8	HP P2000 Remote Snap Software E-LTU	LS	1	incl. above	incl. above
1.6.9	HP 16A High Voltage Modular PDU	LS	2	incl. above	incl. above
1.6.10	HP 8/24 Base 16-ports Enabled SAN Switch	LS	2	incl. above	incl. above
1.6.11	U.S. - English localization	LS	1	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.6.12	HP 3y Support Plus 24 SVC	LS	1	incl. above	incl. above
1.6.13	MSA2000 G3 support	LS	1	incl. above	incl. above
1.6.14	P2000 Snapshot 512 SW LTU SW Support	LS	1	incl. above	incl. above
1.6.15	P2000 Remote Snap SW LTU SW Support	LS	1	incl. above	incl. above
1.6.16	HP B-Series 8/8 and 8/24 Switch Support	LS	1	incl. above	incl. above
1.6.17	HP 3.6m C19 Nema L6-20P NA/JP Pwr Crd	LS	2	incl. above	incl. above
1.6.18	HP installation Service	LS	1	incl. above	incl. above
1.6.19	ProLiant Add On Options installation SVC	LS	4	incl. above	incl. above
1.6.20	LowEnd SAN/Edge Switch/HAFM installation	LS	1	incl. above	incl. above
1.6.21	HP MSA2000 SW installation	LS	2	incl. above	incl. above
1.6.22	HP 15m Multi-mode OM3 LC/LC FC Cable	LS	16	incl. above	incl. above
1.6.23	HP 8Gb Shortwave B-series FC SFP+ 1 Pack	LS	16	incl. above	incl. above
1.7	Reports Server				

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.7.1	windows large san dl380g7 x 1	LS	1	incl. above	incl. above
1.7.2	HP DL380G7 SFF CTO Chassis	LS	1	incl. above	incl. above
1.7.3	HP E5640 DL380G7 FIO Kit	LS	1	incl. above	incl. above
1.7.4	HP E5640 DL380G7 Kit	LS	1	incl. above	incl. above
1.7.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	6	incl. above	incl. above
1.7.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	2	incl. above	incl. above
1.7.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	1	incl. above	incl. above
1.7.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	1	incl. above	incl. above
1.7.9	HP 512MB Flash Backed Write Cache	LS	1	incl. above	incl. above
1.7.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	2	incl. above	incl. above
1.7.11	HP NC360T PCIe DP Gig Adptr	LS	1	incl. above	incl. above
1.7.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.7.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	2	incl. above	incl. above
1.7.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	1	incl. above	incl. above
1.7.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	1	incl. above	incl. above
1.8	MDC (Citrix) Server Farm - 4 Servers				
1.8.1	windows large san dl380g7 x 1	LS	4	incl. above	incl. above
1.8.2	HP DL380G7 SFF CTO Chassis	LS	4	incl. above	incl. above
1.8.3	HP E5640 DL380G7 FIO Kit	LS	4	incl. above	incl. above
1.8.4	HP E5640 DL380G7 Kit	LS	4	incl. above	incl. above
1.8.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	24	incl. above	incl. above
1.8.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	8	incl. above	incl. above
1.8.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	4	incl. above	incl. above
1.8.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	4	incl. above	incl. above
1.8.9	HP 512MB Flash Backed Write Cache	LS	4	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.8.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	8	incl. above	incl. above
1.8.11	HP NC360T PCIe DP Gig Adptr	LS	4	incl. above	incl. above
1.8.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	8	incl. above	incl. above
1.8.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	8	incl. above	incl. above
1.8.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	4	incl. above	incl. above
1.8.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	4	incl. above	incl. above
1.9	DCC Server - 2 Servers				
1.9.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
1.9.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
1.9.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
1.9.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above
1.9.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.10	GTRMD Server - 2 Servers				
1.10.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
1.10.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
1.10.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
1.10.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above
1.10.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above
1.11	Domain Controller Servers - 2 Servers				
1.11.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
1.11.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
1.11.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
1.11.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above
1.11.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above
1.12	SNMP Server - 1 Server				

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.12.1	HP DL360G7 E5640 1P Performance US Svr	LS	1	incl. above	incl. above
1.12.2	HP E5640 DL360 G7 Processor	LS	1	incl. above	incl. above
1.12.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	3	incl. above	incl. above
1.12.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	1	incl. above	incl. above
1.12.5	Proliant Server DL36x HW Supp	LS	1	incl. above	incl. above
1.13	DIS Servers				
1.13.1	HP ML350 g6 SFF Tower Server	LS	9	incl. above	incl. above
1.13.2	HPiLO advanced server license with 24x7 technical support and updates	LS	9	incl. above	incl. above
1.13.3	Proliant Server DL36x HW Supp	LS	9	incl. above	incl. above
1.14	CAD Network Equipment				
1.14.1	Cisco 24 Port Gigabit switch withiP base functionality	LS	2	incl. above	incl. above
1.14.2	Cisco Redundant power supply for 24 port Lan base	LS	2	incl. above	incl. above
1.14.3	Cisco Redundant power supply cable	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.14.4	Cisco SmartNet warranty for 3750X switches, 1 yr	LS	6	incl. above	incl. above
1.14.5	Cisco 4 port 1GBinterface for 3750x	LS	2	incl. above	incl. above
1.15	Server Racks - HP 10642 42U				
1.15.1	HP 10642 42U Shock Rack Pallet	LS	2	incl. above	incl. above
1.15.2	HP 1U 10pk Universal Filler Panel	LS	2	incl. above	incl. above
1.15.3	HP Rack 9000/ Rack 10000 Grounding Kit	LS	2	incl. above	incl. above
1.15.4	HP 24A Low Voltage US/JP Modular PDU	LS	4	incl. above	incl. above
1.15.5	HP 10K Graphite Metallic 42U Side Panel	LS	2	incl. above	incl. above
1.15.6	Avocent Autoview 3200 digital KVM overIP	LS	2	incl. above	incl. above
1.15.7	HPiP KVMinterface adapter	LS	24	incl. above	incl. above
1.15.8	Avocent Console, 17"	LS	2	incl. above	incl. above
1.15.9	14' CAT5e cable, patch	LS	60	incl. above	incl. above
1.16	CAD/AVL Dispatch Workstation				

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
1.16.1	Intel® Xeon® W3530 2.80 8MB/1066 QC CPU	EA	58	\$ 12,104.09	\$702,037.22
1.16.2	Intel® Core™ 2 Duo E8400 3.00 GHz, 6MB Cache, 1333 MHz FSB	LS		incl. above	incl. above
1.16.3	Integrated 4-channel SAS 3Gb/s controller with RAID 0, 1, 0+1 capability	LS		incl. above	incl. above
1.16.4	160GB SAS 3Gb/s NCQ (7200 RPM)	LS		incl. above	incl. above
1.16.5	4GB (4x1GB) DDR3-1333 ECC RAM	LS		incl. above	incl. above
1.16.6	16X DVD+/-RM SuperMulti Drive	LS		incl. above	incl. above
1.16.7	USB Standard Keyboard	LS		incl. above	incl. above
1.16.8	HP USB optical scroll mouse	LS		incl. above	incl. above
1.16.9	Integratedintel Audio	LS		incl. above	incl. above
1.16.10	Integrated 10/100/1000 Gigabit PCIe	LS		incl. above	incl. above
1.16.11	nVidia NVS295 256MB PCIe Video Card	LS		incl. above	incl. above
1.16.12	HP 19' LCD Widescreen LCD	EA	116	incl. above	incl. above
2.2.0	Geographically separated MTMS hot standby system (2.2 - 2.15)		LS	\$ 1,237,194.21	\$ 1,237,194.21

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.2	Backup ORBCAD Application Cluster - 2 Servers				
2.2.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above
2.2.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above
2.2.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above
2.2.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above
2.2.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above
2.2.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above
2.2.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above
2.2.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above
2.2.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above
2.2.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above
2.2.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above
2.2.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb	LS	4	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
	Fibre Channel				
2.2.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above
2.2.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above
2.2.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above
2.3	Backup Active SQL Cluster - 2 Servers				
2.3.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above
2.3.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above
2.3.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above
2.3.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above
2.3.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above
2.3.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above
2.3.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above
2.3.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.3.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above
2.3.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above
2.3.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above
2.3.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	4	incl. above	incl. above
2.3.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above
2.3.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above
2.3.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above
2.4	Backup LTDB SQL Cluster - 2 Servers				
2.4.1	windows large san dl380g7 x 1	LS	2	incl. above	incl. above
2.4.2	HP DL380G7 SFF CTO Chassis	LS	2	incl. above	incl. above
2.4.3	HP E5640 DL380G7 FIO Kit	LS	2	incl. above	incl. above
2.4.4	HP E5640 DL380G7 Kit	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.4.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	12	incl. above	incl. above
2.4.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	4	incl. above	incl. above
2.4.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	2	incl. above	incl. above
2.4.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	2	incl. above	incl. above
2.4.9	HP 512MB Flash Backed Write Cache	LS	2	incl. above	incl. above
2.4.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	4	incl. above	incl. above
2.4.11	HP NC360T PCIe DP Gig Adptr	LS	2	incl. above	incl. above
2.4.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	4	incl. above	incl. above
2.4.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	4	incl. above	incl. above
2.4.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	2	incl. above	incl. above
2.4.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	2	incl. above	incl. above
2.5	BackupSAN				

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.5.1	HP P2000 G3 MSA FC Dual Cntrl SFF Array	LS	1	incl. above	incl. above
2.5.2	HP 146GB 6G SAS 10K 2.5in DP ENT HDD	LS	20	incl. above	incl. above
2.5.3	Factoryintegrated	LS	20	incl. above	incl. above
2.5.4	HPinstallation and Startup Service	LS	1	incl. above	incl. above
2.5.5	HP MSAinstall SVC	LS	1	incl. above	incl. above
2.5.6	HP 5m Multi-mode OM2 LC/LC FC Cable	LS	2	incl. above	incl. above
2.5.7	HP P2000 Snapshot 512 Software E-LTU	LS	1	incl. above	incl. above
2.5.8	HP P2000 Remote Snap Software E-LTU	LS	1	incl. above	incl. above
2.5.9	HP 16A High Voltage Modular PDU	LS	2	incl. above	incl. above
2.5.10	HP 8/24 Base 16-ports Enabled SAN Switch	LS	2	incl. above	incl. above
2.5.11	U.S. - English localization	LS	1	incl. above	incl. above
2.5.12	HP 3y Support Plus 24 SVC	LS	1	incl. above	incl. above
2.5.13	MSA2000 G3 support	LS	1	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax
2.5.14	P2000 Snapshot 512 SW LTU SW Support	LS	1	incl. above	incl. above
2.5.15	P2000 Remote Snap SW LTU SW Support	LS	1	incl. above	incl. above
2.5.16	HP B-Series 8/8 and 8/24 Switch Support	LS	1	incl. above	incl. above
2.5.17	HP 3.6m C19 Nema L6-20P NA/JP Pwr Crd	LS	2	incl. above	incl. above
2.5.18	HP installation Service	LS	1	incl. above	incl. above
2.5.19	ProLiant Add On Options installation SVC	LS	4	incl. above	incl. above
2.5.20	LowEnd SAN/Edge Switch/HAFM installation	LS	1	incl. above	incl. above
2.5.21	HP MSA2000 SW installation	LS	2	incl. above	incl. above
2.5.22	HP 15m Multi-mode OM3 LC/LC FC Cable	LS	16	incl. above	incl. above
2.5.23	HP 8Gb Shortwave B-series FC SFP+ 1 Pack	LS	16	incl. above	incl. above
2.6	Backup Reports Server				
2.6.1	windows large san dl380g7 x 1	LS	1	incl. above	incl. above
2.6.2	HP DL380G7 SFF CTO Chassis	LS	1	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.6.3	HP E5640 DL380G7 FIO Kit	LS	1	incl. above	incl. above
2.6.4	HP E5640 DL380G7 Kit	LS	1	incl. above	incl. above
2.6.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	6	incl. above	incl. above
2.6.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	2	incl. above	incl. above
2.6.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	1	incl. above	incl. above
2.6.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	1	incl. above	incl. above
2.6.9	HP 512MB Flash Backed Write Cache	LS	1	incl. above	incl. above
2.6.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	2	incl. above	incl. above
2.6.11	HP NC360T PCIe DP Gig Adptr	LS	1	incl. above	incl. above
2.6.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	2	incl. above	incl. above
2.6.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	2	incl. above	incl. above
2.6.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	1	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.6.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	1	incl. above	incl. above
2.7	Backup DCC Server - 2 Servers				
2.7.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
2.7.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
2.7.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
2.7.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above
2.7.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above
2.8	Backup GTRMD Server - 2 Servers				
2.8.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
2.8.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
2.8.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
2.8.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above
2.8.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.9	Backup Domain Controller Servers - 2 Servers				
2.9.1	HP DL360G7 E5640 1P Performance US Svr	LS	2	incl. above	incl. above
2.9.2	HP E5640 DL360 G7 Processor	LS	2	incl. above	incl. above
2.9.3	HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	LS	6	incl. above	incl. above
2.9.4	HP DL360 12.7mm SATA DVD-RW Kit	LS	2	incl. above	incl. above
2.9.5	Proliant Server DL36x HW Supp	LS	2	incl. above	incl. above
2.10	Backup MDC (Citrix) Server Farm - 4 Servers				
2.10.1	HP DL380 G7 X5670 Perf US Svr	LS	4	incl. above	incl. above
2.10.2	HP 2GB 2Rx8 PC3-10600R-9 Kit	LS	12	incl. above	incl. above
2.10.3	HP 146GB 6G SAS 15K 2.5in DP ENT HDD	LS	16	incl. above	incl. above
2.10.4	HP 82E 8Gb Dual-port PCI-e FC HBA	LS	4	incl. above	incl. above
2.10.5	HP NC360T PCIe Dp Gigabit Server Adapter	LS	4	incl. above	incl. above
2.10.6	HPiLO Adv 1-Svrincl 1yr TS&U SW	LS	4	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.10.7	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	4	incl. above	incl. above
2.10.8	HP 3y 24x7 SW Support	LS	4	incl. above	incl. above
2.10.9	HPiLO AdvPack NonBL SW Support	LS	4	incl. above	incl. above
2.11	Backup SmartTraveler Server - Signs (Option)				
2.11.1	windows large san dl380g7 x 1	LS	1	incl. above	incl. above
2.11.2	HP DL380G7 SFF CTO Chassis	LS	1	incl. above	incl. above
2.11.3	HP E5640 DL380G7 FIO Kit	LS	1	incl. above	incl. above
2.11.4	HP E5640 DL380G7 Kit	LS	1	incl. above	incl. above
2.11.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	6	incl. above	incl. above
2.11.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	2	incl. above	incl. above
2.11.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	1	incl. above	incl. above
2.11.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	1	incl. above	incl. above
2.11.9	HP 512MB Flash Backed Write Cache	LS	1	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax
2.11.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	2	incl. above	incl. above
2.11.11	HP NC360T PCIe DP Gig Adptr	LS	1	incl. above	incl. above
2.11.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	2	incl. above	incl. above
2.11.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	2	incl. above	incl. above
2.11.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	1	incl. above	incl. above
2.11.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	1	incl. above	incl. above
2.12	Backup SmartTraveler Server - Web (Option)				
2.12.1	windows large san dl380g7 x 1	LS	1	incl. above	incl. above
2.12.2	HP DL380G7 SFF CTO Chassis	LS	1	incl. above	incl. above
2.12.3	HP E5640 DL380G7 FIO Kit	LS	1	incl. above	incl. above
2.12.4	HP E5640 DL380G7 Kit	LS	1	incl. above	incl. above
2.12.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	6	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.12.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	2	incl. above	incl. above
2.12.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	1	incl. above	incl. above
2.12.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	1	incl. above	incl. above
2.12.9	HP 512MB Flash Backed Write Cache	LS	1	incl. above	incl. above
2.12.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	2	incl. above	incl. above
2.12.11	HP NC360T PCIe DP Gig Adptr	LS	1	incl. above	incl. above
2.12.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	2	incl. above	incl. above
2.12.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	2	incl. above	incl. above
2.12.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	1	incl. above	incl. above
2.12.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	1	incl. above	incl. above
2.13	Backup SmartTraveler Server - SMS (Option)				
2.13.1	windows large san dl380g7 x 1	LS	1	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.13.2	HP DL380G7 SFF CTO Chassis	LS	1	incl. above	incl. above
2.13.3	HP E5640 DL380G7 FIO Kit	LS	1	incl. above	incl. above
2.13.4	HP E5640 DL380G7 Kit	LS	1	incl. above	incl. above
2.13.5	HP 4GB 2Rx8 PC3-10600E-9 Kit	LS	6	incl. above	incl. above
2.13.6	HP 146GB 10K 6G 2.5 SAS DP HDD	LS	2	incl. above	incl. above
2.13.7	HP Slim 12.7mm SATA DVDRW Optical Kit	LS	1	incl. above	incl. above
2.13.8	HP DL380G6 3 Slot PCI-E Riser Kit	LS	1	incl. above	incl. above
2.13.9	HP 512MB Flash Backed Write Cache	LS	1	incl. above	incl. above
2.13.10	HP - Power cable -iEC 320 EN 60320 C13 - NEMA 5-15	LS	2	incl. above	incl. above
2.13.11	HP NC360T PCIe DP Gig Adptr	LS	1	incl. above	incl. above
2.13.12	HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	LS	2	incl. above	incl. above
2.13.13	HP 460W HE 12V Hotplg AC Pwr Supply Kit	LS	2	incl. above	incl. above

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.13.14	HPinsight Ctl ML/DL Bdl E-LTU 24x7 SW	LS	1	incl. above	incl. above
2.13.15	Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	LS	1	incl. above	incl. above
2.14	Backup CAD Network Equipment				
2.14.1	Cisco 24 Port Gigabit switch withiP base functionality	LS	2	incl. above	incl. above
2.14.2	Cisco Redundant power supply for 24 port Lan base	LS	2	incl. above	incl. above
2.14.3	Cisco Redundant power supply cable	LS	2	incl. above	incl. above
2.14.4	Cisco SmartNet warranty for 3750X switches, 1 yr	LS	6	incl. above	incl. above
2.14.5	Cisco 4 port 1GBinterface for 3750x	LS	2	incl. above	incl. above
2.15	Server Racks - HP 10642 42U				
2.15.1	HP 10642 42U Shock Rack Pallet	LS	2	incl. above	incl. above
2.15.2	HP 1U 10pk Universal Filler Panel	LS	2	incl. above	incl. above
2.15.3	HP Rack 9000/ Rack 10000 Grounding Kit	LS	2	incl. above	incl. above
2.15.4	HP 24A Low Voltage US/JP Modular PDU	LS	4	incl. above	incl. above

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICEExcl. Sales Tax
2.15.5	HP 10K Graphite Metallic 42U Side Panel	LS	2	incl. above	incl. above
2.15.6	Avocent Autoview 3200 digital KVM overIP	LS	2	incl. above	incl. above
2.15.7	HPiP KVMinterface adapter	LS	24	incl. above	incl. above
2.15.8	Avocent Console, 17"	LS	2	incl. above	incl. above
2.15.9	14' CAT5e cable, patch	LS	60	incl. above	incl. above
3	Underground Stationary Equipment		1	\$ 3,620,104.00	\$ 3, 620,104.00
	12 BDA's; 24 Remote Repeater Units; Antenna Kits; Combiners; Couplers			included above	included above
4	Microwave, DC Power and Other Misc Equipment		1	\$ 1,659,839.94	\$ 1,659,839.94
	Total Subcontractor Equipment				\$ 8,385,985.20
	Sales Tax				\$712,808.74
	Grand Total with Tax				\$ 9,098,793.94

Software License

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
3	System Software Licenses					
3.1	Primary System Software					
3.1.1	Microsoft Windows Server 2008 EnterpriseR2, 64 bit	LS	6	not separately priced	not separately priced	Each Node of clusters (OrbCAD, SQL, LTDB SQL),
3.1.2	Microsoft Windows Server 2008 Client Access License	LS	20	not separately priced	not separately priced	Total CALs for entire system
3.1.3	Microsoft Windows Server 2008 Standard R2	LS	19	not separately priced	not separately priced	Citrix Servers(4), REPORTS, (2), DCC(2), Domain Controller (2), DIS, (9)
3.1.4	Microsoft SQL STD 2008 Processor license	LS	4	not separately priced	not separately priced	One for each processor, shared per SQL cluster, unlimited clients
3.1.5	Crystal Reports Server 2008, 10 CALs	LS	4	not separately priced	not separately priced	??? Users
3.1.6	Crystal Reports Server	LS	4	not separately priced	not separately priced	Developerengine

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
	Developer Advantage					
3.1.7	Citrix Presentation server w Subscription Advantage	EA	32	not separately priced	not separately priced	For up to 32 Concurrent users
3.1.8	Microsoft Terminal Server Cals	EA	32	not separately priced	not separately priced	For up to 32 Concurrent users
3.1.9	ArcView	EA	102	not separately priced	not separately priced	58 OrbCAD local + 44 variant 4 (reduced function CAD only)
3.1.10	Service, SyBase Software License, NSS	LS	1	\$5,700.00	\$ 5,700.00	
3.1.11	Service, SyBase Sftwr License, RNM/CNM	LS	1	\$5,700.00	\$ 5,700.00	
3.1.12	License, Sql 2008 Enterprise Edition	LS	2	\$11, 250.00	\$22, 500.00	
3.2	Backup System Software					
3.2.1	Microsoft Windows Server 2008 EnterpriseR2, 64 bit	LS	6	not separately priced	not separately priced	Each Node of clusters (OrbCAD, SQL, LTDB

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
						SQL),
3.2.2	Microsoft Windows Server 2008 Client Access License	LS	20	not separately priced	not separately priced	Total CALs for entire system
3.2.3	Microsoft Windows Server 2008 Standard R2	LS	14	not separately priced	not separately priced	DCC(2), Domain Controller (2), SmartTraveler(2) Citrix Servers(4), REPORTS, (2), SmartTraveler Web (2),
3.2.4	Microsoft SQL 2008 Processor license	LS	5	not separately priced	not separately priced	One for each processor, shared per SQL cluster, SmartTraveler DB, unlimited clients
3.2.5	Crystal Reports Server 2008, 10 CALs	LS	3	not separately priced	not separately priced	
3.2.6	Crystal Reports Server Developer Advantage	LS	3	not separately priced	not separately priced	Developerengine
3.2.7	Citrix Presentation server w Subscription Advantage	EA	32	not separately priced	not separately priced	For up to 32 Concurrent data only users

Document 530 Part II (COST SCHEDULE & COST BREAKDOWN)

LINE ITEM NO.	DESCRIPTION	System (LS)/ Item (EA)*	Qty	UNIT PRICE* Excluding Sales Tax	EXTENDED PRICE Excl. Sales Tax	Notes
3.2.8	Microsoft Terminal Server Cals	EA	32	not separately priced	not separately priced	For up to 32 Concurrent data only users
3.2.9	EMC Recover Point/CE	LS	6	not separately priced	not separately priced	EMC Remote Cluster enable applicances and software for 3 clusters
3.2.10	Service, SyBase Software License, NSS	LS	1	\$5,700.00	\$ 5,700.00	
3.2.11	Service, SyBase Sftwr License, RNM/CNM	LS	1	\$5,700.00	\$ 5,700.00	
3.2.12	License, Sql 2008 Enterprise Edition	LS	2	\$11 250.00	\$22,500.00	
	Total Harris Software Licenses				\$67,800.00	
	Sales Tax				\$ 5,763.00	
	Grand Total with Tax				\$73,563.00	

RADIO SYSTEM REPLACEMENT PROJECT DESIGN BUILD SERVICES

(CONTRACT NO. 1240)

DOCUMENT 00700: GENERAL CONDITIONS

Document 0700 General Conditions
 TABLE OF CONTENTS

	<u>Page</u>
ARTICLE 1 -- CONTRACT DOCUMENTS	1
1.1. DEFINITIONS	1
1.2. CONTRACT DOCUMENTS AND CONTRACTING REQUIREMENTS	13
1.2.1. Contract Documents	13
1.2.2. Contracting Requirements	14
1.2.3. Severability	14
1.3. MEANING, INTENT AND CONSTRUCTION OF CONTRACT DOCUMENTS	15
1.4. AMENDMENT OF CONTRACT DOCUMENTS	16
1.5. PRECEDENCE OF CONTRACT DOCUMENTS.....	17
1.6. REUSE OF CONTRACT DOCUMENTS	18
1.7. FORCE MAJEURE	18
ARTICLE 2 -- CITY'S RESPONSIBILITIES AND RIGHTS.....	18
2.1. ADMINISTRATION OF THE CONTRACT	18
2.2. INFORMATION AND SERVICES.....	19
2.3. RIGHT TO STOP THE WORK.....	20
2.4. RIGHT TO CARRY OUT THE WORK	21
2.5. AUDIT AND INSPECTION OF RECORDS	21
2.6. NO WAIVER OF RIGHTS.....	23
2.7. OWNERSHIP OF DATA	23
ARTICLE 3 -- CONTRACTOR'S RESPONSIBILITIES	23
3.1. GENERAL DESIGN AND CONSTRUCTION RESPONSIBILITIES	23
3.1.1. Inclusive Services	23
3.1.2. Responsibility	23
3.1.3. Design Standard of Performance	24
3.1.4. No Waiver	24

3.1.5. Percentage of the Work to be Performed by Contractor 24

3.1.6. Qualified Personnel..... 24

3.1.7. Subcontractors 25

3.1.8. City and Other Forces 25

3.1.9. Cooperation 25

3.1.10. Quality Assurance 25

3.1.11. Contractor's License..... 25

3.1.12. Expertise 25

3.1.13. Information and Data 25

3.2. DESIGN SERVICES 25

3.2.1. Contractor Responsible for Design 26

3.2.2. Licensed Designers..... 26

3.2.3. Exception to License Requirements..... 26

3.2.4. Contractor Design Work..... 26

3.2.5. Design Documents..... 27

3.2.6. Open Design 28

3.2.7. Correction of Errors..... 28

3.2.8. Code Compliance..... 29

3.2.9. Coordination and Cooperation with City, other City Consultants and
Contractors, and Other Agencies 29

3.2.10. Ownership of Results 30

3.3. DESIGN REVIEW 31

3.3.1. Time
.....31

3.3.2. Intermediate Design 31

3.3.3. Final Design 32

3.3.4. Design Submission Requirements 32

3.4. PROJECT CONSTRUCTION 32

3.5. SUPERVISION OF THE WORK 32

3.6. CONTRACTOR'S PERSONNEL 34

 3.6.1. Sufficient Resources 34

 3.6.2. Contractor's Project Manager 34

 3.6.3. Contractor's Team..... 34

 3.6.4. Key Personnel..... 34

 3.6.5. Substitution of Key Personnel 35

 3.6.6. Departure Notice and Corrective Action Plan..... 36

 3.6.7. Reassignment Costs 36

 3.6.8. Liquidated Damages 36

3.7. UNFORESEEN OR DIFFERING CONDITIONS 37

3.8. MATERIALS AND EQUIPMENT..... 38

 3.8.1. Measurements 38

 3.8.2. Protection of Materials 38

 3.8.3. Responsibility for Materials, Tools, Labor and Site Safety 38

 3.8.4. Water Supply 38

 3.8.5. Sanitary Rules..... 39

 3.8.6. Illumination of Work..... 39

3.9. PROVISION OF UTILITIES 39

3.10. PERMITS, FEES, REGULATORY APPROVALS..... 39

3.11. DOCUMENTS41

3.12. CONTRACTOR'S DAILY REPORT 41

3.13. PROGRESS AND SUBMITTAL SCHEDULES..... 41

3.14. SUBSTITUTIONS 41

3.15. CONTROL AND USE OF SITE(S)..... 41

3.16. ACCESS TO WORK 42

3.17. CLEANING UP AND REMOVING DEBRIS..... 43

3.18. WARRANTY AND MAINTENANCE..... 43

3.19. TAXES AND POSSESSORY INTEREST..... 44

 3.19.1. Taxes 44

 3.19.2. City is Not Tax Exempt..... 45

3.19.3. Survival of Obligations..... 45

3.20. INDEMNIFICATION..... 45

3.20.1. General Indemnity 45

3.20.2. Hazardous Waste..... 46

3.20.3. Patent and Copyright Infringement..... 46

3.20.4. Duty to Defend 46

3.20.5. Insurance Does Not Limit Liability 46

3.20.6. City's Right to Settle Claims 46

3.21. LIMITS OF LIABILITY 46

3.21.1. Total Liability 46

3.21.2. Liquidated Damages 46

3.21.3. Special Damages 46

3.21.4. Exclusion from Liability Limitations..... 47

3.21.5. Survival..... 47

3.22. COPYRIGHTS AND PATENTS; INDEMNITY FOR INFRINGEMENT 47

3.23. INDEPENDENT CONTRACTOR; PAYMENT OF EMPLOYMENT TAXES AND OTHER EXPENSES 49

3.23.1. Independent Contractor..... 49

3.23.2. Payment of Employment Taxes and Other Expenses 49

3.23.3. Survival..... 50

3.24. RESPONSIBILITY FOR EQUIPMENT 50

3.25. COMPLIANCE WITH LAWS..... 50

ARTICLE 4 -- SUBCONTRACTORS 51

4.1. SUBCONTRACTING 51

4.2. QUALIFIED SUBCONTRACTORS..... 51

4.3. SUBCONTRACTUAL RELATIONS 51

4.4. SUBCONTRACTING, SUCCESSORS AND ASSIGNS 51

4.5. ASSIGNABILITY OF SUBCONTRACTS 53

ARTICLE 5 -- CONSTRUCTION BY CITY OR BY SEPARATE CONTRACTORS..... 53

5.1. CITY'S RIGHT TO PERFORM CONSTRUCTION AND TO AWARD SEPARATE CONTRACTS 53

5.2. COORDINATION 54

ARTICLE 6 -- CLARIFICATIONS AND CHANGES IN THE WORK 55

6.1. GENERALLY55

6.2. REQUESTS FOR INFORMATION, CLARIFICATIONS AND FIELD ORDERS 56

6.3. PROPOSED CHANGE ORDERS..... 56

 6.3.1. Proposed Change Order Initiation..... 56

 6.3.2. PCO Quotation Time Period 56

 6.3.3. PCO Cost Proposal Requirements..... 57

 6.3.4. PCO Time Adjustment Proposal Requirements 57

6.4. CHANGE ORDERS 57

 6.4.1. Execution of Change Orders 57

 6.4.2. Release of Claims 58

 6.4.3. Change Order is Not a Release 58

6.5. UNILATERAL CHANGE ORDERS 58

 6.5.1. General 58

 6.5.2. Protest.....58

6.6. COST OF THE CHANGE ORDER WORK..... 58

 6.6.1. **Direct Cost Defined**..... 58

 1. Equipment 59

 6.6.2. **Costs Included as Part of Markup for Overhead and Profit**.... 60

 6.6.3. **Contractor's Markup for Overhead and Profit** 61

 6.6.4. Bond and Insurance Costs 62

 6.6.5. Assignment and Costs of Subcontractors 62

 6.6.6. Adjustment of Final Quantities of Unit Price Items 62

 6.6.7. Records..... 62

 6.6.8. Escrow Documents 62

6.7. FORCE ACCOUNT WORK 63

 6.7.1. General 63

 6.7.2. Notification and Verification..... 63

 6.7.3. Reports 63

6.7.4. Records..... 64

6.7.5. Agreement 64

ARTICLE 7 -- CONTRACT TIME AND PROJECT COMPLETION 64

7.1. CONTRACT TIME..... 64

7.2. PHASE 4.1: DESIGN ENGINEERING..... 64

7.3. PHASES 4.2 AND 4.3..... 65

7.4. PHASE 4.4: INTEGRATED SYSTEM TESTING 66

7.5. PHASE 4.5: TRAINING, SYSTEM CUTOVER AND AVAILABILITY DEMONSTRATION..... 67

7.6. PROGRESS AND COMPLETION 67

7.7. DELAYS AND EXTENSIONS OF TIME 69

7.7.1. Unavoidable Delays 69

7.7.2. Avoidable Delays 70

7.7.3. Adverse Weather Delays 70

7.7.4. Notice of Delay..... 72

7.7.5. Extensions of Time..... 72

7.7.6. Extensions of Time..... 72

7.8. SUBSTANTIAL COMPLETION..... 73

7.9. PUNCH LIST COMPLETION..... 74

7.10. PARTIAL UTILIZATION 75

7.11. FINAL COMPLETION 76

ARTICLE 8 -- LIQUIDATED DAMAGES, DELAY AND NONCONFORMING WORK .. 76

8.1. LIQUIDATED DAMAGES FOR DELAY 76

8.1.1. Determination of Damages 76

8.1.2. Fair Measure of Damages..... 77

8.1.3. Delay of Substantial Completion 77

8.1.4. Delay in Final Completion 77

8.1.5. Limitation..... 77

8.2. LIQUIDATED DAMAGES FOR FAILURE TO MEET SYSTEM PERFORMANCE SPECIFICATIONS 78

8.2.1. Determination of Damages 78

8.2.2. Measure of Damages 78

8.2.3. System Availability 78

8.3. COLLECTION OF LIQUIDATED DAMAGES 81

8.4. BREACH OF CONTRACT DUE TO DELAY 81

8.5. LIMITATION OF LIABILITY FOR LIQUIDATED DAMAGES 81

ARTICLE 9 -- PAYMENT 81

9.1. CONTRACT SUM 81

9.2. PROJECT PERFORMANCE AND PAYMENT SCHEDULE 82

9.3. PAYMENTS 82

9.4. RETENTION 85

9.5. LONG LEAD ITEMS 86

9.6. TRANSFER OF TITLE AND RISK OF LOSS 87

9.7. ELECTRONIC CERTIFIED PAYROLLS 87

9.7.1. Submission of Payroll Records 87

9.7.2. Retention of Payroll Records 88

9.8. WITHHOLDING PAYMENT 89

ARTICLE 10 -- INSURANCE AND BONDS 90

10.1. INSURANCE REQUIREMENTS 90

10.1.1. Insurance 90

10.1.2. Coverage Amounts 90

10.1.3. Required Insurance Provisions 91

10.1.4. Alternate Coverage 93

10.1.5. Acceptability of Insurers 93

10.1.6. Verification of Coverage 93

10.1.7. Waiver of Subrogation 93

10.1.8. Prohibited Exclusions 94

10.1.9. If Survival of Obligations 94

10.2. PERFORMANCE BOND AND PAYMENT BOND 94

ARTICLE 11 -- LABOR STANDARDS 95

11.1. PREVAILING WAGES 95

11.2. PAYROLLS..... 96

11.3. APPRENTICES 97

11.4. LABOR STANDARDS ENFORCEMENT..... 98

ARTICLE 12 -- SAFETY..... 98

ARTICLE 13 -- PARTNERING AND CLAIMS 99

13.1. PARTNERING 99

13.2. CLAIMS..... 99

13.3. Notice of Potential Claim..... 99

13.4. Contract Claim 100

13.5. Certification Requirements..... 100

13.6. Format of a Contract Claim..... 101

ARTICLE 14 -- TERMINATION OR SUSPENSION OF THE CONTRACT 102

14.1. NOTICE OF DEFAULT; REMEDIES AND TERMINATION BY THE CITY FOR CAUSE..... 102

 14.1.1. Grounds for Default 103

 14.1.2. Bankruptcy 103

 14.1.3. Notice of Default..... 104

 14.1.4. Termination for Cause..... 104

 14.1.5. Remedies 104

 14.1.6. Suspension of Payment 105

14.2. SUSPENSION BY THE CITY FOR CONVENIENCE 105

14.3. TERMINATION BY THE CITY FOR CONVENIENCE..... 105

14.4. Loss of Project Funding 109

ARTICLE 15 -- STATUTORY REQUIREMENTS..... 109

15.1. NONDISCRIMINATION IN CONTRACTS AND BENEFITS..... 109

15.2. MINIMUM COMPENSATION ORDINANCE FOR EMPLOYEES (MCO)..... 110

15.3. HEALTH CARE ACCOUNTABILITY ORDINANCE (HCAO)..... 112

15.4. MACBRIDE PRINCIPLES - NORTHERN IRELAND 114

15.5. PROHIBITION ON POLITICAL ACTIVITY WITH CITY FUNDS..... 114

15.6. PROTECTION OF PRIVATE INFORMATION..... 114

15.7. PUBLIC RECORD - SUNSHINE ORDINANCE 114

15.8. ASSIGNMENT UNDER PUBLIC CONTRACT CODE SECTION 7103.5..... 115

15.9. TROPICAL HARDWOOD AND VIRGIN REDWOOD PRODUCTS BAN 115

15.10. PRESERVATIVE-TREATED WOOD CONTAINING ARSENIC 116

15.11. FOOD SERVICE WASTE REDUCTION REQUIREMENTS 116

15.12. GRAFFITI..... 116

15.13. FIRST SOURCE HIRING..... 117

15.14. SERVICES PROVIDED BY ATTORNEYS 117

15.15. LIMITATIONS ON CONTRIBUTIONS 118

15.16. COMPLIANCE WITH AMERICANS WITH DISABILITIES ACT 118

15.17. CONFLICT OF INTEREST 118

15.18. NON-WAIVER OF RIGHTS 119

15.19. ASSIGNMENT OF CONTRACT 119

15.20. SUBMITTING FALSE CLAIMS; MONETARY PENALTIES..... 119

15.21. EARNED INCOME CREDIT (EIC) FORMS..... 119

15.22. PUBLIC ACCESS TO MEETINGS AND RECORDS..... 120

15.23. GOODS NOT TO BE PRISON MADE 120

15.24. DISALLOWANCE..... 120

ARTICLE 16 -- FEDERAL TRANSIT ADMINISTRATION REQUIREMENTS 120

16.1. DEFINITIONS. 121

16.2. FLY AMERICA 122

16.3. BUY AMERICA 122

16.4. CARGO PREFERENCE REQUIREMENTS 123

16.5. SEISMIC SAFETY REQUIREMENTS 123

16.6. ENERGY CONSERVATION REQUIREMENTS 123

16.7. ACCESS TO RECORDS AND REPORTS 123

16.8. CLEAN AIR REQUIREMENTS 124

16.9. CLEAN WATER REQUIREMENTS 124

16.10. RECYCLED PRODUCTS 124

16.11. DAVIS-BACON AND COPELAND ANTI-KICKBACK ACTS 125

 16.11.1. Minimum Wages..... 125

 16.11.2. Withholding..... 127

16.11.3. Payrolls and Basic Records..... 127

16.11.4. Apprentices and Trainees..... 128

16.11.5. Compliance with Copeland Act Requirements 130

16.11.6. Subcontracts 130

16.11.7. Contract Termination: Debarment 130

16.11.8. Compliance with Davis-Bacon and Related Act
Requirements..... 130

16.11.9. Disputes Concerning Labor Standards..... 130

16.11.10. Certification of Eligibility 130

16.12. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT 131

16.12.1. Overtime Requirements..... 131

16.12.2. Violation; Liability for Unpaid Wages; Liquidated Damages131

16.12.3. Withholding for Unpaid Wages and Liquidated Damages 131

16.12.4. Subcontracts 131

16.13. NO GOVERNMENT OBLIGATION TO THIRD PARTIES 131

16.14. PROGRAM FRAUD AND FALSE OR FRAUDULENT STATEMENTS AND RELATED
ACTS 132

16.15. CIVIL RIGHTS REQUIREMENTS 132

16.15.1. Nondiscrimination..... 132

16.15.2. Equal Employment Opportunity 133

16.15.3. Age 134

16.15.4. Disabilities 134

16.15.5. Equal Opportunity Clauses..... 134

16.16. SUBSTANCE ABUSE 139

16.17. BONDING REQUIREMENTS 139

16.18. DEBARMENT AND SUSPENSION 140

16.19. TERMINATION FOR CONVENIENCE OF CITY 140

16.20. TERMINATION FOR DEFAULT 140

16.21. INCORPORATION OF FTA TERMS 140

16.22. FEDERAL CHANGES..... 140

16.23. PATENT RIGHTS 140

16.23.1. RIGHTS IN DATA AND COPYRIGHTS..... 141

16.23.2. Definition 141

16.23.3. Federal Restrictions 141

16.23.4. FTA Intention..... 142

16.23.5. Hold Harmless..... 142

16.23.6. Restrictions on Access to Patent Rights..... 142

16.23.7. Application to Data Incorporated into Work 142

16.23.8. Application to Subcontractors..... 143

16.23.9. Provision of Rights to Government..... 143

16.23.10. Flow Down..... 143

16.24. ITS ARCHITECTURE 143

16.25. RECYCLED PRODUCTS 143

GENERAL CONDITIONS

ARTICLE 1 -- CONTRACT DOCUMENTS

1.1. DEFINITIONS.

Wherever a word or phrase defined below, or a pronoun used in place thereof, is used in the Contract Documents, it shall have the meaning set forth in this Section 1.1. References to related Sections or Documents are provided for convenience but not to exclude other Sections or Documents where such terms may be used. The colon (":") is employed in this Section as a symbol for "shall mean". A colon also may be employed in these General Conditions or elsewhere in the Contract Documents to set off a paragraph title or heading from the text that follows or as a punctuation mark in a sentence to direct attention to the matter that follows.

The definitions of terms defined in the RFQ/RFP and RFAP shall also apply to this Contract and the Contract Documents. Definitions of verbs in the present tense also apply to the same verb in past, future tense, and gerund form. In addition to the terms defined in this Section 1.1, operative terms may also be defined in other Sections of this Agreement and in other Contract Documents. For avoidance of doubt, where the definition of a term within a particular Contract Document differs from the definition of that or a similar term in another Contract Document, the definition provided in the particular provision or Contract Document at issue shall govern. All defined terms are generally indicated by capitalization, however, the definition of a term may also apply to noncapitalized terms where the context and reason so require.

1.1.1. Accepted, Approved. Written determination and communication to Contractor by the City that the Work or relevant portion thereof meets the requirements of the Contract Documents and is satisfactory to the City, unless otherwise specified. Where used in conjunction with the City's response to submittals, requests, applications, inquiries, proposals and reports by Contractor, the term "approved" shall not limit the City or the Contractor's responsibilities and duties as specified in these General Conditions. In no case shall the City's Conditional Acceptance, Final Acceptance, or other approval be interpreted as a release of Contractor from its responsibilities to fulfill the requirements of the Contract Documents or a waiver of any of the City's rights under the Contract Documents or Laws. System Acceptance means Final Acceptance (see Section 1.1.53).

1.1.2. Application for Payment. Written request submitted by Contractor to the City for payment of Work completed in accordance with the Contract Documents. (See Section 9.3 of the General Conditions and Document 809.)

1.1.3. Architect. See "Designer."

1.1.4. Availability. The metric of Contractor performance of the Work that measures by time the ability of the SFMTA to send and receive messages and data via the Replacement Radio System. See Design Criteria Package, Doc. 0900, Section 1.2 (Design Criteria).

1.1.5. Bonds. Bid, performance and payment (labor and materials) bonds and other instruments of security acceptable to the City.

1.1.6. By Others. Work on this Project that is outside the scope of Work to be performed by Contractor under this Contract, but that will be performed by the City, other contractors, or by other means, and at other expense.

1.1.7. CDRL. CDR List. The list of Contract Data Requirements set out in Document 0900, Section 1.2 (Design Requirements).

1.1.8. Certified Amount. The value of funding that the Controller has certified is budgeted and available to be paid to Contractor under this Contract.

1.1.9. Change Order (Contract Modification). A written instrument prepared by the City issued after the effective date of the Design-Build Agreement and executed in writing by the City and Contractor, stating their agreement upon all of the following: (i) a City requested change in the Work; (ii) the amount of the adjustment in the Contract Sum, if any; (iii) the extent of the adjustment in the Contract Time, if any; and (iv) an amendment to any other Contract term or condition.

1.1.10. City. The City and County of San Francisco, California, and its constituent departments and agencies identified as such in the Design Build Agreement and referred to throughout the Contract Documents as if singular in number.

1.1.11. City Representative. The authorized representative of the City (also referenced as the "Project Manager" or the "Engineer"), identified by the City in writing and designated by the SFMTA's Director of Capital Programs and Construction, will act as the City's representative with respect to Contractor's performance of the Work and administration of the Contract. Such person shall have complete authority to transmit instructions, receive information, interpret and define the City's policies, and make decisions with respect to the performance of the Work and administration of the Contract. All communications between the City and Contractor shall be directed through the City Representative.

1.1.12. Clarification. A document consisting of supplementary details, instructions or information issued by the City which clarifies the Criteria Package or any of the Contract Documents. A Clarification does not constitute a change in Contract Work, Contract Sum or an extension of Contract Time. A Clarification is not a unilateral change order.

1.1.13. Code. Code or codes applicable to the Work. Wherever reference is made to Code, that reference shall be construed to mean applicable building codes and regulatory requirements for the Project and the constructed Work in particular.

1.1.14. Conditional Acceptance. The review, verification or approval by the SFMTA (and where applicable other stakeholders) of System designs, test results, and elements of the Work to generally confirm the appropriate progression of the Work necessary for the SFMTA to approve and issue progress payments and NTP for subsequent Phases of the Work.

1.1.15. Construction Documents. The Drawings, Specifications, and Submittals prepared by Contractor and approved by the City.

1.1.16. Construction Phase. Phase 4.2, 4.3, 4.4 and 4.5 of the Project.

1.1.17. Construction Submittal. Documents, including shop drawings, material and equipment specifications, and test reports submitted to the City by and through Contractor, indicating how Contractor and its Subcontractors intend to comply with the requirements of the Construction Documents. Submittals may also include progress and submittal schedules, product data, samples, design data, and certificates.

1.1.18. Construction Work. The performance by Contractor of all of its responsibilities and obligations under the Contract Documents for the building, erection or renovation of facilities, tunnel work and the installation of the Stationary Equipment for the Project, including providing all necessary labor, materials, equipment, and documentation to construct the Facilities and Install the Stationary Equipment.

1.1.19. Contract ("Agreement"). The Design-Build Agreement (Document 00520) and the Contract Documents (see Section 1.2 of this Document) and all documents referenced therein to be entered into by and between the City and Contractor relating to the design and construction of the Project; also referred to as the "Agreement" or the "Design Build Agreement."

1.1.20. Contract Amount. (See Contract Sum.)

1.1.21. Contract Claim. A written demand by Contractor for an adjustment in the Contract Sum or Contract Time, or both, which is submitted in accordance with the requirements of the Contract Documents. Refer to Section 13.2 of the General Conditions.

1.1.22. Contract Deliverable Requirement (CDR). Design elements, Equipment, Items and other Work to be delivered to City by Contractor for the Project, as described in the Document 0900, Section 1.2.

1.1.23. Contract Documents. Refer to Section 1.2 of the General Conditions.

1.1.24. Contract Sum. (Also the "Contract Amount" or "Total Amount.") The not-to-exceed amount stated in the Contract that Contractor guarantees is the maximum sum the City shall pay Contractor for the performance of the Work under the Contract Documents.

1.1.25. Contract Time(s). The number of successive days as stated in the Contract for the Contractor to: (i) complete the design, Furnish and Install equipment and construct, implement and test the Project; (ii) achieve Substantial Completion; (iii) achieve Punch List Completion; and (iv) achieve Final Completion. (See General Conditions, Article 7.)

1.1.26. Contracting Requirements. The Project requirements and specifications set out in the Contract Documents. Refer to Section 1.2.

1.1.27. Contractor. The person or entity selected by the City to design and build the Project and with whom the City has executed the Contract.

Contractor is referred to throughout the Contract Documents as if singular in number and neuter in gender. The term "Contractor" means Contractor and its authorized representatives and agents, employees, successors and assigns, and any persons or entities (including but not limited to Subconsultants, and Subcontractors and Suppliers for this Project) who work by, through, or for any of them.

1.1.28. Correction Period. (Refer to Warranty Period.)

1.1.29. Coverage. The metric of Contractor performance of the Work that measures by cells and geographic location the ability of the SFMTA to communicate using voice and data via the Replacement Radio System. See Document 0900, Appendix 12 § 2.

1.1.30. Data. All information and data of any type, form or nature (including but not limited to designs, drawings, blueprints, tracings, plans, models, layouts, Software documentation, user documentation and manuals, training materials, specifications, technical publications, electronic transmittals, customer website data and memoranda, test results, and data and information generated by the existing radio system and/or by the Replacement Radio System) which may be furnished, created, generated, archived, or otherwise made available to the City, directly or indirectly as a result of this Agreement.

1.1.31. Day. Reference to "day" or "Day" shall be construed to mean a calendar day of 24 hours, unless otherwise specified. A "business day" is a day other than a Saturday, Sunday or a City holiday.

1.1.32. Days. Consecutive calendar days.

1.1.33. Default. Material breach of the Contract. (See Article 14 of these General Conditions.)

1.1.34. Deficiency List. A list of Items and Work that must be completed or corrected before the City may determine that the Work has reached Substantial Completion and that the City may have beneficial use thereof.

1.1.35. Delivery. In reference to an item specified or indicated shall mean to transport to a Site and unload and store with proper protection.

1.1.36. Design. The design-related work and construction support services required to be provided by Contractor as set forth in the Contract Documents and required to be performed by properly licensed design professionals.

1.1.37. Design Criteria Package. Document 0900 of the Contract, revised by agreement of the parties and dated as March 29, 2012, which comprise the portion of the Contract Documents specifying in detail criteria and requirements for the Work, including all of its appendices and attachments. (Also referred to as the Criteria Package.)

1.1.38. Design Phase. Phase 4.1 of the Project in which Contractor shall complete the final design of the Project.

1.1.39. Design Requirements. The performance requirements set out in the Contract Documents that the Project must meet. Also referenced as "Performance Requirements."

1.1.40. Design Submittal. Documents, usually drawings and/or specifications, submitted to the City to indicate how Contractor intends to build the Project, and which if approved by the SFMTA shall be included in the Construction Documents.

1.1.41. Designer or Design Professional. A person or entity that is a member of Contractor's team who is lawfully entitled to practice architecture or engineering in the State of California and who will provide design (engineering and architecture) services for the Project. The Designer is referred to throughout the Contract Documents as if singular in number and neuter in gender. The term "the Designer" means any such professional engineer or architect and its/their authorized representatives and agents, employees, Subconsultants, successors and assigns, and any persons or entities who work by, through, or for any of them.

1.1.42. Differing Conditions. Refer to Section 3.7 of the General Conditions.

1.1.43. Director. The Director of Transportation of the SFMTA or his/her properly authorized designee(s), limited by the particular duties entrusted to them.

1.1.44. Discipline. The area of primary technical capabilities of Key Team Members, as evidenced by academic degrees, professional registration, certification, and/or extensive experience.

1.1.45. Drawings. The graphic and pictorial portions of the Construction Documents to be prepared by Contractor and approved by the City showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules, addenda, permit drawings, and diagrams.

1.1.46. Effective Date. The date indicated in the Contract on which it was executed, but if no such date is indicated it shall mean the date on which the Agreement is signed by the last of the two Parties to sign, or when the Controller of the City and County of San Francisco certifies the availability of funds, whichever is later.

1.1.47. Engineer. (See "City Representative.")

1.1.48. Environmental Review Certification. The City's final certification of the categorical exemption, environmental review or other determination of the Project's environmental impact prepared by the City or other lead agency in connection with the Project.

1.1.49. Equipment. The electronic, electrical, and mechanical apparatus Contractor shall Furnish and Install under the Contract that are necessary for the operation and maintenance of the Project, and as described in Section 1.6 of the RFP. There are two types of Equipment: Stationary Equipment and Mobile Equipment. (The term Mobile Equipment includes Vehicle Equipment.)

1.1.50. Essential Purpose. See Section 1.3.2.

1.1.51. Facilities. The structures, control rooms, vaults, foundations, and erections Contractor shall construct under the Contract for the installation and operation of the Replacement Radio System.

1.1.52. Field Order. A written order issued by the City which requires minor changes in the Work but which does not involve a change in the Contract Sum or the Contract Time.

1.1.53. Final Acceptance. (or "Final Completion.") The date of written acceptance of the Work by the City, issued in accordance with Section 6.22(K) of the San Francisco Administrative Code when the Contract has been fully performed, including all Punch List items, validation and Testing, and all contractual and administrative requirements have been fulfilled, including final adjustment of quantities. Among other specific requirements for Final Completion set forth in the Contract Documents, Final Completion shall require the issuance of final approval by the SFMTA indicating that the Project functions as required by the Contract Documents.

1.1.54. Final Design. The completion of the Design and the City approval of the Construction Documents. See Sections 3.2 and 3.3 of the General Conditions.

1.1.55. Force Account Work. Change Order Work to be paid for on the basis of direct costs plus markup on direct costs for overhead and profit as provided in Section 6.6 of the General Conditions.

1.1.56. Force Majeure. Any event arising subsequent to Effective Date which is beyond the control, and not caused by the fault or negligence, of either party, including governmental actions, war or war conditions, acts of terrorism, riots, sabotage, fire, flood, typhoons, earthquakes, accidents, hurricanes, explosions, pandemics, epidemics, quarantine restrictions, embargoes, or strikes, failure or delay of third parties or governmental bodies from whom a party is obtaining or must obtain approval, authorizations, licenses or permits (including but not limited to import or export approvals or licenses).

1.1.57. Furnish. Purchase and deliver to a Site ready for installation, including proper storage; Installation is not a subtask to Furnish. The term "Furnish" also means to Supply and Deliver to a Site.

1.1.58. General Conditions. The requirements, terms and conditions of the Contract set out in the Document 0700.

1.1.59. Hazardous Materials. Materials that are regulated due to potential or actual harm and that require special handling and licensing for demolition or disposal. (See California Health and Safety Code section 25117.)

1.1.60. Incidental Work. Activities of the Contractor that are reasonably within the general scope of the Work or are necessary to perform the Work, and therefore are within the Contract Amount.

1.1.61. Indemnitees. Those persons and entities to which Contractor shall have a duty to provide legal indemnity from claim or action, including but not limited to the City and County of San Francisco, its agencies, departments, boards

and commissions, and all of their officers, agents, members, employees, and authorized representatives.

1.1.62. Indicated. Shown or noted in the Contract Documents.

1.1.63. Install. Apply, connect, load, construct, customize, configure, integrate or erect Items for incorporation into the Project; Furnishing or Supplying is not included as a subtask of Install. The term "Install" also describes operations at a Site or Vehicle, including unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, and similar operations.

1.1.64. Installer. A person engaged by Contractor, its Subcontractor or Lower-Tier Subcontractor for performance of a particular element of construction at a Site or a Vehicle, including installation, erection, application and similar required operations.

1.1.65. Item. A separate, distinct portion of the whole Work, which may comprise material, Equipment, article, software, imbedded code, or process.

1.1.66. Intermediate Design Completion. See Section 3.3.2 of the General Conditions.

1.1.67. Job Site. Refer to "Site."

1.1.68. Key Personnel (Key Team Members). The Contractor's Project Manager and Contractor's employees and subcontractors assigned to the Project who are instrumental to the success of Project or otherwise contribute in a substantive, measurable way to the Project's development. Contractor's Key Team Members are listed in Section 3.6 of the General Conditions.

1.1.69. Law or Laws. Any one or more of all present and future applicable laws, ordinances, rules, regulations, permits, authorizations, requirements, and orders of any properly constituted authority affecting this Contract, the Work and the performance of the Work, the completed Project, and any persons connected with the Work, whether or not in the contemplation of the Parties at the Effective Date, including, without limitation, all consents or approvals required to be obtained from, and all rules and regulations of, and all building and zoning laws of all federal, state, county, and municipal governments, the departments, bureaus, agencies or commissions thereof, authorities, board of officers, any national or local board of fire underwriters, or any other body or bodies exercising similar functions, having or acquiring jurisdiction of, or which may affect or be applicable to the Project or the City's use of the Project and/or a Site or any part thereof, including, without limitation, any subsurface area, use thereof and the buildings and improvements thereon.

1.1.70. Legal Claim. A claim by Contractor against City brought under the Government Claims Act, California Government Code section 900, et seq., and San Francisco Administrative Code Chapter 10.

1.1.71. Local Office. Office maintained by Contractor in San Francisco for the Term of the Project in which the Contractor's Key Personnel shall be located.

1.1.72. Long Lead Item. Equipment listed in Section 9.5.1, herein, or that the SFMTA agrees has: (1) a purchase price of greater than \$10,000 per unit; (2)

that is highly specialized or unique, that is not readily available from suppliers; (3) for which the supplier requires advance payment; (4) that requires a lead time of more than 6 months to manufacture or otherwise procure; and (5) the absence of which would delay the Project or otherwise impact the critical path of the Project if said Item is not ordered in advance and prepaid to the supplier.

1.1.73. Lower-Tier Subconsultant, Subcontractor or Supplier. A person or entity who has a direct contract with a Subconsultant, Subcontractor or Supplier, or with another Lower-Tier Subconsultant, Subcontractor or Supplier, to perform a portion of the Work at a Site or to Furnish materials or equipment to be incorporated in the Work by Contractor, Subcontractor or Lower-Tier Subcontractor, as applicable.

1.1.74. Milestone. A defined task or set of tasks set out in Contract Deliverable Requirements (CDR) List or other deliverable that is a subset of the Project the completion of which is required on or before a certain time, and upon which a payment obligation or liquidated damages obligation arises. (See Document 530, Cost and Payment Schedule)

1.1.75. Mobile Equipment. Equipment installed on a Vehicle or carried by a person, including portable and hand-held radio sets, wire harnesses, and mobile antennas.

1.1.76. Modification. A document incorporating one or more Change Orders approved by the City.

1.1.77. Nonconforming Work. Work that, in the sole determination of the City or authorities having jurisdiction, is unsatisfactory, faulty, defective, or deficient; Work that does not conform to the requirements of the Contract Documents; Work that does not meet the requirements of inspection, reference standards, tests, or approval referred to in the Contract Documents; or Work that has been damaged or otherwise does not meet performance requirements prior to Final Completion.

1.1.78. Notice of Potential Claim. Refer to Section 13.2 of the General Conditions.

1.1.79. Notice to Proceed or NTP. Written notice issued by the City to Contractor authorizing Contractor to proceed with a Phase of the Work. NTP for Phase 4.1 establishes the date of commencement of the Contract Time.

1.1.80. Notice of Substantial Completion. Written notice issued by the City to Contractor acknowledging that the Work is Substantially Complete as determined by the City.

1.1.81. Option. Work identified in the Contract that Contractor shall perform if requested by the City for the price provided in Contractor's Proposal.

1.1.82. Owner. The Municipal Transportation Agency of the City and County of San Francisco (also referenced as the "SFMTA.")

1.1.83. Partial Utilization. Right of the City to use a portion of the Work prior to Substantial Completion of the Work. See General Conditions § 7.10.

1.1.84. Party or Parties. The City and/or Contractor, the entities that execute the Contract.

1.1.85. Payment Schedule. See Document 530. (Cost and Payment Schedule).

1.1.86. Performance Guarantees. The standards of operational performance, including system ability, functionality and availability, for the Project or portions of the Project, guaranteed by Contractor, as set forth in the Contract Documents. (See Article 4 of Document 00520.)

1.1.87. Performance Schedule. See the Project Schedule.

1.1.88. Phase. A large, defined portion of the Work or Project characterized by a focus on either the design and engineering of the Project (such as 4.1, Design Phase) or the construction, installation, implementation and testing of the Project (such as Construction Phases 4.2-4.5). (See Article 7 of the General Conditions.)

1.1.89. Phase Time. The time allowed under the Contract in which Contractor must complete the Work included within a particular Phase of the Project, measured in Days and commencing upon the date the SFMTA issues a NTP for that Phase.

1.1.90. Project. The Replacement Radio System that constitutes the Work that is to be designed, constructed, installed, configured, implemented, and tested by Contractor in accordance with the Contract Documents that will result in a fully functioning radio communications system that meets or exceeds the Contract requirements and the performance specifications set out in the Criteria Package, as they may be amended.

1.1.91. Project Manager. (See "City Representative.")

1.1.92. Project Schedule. The baseline schedule Contractor shall provide following NTP, as provided in Document 00833.

1.1.93. Proposal. The document(s) submitted to the SFMTA in response to the RFQ/RFP and RFAP; which includes: (1) the Statement of Qualifications to establish that the Proposer was qualified to perform the Work; and, (2) a proposal to perform the Work, including a cost proposal (bid), describing in greater detail Contractor's qualifications, approach, means and methods.

1.1.94. Proposed Change Order (PCO). A document prepared by the City requesting a quotation of cost or time from Contractor for additions, deletions or revisions to the Work initiated by the City.

1.1.95. Proposer. Any entity, corporation, joint venture partnership or other entity that submits a Proposal.

1.1.96. Provide. Furnish and Install, or Supply and Install, complete in place at a Site. Whenever the word or term "provide," "to be provided," "provision," or similar phrase (whether or not capitalized) is used in the Contract Documents, in regards to any and all Items or things or any part of the Project to be provided under the Contract by Contractor, this word or these phrases shall mean that Contractor shall perform all tasks and take all steps necessary to

provide the Project such Item or thing new, complete, properly configured, incorporated into the Project and in satisfactory operating condition as called for by the Criteria Package or elsewhere in the Contract Documents, at no additional cost to the City and without any change in the Contract Sum. In this regard, the above-referenced word, term or phrase shall be interpreted to include, but shall not be limited to, all design, re-design, engineering, re-engineering, coordinating, drafting, programming, administration, supervision, monitoring, management, overhead and profit, shipping and handling, delivery, installation, erection, assembly, construction, adjusting, testing, balancing, connecting, procurement, and/or rental of equipment with the necessary appurtenances, tools, devices, computer hardware and software, provision of labor and materials or any other item necessary to perform all tasks associated with and necessary to the Work, including all remedial and corrective work, and payment of all required permits fees.

1.1.97. Punch List. A list of incomplete Work, not performed Work, and Nonconforming Work that is minor in nature that Contractor must complete for the City to determine that the Work has reached Final Completion may be finally accepted by the SFMTA. (See Article 9.)

1.1.98. Quantities. The actual number of units of types of Equipment actually delivered under this Contract.

1.1.99. Record Documents. Conformed as-built design documents reflecting the final construction and configuration of the Project.

1.1.100. Reference Documents. Refer to the Request for Proposals, the Criteria Package, and in the Statement of Work for identification of Reference Documents.

1.1.101. Regular Working Hours. 7:00 a.m. to 5:00 p.m., Monday through Friday, except City legal holidays.

1.1.102. Replacement Radio System or Radio System Replacement Project. Refer to Project.

1.1.103. Request for Information (RFI). A document prepared by Contractor or the City requesting information from one of the parties regarding the Project or Contract Documents.

1.1.104. Required. In accordance with the requirements of the Contract Documents (definition applies whether or not the word is capitalized).

1.1.105. RFQ/RFP and RFAP. The Request for Qualifications/Request for Proposals to Provide Design-Build Services for the Project dated December 18, 2009, issued by the SFMTA, including all Addenda, and the Request for Amended Proposals issued December 8, 2010.

1.1.106. Section. A paragraph or Section under an Article of these General Conditions (Document 00700) and, where specifically referenced by title or document number, other Contract Documents. Refer to the "Table of Contents" for a listing of Article and Section numbers and titles. The terms Section and Subsection when referencing a portion of the Contract are synonymous.

1.1.107. Site. The real property or a SFMTA Vehicle maintenance facility or portion thereof and Vehicles thereon available to Contractor for performance of the Work, as indicated in the Contract Documents, including any access easement and temporary construction easement, and including sites designated by SFMTA for installation of Equipment into Vehicles. Also referenced as "Job Site" or "Work Area." There will be multiple Sites on the Project.

1.1.108. Software. Machine readable object code, computer program or electronic compilation of Data that is fixed in any tangible medium of expression, or any storage medium from which said code, program or Data may be perceived, reproduced or otherwise communicated, either directly or with the aid of a machine or device, and shall include without limitation any proprietary operating system that is provided for the operation or maintenance of the Replacement Radio System, any optional software to enhance the operation of the Replacement Radio System, as well as any updates, revisions, or upgrades of Software that Contractor provides to the City under a software license agreement or maintenance agreement . (including but not limited to Software License Agreement, Software Maintenance (FX) Agreement, SUMS Agreement, as listed in Section 1.2.)

1.1.109. Specifications. The system performance requirements set out in the RFQ/RFP and the Criteria Package as amended by approved Submittals and approved Construction Documents.

1.1.110. Specified. Called for or required by the Contract Documents, including, but not limited to, the Criteria Package.

1.1.111. Statement of Work (SOW). Summary of agreed changes to Contractor's Proposal submitted in response to the RFAP.

1.1.112. Stationary Equipment. Equipment that is not Mobile Equipment, which includes but is not limited to radio antennas, consoles, base stations, computers, servers, and control systems. Also referred to as Fixed End Equipment.

1.1.113. Subconsultant. A person or entity that has a direct contract with Contractor to provide professional services, such as design and/or construction administration services for the Project.

1.1.114. Subcontractor. A person or entity who has a direct contract with Contractor to perform a portion of the Work. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and neuter in gender and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" shall also include contracts assigned to Contractor if approved by the City for work on the Project.

1.1.115. Substantial Completion. When the City determines that Contractor has successfully completed the Work (with the exception of minor Punch List Work and the Work associated Option 15 - Lennnox Site) and the SFMTA has given Conditional Acceptance of all deliverables due under Phase 4.1, 4.2, 4.3, 4.4 and 4.5, including all executed Options. Substantial Completion shall also include any testing and regulatory approvals, including required permit approval of the Department of Building Inspection and any other agencies that

have regulatory approval authority over the Work (that are not City stakeholders exercising business discretion), including without limitation the receipt of a temporary certificate of occupancy issued by the agency having jurisdiction over the Work (if applicable) so that the Work can be utilized for the purposes for which it is intended. (See Sections 7.1.2 and 7.6.4 of the General Conditions.

1.1.116. Substantial Completion Date. The date that is 1110 Days from that date that the SFMTA issues NTP to Contractor to commence Work in Phase 4.1.

1.1.117. Supplemental Conditions. The part of the Contract Documents that amends, modifies, or supplements these General Conditions and provides performance criteria and requirements for the Project. The Supplemental Conditions are stated in the 00800-series Documents listed in the Table of Contents. (Also generally referenced as "Special Conditions," "Special Provisions," "Supplemental Provisions" or "Supplementary Conditions.")

1.1.118. Supplier. A manufacturer, fabricator, distributor, or vendor having a direct contract with Contractor or with a Subcontractor to Furnish materials or equipment to be incorporated in the Work.

1.1.119. Supply. Refer to "Furnish."

1.1.120. System. The Replacement Radio System to be provided under this Contract.

1.1.121. Team. The personnel on Contractor's team identified in the Proposer's Experience Statements submitted in response to the City's RFQ/RFP, and which will be agreed upon by Contractor and the City prior to the start of each Phase of Work.

1.1.122. Term. The period in which the Contract is in effect, commencing upon the Effective Date and ending upon Final Acceptance by the SFMTA.

1.1.123. Test Director. The individual or entity who coordinates the Test Plan.

1.1.124. Test Plan. A document that sets forth the organization, schedule, allocation of resources and documentation requirements for the testing of the Project.

1.1.125. Testing. A systematic quality assurance process for achieving, verifying, and documenting the performance of facilities, systems, and assemblies to ensure that they meet the requirements of the Contract Documents. The Testing process includes specific tasks during the Work to verify that design, construction and training meet the requirements of the City and third parties and regulatory agencies whose approval is required for operation of the Project.

1.1.126. Testing Agency. An independent entity engaged by the City or Contractor, as specified in the Contract Documents, to perform specific inspections or tests, either at a Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.1.127. Transit Vehicle. A SFMTA vehicle, including but not limited to a bus, trolley, streetcar, light rail vehicle, truck, automobile and other non-revenue or revenue service vehicle into which Contractor shall Install Equipment

1.1.128. Unavoidable Delay. Refer to Section 7.7 of these General Conditions.

1.1.129. Unforeseen Condition. Refer to Section 3.7 of these General Conditions.

1.1.130. Unilateral Change Order. A written Change Order issued by City to Contractor after the Effective Date in accordance with Section 6.5 of these General Conditions.

1.1.131. Vehicle. Refer to Transit Vehicle.

1.1.132. Vehicle Equipment. Equipment installed on a Vehicle, including but not limited to mobile radio sets, wire harnesses, and mobile antennas.

1.1.133. Warranty. The warranties for the Work to be provided by Contractor, as set forth in Section 3.18, Document 00835.

1.1.134. Warranty Period. The two-year period commencing on Final Acceptance during which Contractor shall provide warranty and maintenance services, as described in Section 3.18 (Warranty and Maintenance), Document 900, Appendix 12, section 8.3.1., and Document 00835.

1.1.135. Work. The performance by Contractor of all its responsibilities and obligations set forth in the Contract Documents, including but not limited to, providing all labor, and Furnishing all materials, Equipment, administrative services, design services, Testing services, and documentation required by the Contract Documents for the design and construction of the Project, including Equipment installation, testing and cutover from the existing radio system to the operational Project, and warranty obligations. References in the Contract Documents to "Work" may be to Items or subtasks or portions of Work.

1.1.136. Work Area. An area on SFMTA property that is assigned by the SFMTA for Contractor to perform the Work. See Site.

1.2. CONTRACT DOCUMENTS AND CONTRACTING REQUIREMENTS.

1.2.1. Contract Documents. The Contract Documents set forth all of the terms, conditions, requirements, obligations, and standards of performance concerning and relative to Contractor's design and construction of the Project. The Contract Documents form the entire Contract, and consist of the documents listed below and any subsequently executed modifications thereto:

- A.** Design-Build Agreement (Document 00520) and any properly executed written modifications, attachments and exhibits thereto;
- B.** Cost and Payment Schedule (Document 0530)
- C.** Performance Bond and Payment Bond (Document 01003);

- D. General Conditions (Document 00700);
- E. Supplementary Conditions (Documents 00800 et seq.);
- F. Design Criteria Package (Document 00900); as revised by the parties and dated March 29, 2012 including all appendices and attachments;
- G. Statement of Work, dated March 29, 2012;
- H. Completed Forms (Document 01000);
- I. Construction Documents approved by the City;
- J. RFQ/RFP for Design-Build Services for the Project dated December 2009, as amended by the RFAP, and all Appendices to those documents not listed elsewhere in this Section 1.5. including all Addenda in chronological order, to the extent not in conflict with any of the foregoing;
- K. Harris Software License Agreement dated March 29, 2012.
- L. Harris Software Maintenance Agreement dated March 29, 2012.
- M. Harris Security Update Management Service (SUMS) Agreement dated March 29, 2012.
- N. ACS Software License (when completed) dated for convenience March 29, 2012.
- O. Contractor's Proposal, to the extent not in conflict with any of the foregoing.

1.2.2. Contracting Requirements. The General Conditions and Supplementary Provisions contain information necessary for completion of every part of the Project and apply to all Criteria Package requirements.

A. This Document 00700 (General Conditions), the Design-Build Agreement (Document 00520), and the Documents listed in Sections 1.2 and 1.5 of this document. establish the rights, obligations and responsibilities of the Parties.

B. The Supplementary Conditions and the Design Criteria Package contain additional requirements that the Contractor must meet in its design, construction, testing and completion of the Project.

C. The Project system performance standards are set out in the Contract Documents. If a specific standard of performance for the completed Project is not stated, then the applicable industry standard applied within California to a location of similar geography and an application of similar complexity shall apply.

1.2.3. Severability. Should the application of any provision of this Contract to any particular facts or circumstances be found by a court of competent jurisdiction to be invalid or unenforceable, then (a) the validity of other provisions of this Agreement shall not be affected or impaired thereby, and (b) such provision shall be enforced to the maximum extent possible so as to effect the intent of the Parties and the Essential Purpose (see Section 1.3.2, below) of this Contract and

shall be reformed without further action by the Parties to the extent necessary to make such provision valid and enforceable.

A. Assignment. The services to be performed by Contractor are personal in character and neither this Agreement nor any duties or obligations hereunder may be assigned or delegated by Contractor unless first approved by City by written instrument executed and approved in the same manner as this Agreement.

B. Standard of System Performance. The system performance standards for the completed Project are set out in the Contract Documents. If a specific standard of performance for the completed Project is not stated, then the applicable industry standard applied within California to a radio system and communication technology project to a location of similar geography and an application of similar complexity shall apply.

1.3. MEANING, INTENT AND CONSTRUCTION OF CONTRACT DOCUMENTS.

1.3.1. The Contract Documents are complementary; what is required by one shall be as binding as if required by all.

1.3.2. The intent and Essential Purpose of the Contract Documents is to describe and provide for a functionally complete and operational Replacement Radio System to be designed, constructed, installed, configured, tested, commissioned, and provided by Contractor to and for the benefit of the SFMTA in a new, complete and satisfactory operating condition in accordance with the Contract Documents, including, but not limited to, the Criteria Package. All Work, materials, and Equipment that may reasonably be inferred from the Contract Documents as necessary to properly execute and complete the Work to conform to the requirements of the Contract Documents shall be provided by Contractor with no change in the Contract Sum or Contract Time.

1.3.3. The formation, interpretation and performance of the Contract shall be governed by and construed in accordance with the laws of the State of California, the City's Charter and Administrative Code, and other applicable Laws. Venue for all litigation relative to the formation, interpretation and performance of this Contract shall be in San Francisco. All paragraph captions are for reference only and shall not be considered in construing this Agreement.

1.3.4. In interpreting the Contract Documents, words describing materials or work with a well-known technical or trade meaning, unless otherwise specifically defined in the Contract Documents, shall be construed in accordance with such well-known meaning.

1.3.5. The conceptual and preliminary designs for the Project are set out in the Contract Criteria Package (Document 900) which sets forth the performance requirements of the Project, and the evaluation criteria and metrics for workmanship and Equipment and materials for the Work. Where necessary, and where reasonably inferable from the Contract Documents, Contractor shall adapt such representative detail for application to such corresponding parts of the Work. The details of such adaptation shall be subject to acceptance by the City.

Repetitive features shown in outline on the Design Criteria Package shall be in exact accordance with corresponding features completely shown.

1.3.6. In the event of a conflict within or among the Contract Documents regarding the quality of a product, Contractor shall request Clarification from the City as provided in Section 6.2 before procuring said product or proceeding with the Work affected thereby.

1.3.7. In the interest of brevity, the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

1.3.8. For avoidance of doubt, if there is a conflict between actual existing conditions at a Site and information indicated in the Contract Documents, other than Differing Conditions as defined in Section 3.7, the existing condition shall govern. Contractor shall perform the Work and adjust to the condition at the Site at no change in the Contract Sum and no adjustment in the Contract Time.

1.3.9. All references in the Contract Documents to satisfactory, sufficient, reasonable, acceptable, suitable, proper, correct, or adjectives of like effect shall be construed to describe an action or determination of the Engineer for the sole purpose of evaluating the completed Work for compliance with the requirements of the Contract Documents and conformance with the Essential Purpose of the Contract as expressed in Section 1.3.2. Such determinations of the Engineer shall be final and conclusive. Whenever the words "as directed," "as required," "as permitted," or words of like effect are used, it shall be understood as the direction, requirement, or permission of the SFMTA. The words "sufficient," "necessary," or "proper," and the like, mean sufficient, necessary or proper in the judgment of the SFMTA, unless otherwise indicated by the context.

1.3.10. For avoidance of doubt, wherever in any Contract Document a provision is silent as to the actor or party having the duty or obligation to perform, it is agreed that said provision(s) shall be construed so that Contractor is the actor and has the duty or obligation to perform unless the opposite result is clearly and unambiguously intended from the context of the Contract provision. The City shall be the beneficiary of all Work and actions performed in furtherance of the Work under the Contract. Where two provisions of the Contract Documents conflict, the more restrictive requirement shall apply, unless the City directs that that less restrictive requirement should apply.

1.3.11. The Contract Documents contain the entire agreement of the Parties as to the all matters described in Contract, which supersede all other oral or written provisions. The Contract may only be modified by written instrument executed as required by the terms of the Contract and applicable law.

1.4. AMENDMENT OF CONTRACT DOCUMENTS.

1.4.1. The Contract Documents may be amended after execution of the Contract to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof in only by one or more of the following ways: (i) a written Change Order, or (ii) a written Unilateral Change Order. The City shall

exercise Additive Options by use of either a Change Order or a Unilateral Change Order within the periods stated in the Statement of Work.

1.4.2. In addition, the requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized with no impact to cost or time, in one or more of the following ways: (i) a Field Order; or (ii) a Clarification, written interpretation or other written instruction issued by the City.

1.5. PRECEDENCE OF CONTRACT DOCUMENTS.

In the case of discrepancy, conflict of terms, ambiguity or silence in, among, and/or between the Contract Documents, the following order of precedence shall prevail (that is, Contract Documents are listed in descending order of highest to lowest precedence). Contract Document(s) of lower precedence are subordinate to and governed by Contract Document(s) of higher precedence. Said order of precedence shall apply to all provisions and to all Contract Documents that comprise the Agreement. Any language contained within a Contract Document of lesser precedence that attempts to create an exception to the order of precedence set out in this Section 1.5 shall be considered a drafting error and such language shall be void and have no force or effect whatsoever.

1.5.1. Modifications to the Contract executed in accordance with Section 1.4, above, in inverse chronological order and in same order as specific portions they are modifying.

1.5.2. The Executed Design Build Agreement. (Doc. 520)

1.5.3. The Design Criteria, Doc. 900, 1.2 (Design Requirements), as revised by the parties, dated March 29, 2012.

1.5.4. The Supplementary Conditions (Document series 800).

1.5.5. The General Conditions (Document 700).

1.5.6. Document 530 (Costs and Payment Schedule).

1.5.7. The approved Construction Documents.

1.5.8. The drawings included in the Criteria Package (Document 900, Section 1.1).

1.5.9. Statement of Work, dated March 29, 2012

1.5.10. RFQ/RFP as amended by the RFAP, all Addenda to the RFP and RFAP, and all Appendices to those documents not listed elsewhere in this Section 1.5.

1.5.11. The following software licenses:

(A) Executed Harris Software License Agreement dated March 29, 2012.

(B) Executed Harris Software Maintenance (FX) Agreement dated March 29, 2012.

(C) Executed Harris Security Update Management Service (SUMS) Agreement dated March 29, 2012.

(D) ACS Hardware License Agreement (when completed) dated for convenience as March 29, 2012

1.5.12. Contractor's Response to the RFAP, dated February 14, 2011.

1.5.13. Required Forms (Doc. 1000) and all other documents listed in Section 1.2.1, above.)

1.6. REUSE OF CONTRACT DOCUMENTS.

The Contract Documents were prepared for the Work of this Contract only. No part of the Contract Documents shall be used for any other construction or for any other purpose except with the written consent of the City. Any unauthorized use of the Contract Documents is at the sole liability of the user. See Section 3.2.10 and Document 00825 for specific requirements regarding the use and ownership of the Construction Documents.

1.7. FORCE MAJEURE.

In the case of a Force Majeure event, Contractor shall inform the City in writing of the event affecting the performance of the Agreement, within ten (10) business days of becoming aware of the event, and shall submit to the City a statement providing specific details of the event and the extent to which the performance of the Agreement has been affected, including any documentation of delays required by Section 13.2. Force Majeure events constitute excusable delays to the extent that the Contractor cannot mitigate or avoid said delays.

ARTICLE 2 -- CITY'S RESPONSIBILITIES AND RIGHTS.

2.1. ADMINISTRATION OF THE CONTRACT.

2.1.1. The City's involvement and oversight of the Contract and the Work is described in the Contract Documents.

2.1.2. The SFMTA's Director of Transportation or its Director of Capital Programs and Construction (or the person serving in an equivalent position of authority) will designate in writing an Engineer who will have limited authority to act on behalf of the City. The City may at any time during the performance of the Work make changes in the authority of any representative or may designate additional representatives in accordance with the City's Charter and codes. These changes will be communicated to Contractor in writing. Contractor assumes all risks and consequences of performing work pursuant to any order, including but not limited to instruction, direction, interpretation or determination, of anyone not authorized to issue such order.

2.1.3. The City's review, approval, or other action taken by the City upon Contractor's Design Submittals shall apply only as to whether the design, drawings and specifications are in conformance with the intent and requirements of the Contract Documents. The City's review, approval, or other action taken by the City upon Contractor's Construction Submittals shall be for strict compliance

with the Construction Documents. The City's action will be taken with reasonable promptness provided that the City shall be provided a reasonable time, as set forth in the General Conditions, to permit adequate review. The City's review of Contractor's work shall in no way relieve Contractor from its responsibility to complete a fully functional and operational Replacement Radio System, nor from providing all labor, tools, Equipment, and materials in accordance with the requirements of the Contract Documents necessary for the proper and timely execution of the Work. Should the City request a change that affects the cost or time of performance to a Contractor's Submittal that was previously approved by the City, and the Submittal conforms to the requirements of the Criteria Package or incorporates deviations from the Criteria Package specifically approved by the City, Contractor may submit a Contract Claim in accordance with Article 13. Contractor shall be responsible to provide design and engineering or other related services necessary to prepare the Submittals and obtain approvals required by the Contract Documents from the City or other entities that have authority over the Project. The City is not precluded, by virtue of approving a change in the requirements of the Contract Documents, from obtaining a credit for construction cost resulting from allowed concessions in the Work or materials therefore.

2.1.4. Should any question arise as to the meaning and intent of this Contract, the question shall, prior to any other action or resort to any other legal remedy, be referred to the Director or his authorized representative who shall determine its true meaning and intent.

2.2. INFORMATION AND SERVICES.

2.2.1. The City shall make a Site available to Contractor so that Contractor can inspect a Site(s) and perform the Work.

2.2.2. The City shall make available surveys and reports in its possession that describe physical characteristics, legal limitations and utility locations for a Site(s).

2.2.3. The City shall make available to Contractor as Reference Documents only, information available to the City concerning the Job Sites and the Project. The City will provide assistance with, but will not be responsible for, the filing of documents as is required to obtain necessary approvals of governmental authorities, jurisdictional agencies, or utility companies having jurisdiction over the Project or portions thereof. Such assistance may be in the form of executing permits where owner's signature is required or in the providing of information that would not otherwise be available to Contractor. Payment for related services, fees or taxes is not the responsibility of the City except as specifically provided in this Contract.

2.2.4. City shall assist Contractor as and to the extent indicated in the Contract Documents to facilitate Contractor's Work. Such assistance shall be as required in the Contract and shall be limited to responding to Contractor's inquiries and providing information that is in the SFMTA's possession, review of Contractor's designs and Work, providing timely access to facilities and Vehicles, all within the times designated in the Contract or within a reasonable time if no specific time is stated in the Contract. The SFMTA's provision of assistance to

Contractor shall not excuse or otherwise relieve Contractor of any obligation or duty under the Contract.

2.3. RIGHT TO STOP THE WORK.

2.3.1. In the event of any material breach of the Contract by Contractor, the City may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated. Any such order to stop the Work shall be in writing and shall be signed by the Engineer and, unless otherwise agreed to by the City, the Contract Time will not be extended as a result of an order to stop the Work.

2.3.2. The right of the City to stop the Work shall not give rise to a duty on the part of the City to exercise this right for the benefit of Contractor or any other person or entity.

2.3.3. Reasons for ordering Contractor to stop the Work, or a portion thereof, include but are not limited to the following:

- A.** Contractor fails to correct Work which is not in accordance with the requirements of the Contract Documents; or
- B.** Contractor fails to carry out Work in accordance with the Contract Documents; or
- C.** Contractor disregards the authority of the authorized Engineer; or
- D.** Contractor disregards the Laws or orders of a public body having jurisdiction over the Project; or
- E.** Contractor violates any material provision of the Contract Documents; or
- F.** Contractor fails to maintain current certificates of insurance on file with the City; or
- G.** Contractor is proceeding with original Contract Work, which will be modified by a pending Change Order, or
- H.** Contractor fails to maintain required State licenses to perform the Work.
- I.** Contractor commits criminal or unlawful acts.
- J.** Contractor creates safety hazards or commits acts or creates conditions that would have an immediate adverse impact on the well-being of the Project, the City, and/or Contractor's employees.

2.3.4. In the event the City intends to order Contractor to stop Work, the City shall issue a written notice to Contractor. The notice shall identify the ground(s) for ordering Contractor to stop Work and provide Contractor with a reasonable cure period or such period specifically provided in the Contract to complete necessary corrective Work and/or actions. In the event that necessary corrective Work and/or actions cannot be completed within the cure period through no fault of Contractor or its Subconsultants, Subcontractors and Suppliers, Contractor shall, within said cure period, (i) provide the City with a schedule, acceptable to the City, for completing the corrective Work and/or

actions; and (ii) commence diligently the corrective Work and/or actions. The City, after accepting Contractor's proposed schedule, will amend the stop work notice in writing to set forth the agreed-upon cure period. If Contractor fails to completely cure the ground(s) for stopping Work either (i) within the cure period set forth in the notice; or (ii) within the agreed-upon cure period set forth in an amended notice, the City may, without prejudice to any other rights or remedies that the City may have, order Contractor to stop the Work until the cause for such order has been eliminated.

2.3.5. The City's exercise of its right to stop the Work due to unsafe working conditions of the Contractor or for any other reason shall in no way affect or modify the Contractor's responsibility for maintaining safety at its Job Site(s), nor shall it in any way diminish or otherwise affect the Contractor's obligation to indemnify the City as provided in this Agreement.

2.4. RIGHT TO CARRY OUT THE WORK.

In the event that Contractor fails to carry out the Work in accordance with the Contract Documents and fails to promptly correct or prosecute the Work within such cure period(s) as may be specified in the Contract Documents or in the City's written notice, the City may, without prejudice to other remedies the City may have, correct such deficiencies. In such case, the City will, at its option, deduct all costs of such corrections, including the costs of City staff and contractors, from the Contract Sum.

2.5. AUDIT AND INSPECTION OF RECORDS.

2.5.1. Contractor shall maintain in accordance with generally accepted accounting principles and practices, complete books, accounts records and data with respect to actual time devoted and costs incurred for Work performed under this Agreement. Such documentation shall be supported by properly executed payrolls, invoices, contracts and vouchers evidencing in detail the nature and propriety of any charges and sufficient to allow a proper audit. All checks, payrolls, invoices, contracts and other accounting documents pertaining in whole or in part to the Work shall be clearly identified and readily accessible.

2.5.2. During the Term of the Contract and for a period of three (3) years following Final Acceptance, the City shall have the right to audit, examine, copy, make excerpts and transcripts, and audit all documents, whether paper, electronic, or other media, and electronically stored information, including but not limited to, any and all books, estimates, records, contracts, cost data, subcontracts, schedules and schedule analysis, job cost reports, invoices, materials, payrolls, records or personnel and other data related to all other matters covered by this Agreement, including computations and projections of Contractor, Subconsultants, Subcontractors, and Suppliers related to negotiating, pricing, or performing the Work covered by: (i) this Agreement; (ii) a Proposed Change Order Cost Proposal; (iii) a Proposed Change Order Time Adjustment Proposal; (iv) Force Account Work; or, (v) a Contract Claim; or other request for compensation. In the event that Contractor is a joint venture, said right to examine, copy and audit shall apply collaterally and to the same extent to the records of the joint venture sponsor, and those of each individual joint venture member.

2.5.3. Upon written notice by the City, Contractor immediately shall make available at its office at all reasonable times the materials noted in subsection 2.5.2 for examination, audit, or reproduction. Notice shall be in writing, delivered by hand or by certified mail, and shall provide not fewer than five-days' notice of the examination and/or audit. The City may take possession of the records and materials noted in subsection 2.5.2 by reproducing documents for off-site review or audit. When requested in the City's written notice of examination and/or audit, Contractor shall provide the City with copies of electronic documents and electronically stored information in a reasonably usable format that allows the City to access and analyze all such documents and information. For documents and information that require proprietary software to access and analyze, Contractor shall provide the City with two end user licenses with maintenance agreements authorizing the City to access and analyze all such documents and information.

2.5.4. The City has sole discretion as to the selection of an examiner or auditor and the scope of the examination or audit.

2.5.5. Contractor shall maintain such data and records in an accessible location and condition to make available in its office or in the offices of the SFMTA, as required by the SFMTA, for a period of not less than five years after final payment under this Agreement or until after final audit has been resolved, whichever is later, during which time the City shall have all audit rights provided under this Section 2.5.

2.5.6. The State of California or any federal agency having an interest in the subject matter of this Agreement shall have the same rights conferred upon City by this Section 2.5.

2.5.7. Failure by Contractor to make available any of the records or materials noted in subsection 2.5.2 or refusal to cooperate with a notice of audit shall be deemed a material breach of the Contract, for which the City may terminate the Contract for cause and seek all other remedies available including but not limited injunction or other court order requiring Contractor to produce the requested records.

2.5.8. Each party shall bear its own costs incurred in any audit under this Agreement that does not result in a finding of False Claims (see Section 15.20) or other statutory violation. If in the course of an audit, Contractor's violation of a statute is discovered, Contractor shall be liable for all audit costs, as provided by the relevant statute.

2.5.9. Contractor shall insert a clause containing all the provisions of this Section 2.5 in all subcontracts of Subconsultants, Subcontractors, Lower-Tier Subconsultants, Lower-Tier Subcontractors and Suppliers for this Contract for Work valued over \$10,000.

2.5.10. The City agrees that to the extent allowed by law and except as required to support any action or claim following an audit, the City will maintain documents and materials reviewed in the course of an audit under this Section 2.5 as confidential.

2.5.11. Contractor shall as requested by the SFMTA, participate and assist the SFMTA in any audit or inquiry by any agency with oversight authority over the SFMTA, including but not limited to the FTA.

2.6. NO WAIVER OF RIGHTS.

None of the following shall operate as a waiver of any provision of the Contract Documents or of any power herein reserved by the City or any right to damages herein provided:

2.6.1. Inspection by the City or its authorized agents or representatives;
or

2.6.2. Any order or certificate for payment, or any payment for, or acceptance of the whole or any part of the Work by the City; or

2.6.3. Any extension of time; or

2.6.4. Any position taken by the City, or its authorized agents, or representatives.

2.7. OWNERSHIP OF DATA.

The City shall own all Data entered, gathered, acquired, accumulated, processed, and/or stored by the Replacement Radio System, without limitation. Contractor shall have no right or claim whatsoever to the ownership, control or use of said Data. For avoidance of doubt, the City may in its sole and absolute discretion process, store, manipulate, and use any Data for any purpose, governmental or commercial.

ARTICLE 3 -- CONTRACTOR'S RESPONSIBILITIES

3.1. GENERAL DESIGN AND CONSTRUCTION RESPONSIBILITIES.

3.1.1. Inclusive Services. Contractor shall perform or cause to be performed and provide all architectural, engineering, technology, design, and other professional and consulting services as set forth in the Contract Documents necessary to complete the design of the Project, produce the Construction Documents, and support the construction of the Project. As provided in the Contract Documents, Contractor shall also provide all necessary construction, installation, programming, integration, and testing services necessary to construct Contractor's design of the Project. Contractor shall provide all design and construction services necessary for receipt of all permits and authorizations to commission and operate the Project. Contractor shall deliver the constructed Project so that it meets or exceeds all design and specification requirements set out in the Contract Documents, including but not limited to compliance with all City performance requirements, industry standards, all applicable codes and regulations, and Contract deadlines. Contractor assumes responsibility for on-budget, on-schedule delivery of the Project, regardless of its contractual agreements with parties other than City.

3.1.2. Responsibility. In all Work performed by Contractor and its design Subconsultants and construction Subcontractors, and materials and Equipment provided by Contractor and Suppliers, Contractor shall be responsible

for the quality, technical adequacy and accuracy, timely completion and coordination of all Work for the Project, including but not limited to plans, designs, drawings, specifications, cost estimates, reports, and other design services prepared or performed by Contractor and its design subconsultants, and all construction, demolition, fabrication, installation, testing of the Work. Contractor shall be responsible for the performance of the Work by all architects, engineers, experts, design subconsultants and construction and installation subcontractors engaged by Contractor.

3.1.3. Design Standard of Performance. Contractor shall perform the design elements of the Work to conform to highest professional standards applicable to the types of services and work provided hereunder as measured by professional engineering standards applicable in California and where more particularly applicable, the San Francisco Bay Area. The remedies stated herein for Contractor's failure to meet that standard are nonexclusive, cumulative and are in addition to any other remedy available to SFMTA under this Agreement or otherwise provided by law or in equity.

3.1.4. No Waiver. SFMTA's approval of any of the design elements of Contractor's Work or services shall not in any way relieve Contractor of responsibility for the technical adequacy or accuracy thereof or of the conformance of the Work to the Contract Documents. Neither SFMTA's review, approval, acceptance of, nor payment for any of the services or Work Product shall be construed to operate as a waiver of any rights under this Agreement.

3.1.5. Percentage of the Work to be Performed by Contractor. Contractor shall perform with its own personnel and organization, work equivalent to at least Ten Percent (10%) of the total amount of the Work to be performed under the Contract. If, during the progress of the Work hereunder, Contractor requests a reduction in such percentage and the Engineer determines that it would be to the City's advantage, the percentage of the Work required to be self-performed by Contractor may be reduced, provided written approval of such reduction is obtained by Contractor from the SFMTA. Contractor shall be responsible for and shall perform with its own organization and personnel all Systems Integration Work on the Project. Contractor shall not subcontract Systems Integration Work except with the express permission of the SFMTA

3.1.6. Qualified Personnel. Work under this Agreement shall be performed only by competent personnel under the supervision of and/or in the employment of Contractor. Contractor shall commit adequate resources to complete the Project within the Project schedule specified in this Agreement. Contractor shall at all times maintain good discipline and order at each Job Site. Upon the City's notification, Contractor shall discharge from the Work and replace, at no additional cost to the City, any employee, Subconsultant, Subcontractor or Supplier used in the Work who, in the City's sole judgment: (i) is incompetent, obnoxious, or disorderly; or (ii) has intimidated or sexually harassed a City employee, agent or member of the public; or (iii) is refusing to carry out the provisions of the Contract Documents. Contractor shall comply with City's reasonable requests regarding assignment or reassignment of its personnel, but Contractor must supervise all personnel, including those assigned or reassigned at City's request.

3.1.7. Subcontractors. Contractor shall engage at its sole expense all engineers, architects, cost estimators, experts, technology vendors and consultants, design subconsultants, and construction subcontractors as may be required for the proper performance of the Contract and completion of the Project in accordance with the Contract Documents.

3.1.8. City and Other Forces. The City reserves the right to provide design or construction services to the Project through City and other forces, in which case there will be an equitable reduction in the Contract Sum, which amount shall accrue to the benefit of City.

3.1.9. Cooperation. Contractor and City shall fully cooperate with the each other, and their respective employees, contractors, and other representatives, and representatives of other authorities that have jurisdiction over the Project, with full cooperation in the performance of their duties and responsibilities related to the Project. Such cooperation may take the form of providing appropriate personnel to attend meetings, reviews, hearings, inspections, or similar Project-related functions, and to provide documents as requested.

3.1.10. Quality Assurance. As more specifically provided in Document 00824, "Quality Programs," Contractor shall establish and maintain a Quality Assurance Plan, subject to the approval of the SFMTA, setting forth Contractor's policy for quality assurance and procedures for implementing that policy. Contractor's Quality Assurance Plan must apply to all of Contractor's employees, Subcontractors and Subconsultants performing Work on the Project, and must provide written procedures for the performance of all Project activities, and provide sufficient information to the Engineer and Contractor's senior managers to allow them to effectively supervise the Project. The procedures shall provide for sufficient documentation to allow review and audit by the SFMTA or its designees. Contractor shall submit two copies of its Quality Assurance Plan to the Engineer for SFMTA review within Ten (10) Days of the Effective Date.

3.1.11. Contractor's License. At the time of award of the Contract by the SFMTA Board of Directors and for the full term of the Contract, including all warranty periods, Contractor and all Subcontractors that will perform construction activities on the Project shall be licensed with the Department of Consumer Affairs of the State of California in the class appropriate for the construction portions of the Work contemplated. Failure of Contractor or its Subcontractors to possess such current license will be deemed a default of this Contract.

3.1.12. Expertise. Contractor represents and warrants that it, its employees, and its design Subconsultants and construction Subcontractors possess the professional and technical expertise and experience necessary to perform the Work.

3.1.13. Information and Data. Contractor shall request in writing any information and data it will require from the Agency for its Work. Contractor shall identify the timing and priority for which this information and data will be required in its request for that information. Contractor shall plan its Work to allow adequate time for the City to provide the requested information.

3.2. DESIGN SERVICES.

This Section 3.2 sets forth basic Design services to be provided by Contractor for the Project. Additional, specific requirements are set out in the Criteria Package.

3.2.1. Contractor Responsible for Design. Contract shall be wholly responsible for all the design of the Project, including engineering and design of all Items required to be designed by Contractor regardless of any contribution, input, review, participation, or coordination that the City, its agents, members, employees, and authorized representatives may have provided to Contractor or its Designer.

3.2.2. Licensed Designers. Where required by Law, design Work for the Project shall be performed by Design Professional(s) employed by or contracted to Contractor who are licensed in the State of California and have the necessary expertise and experience required to prepare design documents to enable Contractor to complete the Project in accordance with the requirements of the Contract Documents. Where required by Law, design Work shall be stamped by licensed architects or engineers, as appropriate. Such Design Professional(s) shall be vested with the authority to act on behalf of Contractor in all matters relating to design or supervision of construction of that Item(s) for which he or she is responsible. Contractor's Design Professional(s) may be replaced only with the approval of the City.

3.2.3. Exception to License Requirements. For Design Work for the Project for which there is not a state license requirement, including but not limited to Software programming and configuration, system integration, radio system coverage engineering, Contractor shall employ only Design Professionals who possess substantial experience and expertise in the design and implementation of communications systems of similar size and complexity to the Project.

3.2.4. Contractor Design Work. Contractor shall be responsible without limitation for the following:

A. Consult with authorized employees, agents and representatives of the City relative to the City's requirements for the design and construction of the Project.

B. All Work within the scope of the Contract required for the completed Project to comply with local, State and federal codes, regulations and standards, as interpreted by local, State or federal agencies, as such codes, regulations and standards may be amended during the Term of this Agreement.

C. All Work related to addressing review comments and/or incorporating appropriate review comments into deliverable documents.

D. Before undertaking each part of the Work, review the Criteria Package and Reference Documents and advise the City whether such data and documents are sufficient for purposes of design, and whether additional data is necessary before Contractor can proceed with the Work. Contractor shall identify and request additional information required from the City in writing promptly, as specified in Section 6.2 upon discovery of any conflict, error, fault, ambiguity, discrepancy, or defect in the Reference Documents or Criteria Package, and the City will reply, as provided under the Contract, as to next steps.

E. Provide additional surveys, studies, investigations, reports and information related to the Sites, which the City authorizes as necessary for the Project.

F. Provide design-related services for preparing Design Submittals and Construction Documents (stamped where required) necessary for Contractor to construct and interface the Item(s) in complete conformance with the intent and performance requirements of the Contract Documents.

G. Provide to the City design data, technical criteria and assistance necessary for supporting, protecting, and incorporating into the Project the Item(s) designed by the Design Professional.

H. Provide assistance in connection with the start-up, testing, refining and adjusting of Equipment and systems designed by the Design Professional for incorporation into the Project.

I. Assist the City in training staff and developing processes and procedures for operation, maintenance and record keeping for Equipment and systems designed by the Design Professional for incorporation into the Project.

J. Submit written reports monthly or as otherwise required by the Contract Documents and as requested by the SFMTA describing the Work completed, expected Work to be undertaken in the next month, problems encountered, and any other related or specified matters. Format for the content of such reports shall be determined by the SFMTA. The timely submission of all reports is a necessary and material term and condition of this Agreement. The reports, including any copies, shall be submitted on recycled paper and printed on double-sided pages to the maximum extent possible.

3.2.5. Design Documents.

A. Design documents and Construction Documents shall be submitted to the City for review and acceptance for conformance with the intent and performance requirements of the Contract Documents. Construction Documents bearing the stamp of Contractor's Engineer of Record or other authorized professional engineer shall be submitted to the City for review and acceptance prior to Contractor initiating permit or construction activities based on such Construction Documents. The Construction Documents approved by the City shall be the design of record for the construction of the Project.

B. The City's review, approval or acceptance of Design Documents and Construction Documents submitted by Contractor shall neither release Contractor from its responsibilities to coordinate the various portions of the design and to provide accurate and complete design documents to fulfill the intent and requirements of the Contract Documents, nor transfer any design liability from Contractor to City.

C. Contractor may use Computer Aided Design Documents ("CADD") or similar technology in developing the design for the Project. The cost of any software, hardware, clerical work, or services related to CADD support shall be included in the Contract Sum (at no additional cost to the City).

D. All Design documents and Construction Documents, including CADD and other electronic media prepared by Contractor's Design Professionals, and all other documents prepared by Contractor or its Subconsultants in connection with Design Professional services, shall be made and remain the property of the City, except as otherwise provided herein; provided, however, Contractor shall be entitled to one reproducible copy thereof, made at Contractor's expense. If the City does not already possess it, Contractor will provide the City with software that will allow the City to view and modify the electronic CADD files in an AutoCad version in accordance to the City's CADD Standard. Regardless, the CADD files shall be provided to the City in native AutoCad format prior to Final Acceptance.

E. At all times during the design of the Project, the City and its representatives shall have full access to design documents and design meetings.

F. The Design documents and Construction Documents will be prepared for the Work of the Contract only. Any unauthorized use of the Design Development Documents and Construction Documents is at the sole liability of the user. The City and Contractor may make and retain copies of the Design Documents and Construction Documents for information and reference in connection with the use and occupancy of the Project by the City.

3.2.6. Open Design. In the performance of this Agreement, Contractor shall, to the extent practicable, provide for maximum use of structures, machines, products, materials, construction methods, and equipment that are readily available through competitive procurement, or through standard or proven production techniques, methods, and processes. Unless Contractor presents evidence justifying the use of a sole source and seeks prior written approval from the SFMTA, Contractor shall not produce a design or specification for the Project that would require the use of structures, forms, machines, products, materials, construction methods, Equipment, or processes that Contractor knows or reasonably should know to be patented or that would be restrictive or written in such a manner as to contain proprietary, exclusionary, or discriminatory requirements other than those based upon performance, unless such requirements are necessary to test or demonstrate a specific thing, or to provide for necessary interchangeability of parts and equipment. When Contractor specifies in its design the use of Items that are brand names or trade names, the specification shall provide for Items of comparable quality or utility and specification must be followed by the words "or approved equal."

3.2.7. Correction of Errors. Within 7 Days of notice from SFMTA, Contractor shall, without additional compensation, commence to correct or revise (and shall also provide a schedule to the City for the completion thereof) any errors, omissions, or other deficiencies in such plans, designs, drawings, specifications, reports, and other services. In the event of any deficiencies in such plans, designs drawings, specifications, reports, or other services result from Contractor's professional negligence or from the professional negligence of Contractor or its Subcontractors and Subconsultants, whether or not said deficiencies have been brought to the attention of SFMTA, Contractor shall indemnify and reimburse SFMTA for the cost of the corrective remedial work (including, without limitation, design, demolition, and construction) necessary to

correct any such deficiencies and the consequences of such deficiencies caused by said professional negligence.

3.2.8. Code Compliance.

A. Contractor shall have knowledge of and comply with requirements of all applicable codes, regulations, and current written interpretation thereof published and in effect during Contractor's services.

B. Contractor shall be deemed to have had notice of any applicable law or regulation announced or enacted at the time of the Effective Date, even though such law or regulation did not take effect or become operative until some date after the Effective Date. In the event of changes in such codes, regulations or interpretations during the course of the Project that were not and could not have been reasonably anticipated by Contractor and which result in a substantive change to the Construction Documents, Contractor shall not be held responsible for the resulting additional costs, fees or time, and shall be entitled to reasonable additional compensation for the time and expense of responding to such changes. Contractor shall be responsible, however, to identify, analyze and report to the SFMTA pending changes to Laws, codes and regulations that would reasonably be expected to affect the design of the Project, including pending changes to the California building codes and San Francisco Building Code and other amendments.

C. Contractor shall, immediately upon becoming aware of any such imposition or change of requirement, provide SFMTA with full and detailed particulars of the changes required in the Design and Equipment and of costs involved therein, or shall be deemed to have waived any rights for additional compensation for additional effort expended to comply with the changed requirement. In the event any governmental requirements are removed, relaxed or changed in any way after the Effective Date so as to make Contractor's performance less expensive, or less difficult, then SFMTA shall have the option either to require Contractor to perform pursuant to the more rigorous requirements or to receive a reduction in the price of the equipment affected for all savings in direct costs which may be realized by Contractor by reason of such change and appropriate adjustments in deductions for overhead and profit made so as to reflect actual savings made by Contractor. SFMTA shall give Contractor notice of SFMTA's determination, and anticipated savings.

3.2.9. Coordination and Cooperation with City, other City Consultants and Contractors, and Other Agencies.

A. City Agencies. Contractor shall coordinate, meet regularly and work with the SFMTA, Engineer, and other assigned City staff or consultants, to keep the Project progressing in accordance with the Project Schedule. As directed by the SFMTA, Contractor shall coordinate, meet and work with and make presentations to other City agencies and personnel. Such departments include, but are not limited to the Department of Planning, the Department of Public Works, the San Francisco Public Utilities Commission, the Department of Building Inspection, the Fire Department, the Police Department, and the Department of Recreation and Parks, Department of Emergency Services, and

City Administrator's Office for the purposes of providing said agencies information about the Project and assisting the SFMTA in obtaining permits, licenses and other approvals required for the Project.

B. Other Agencies. As directed by the SFMTA, Contractor shall coordinate, meet, work with and make presentations to outside agencies and personnel necessary to determine relevant requirements, develop designs that conform to those requirements, obtain required review and approvals of the designs. Such agencies include the California Public Utilities Commission, the Federal Communications Commission, the Federal Transportation Agency, Bay Area Rapid Transit Authority, the State Fire Marshall, and any other State or federal agency that has regulatory authority over the Project or that has a proprietary interest in it.

C. Funding Agencies. As directed by the SFMTA, Contractor shall cooperate, meet with and make presentations to the FTA and its consultant(s), and to the San Francisco County Transportation Authority.

3.2.10. Ownership of Results.

If, in connection with the Design Professional services performed under the Contract, Contractor or its Subcontractors create artwork, copy, posters, billboards, photographs, videotapes, audiotapes, systems designs, software, reports, diagrams, surveys, blueprints, Software unique to the Project, or any other original works of authorship, such works of authorship shall be works for hire as defined under Title 17 of the United States Code, and all copyrights in such works are the property of the City. If it is ever determined that any works created by Contractor under the Contract are not works for hire under U.S. law, Contractor hereby assigns all copyrights to such works to the City, and agrees to provide any material and execute any documents necessary to effectuate such assignment. With the approval of the City, Contractor may retain and use copies of such works for reference and as documentation of its experience and capabilities.

A. All drawings, manuals, design documentation, software, firmware specifications, reports and other data and documentation (other than Software and other material that is provided under a license) that is required to be delivered under this Contract by Contractor, its assigned employees, Subconsultants and Subcontractors shall become the property of the SFMTA when submitted to and accepted by the Agency. All such data and documentation shall be delivered to the SFMTA prior to Final Completion.

B. Any interest of Contractor or its Subcontractors, in drawings, plans, specifications, blueprints, studies, reports, memoranda, computation sheets, computer files and media or other documents ("Documents") prepared by Contractor or its subcontractors for the Project shall become the property of and will be transmitted to City prior to Final Completion. However, Contractor may retain and use copies for reference and as documentation of its experience and capabilities. Contractor shall retain full ownership of Documents and other materials created by Contractor prior to the Effective Date, that are not unique to

Project, and that are proprietary to Contractor, such as Software, operations manuals, and Equipment designs, but the City shall have and is hereby granted a nontransferable perpetual license to use said materials for the limited purposes of operation and maintenance of the Replacement Radio System and any extension of the Replacement Radio System necessary due to changes in SFMTA operations.

3.3. DESIGN REVIEW.

3.3.1. Time. As provided in Section 7.2, Contractor shall complete the Intermediate Design and Final Design of the Project within 330 Days from the date the City issues NTP for Phase 4.1. The City shall have no obligation to compensate Contractor for Design Work until Contractor has successfully completed Design deliverables and met Design Milestones.

3.3.2. Intermediate Design. Contractor shall complete Intermediate Design of the Project within 190 Days from the date the City issues NTP for 4.1. Said time limit includes 30 Days for the City to review the Intermediate Design Work. The Intermediate Design Work will contain sufficient documents, drawings, specifications and other Design Submittals for the City to confirm that the Project is feasible and when constructed and fully implemented will meet Design Requirements. Intermediate Design must at a minimum contain Drawings and Specifications and other documents that address the following:

- A. Identify Design methods, formulas, assumptions and constraints;
- B. Identify and describe support requirements Contractor will need from the City, such as Site access, technical documentation for interface development;
- C. Identify Design elements that differ from the Design Criteria Package and describe any resulting Project schedule or cost impacts;
- D. Identify and quantify Project schedule, cost, and technical risks;
- E. Identify all physical impacts of construction and well describe Facility sizes, heights, locations, orientation, arrangement, footprint, construction materials and specifications, and means and methods of construction/installation;
- F. Identify all physical interfaces, including electrical, mechanical, civil work;
- G. Identify all systems for interface development;
- H. Well describe Equipment placement and cable routing;
- I. Respond to City's comments to the Design Submittals received in the first 240 Days from the City's issue of NTP for Phase 4.1;
- J. Respond and correct faults discovered during quality audit and management review processes;
- K. Describe Equipment quantities and specifications;
- L. Reconcile inch-pound vs. metric specifications and standardize design to a single measurement system;

M. Draft Cutover Plan.

3.3.3. Final Design. Contractor shall complete Final Design of the Project within sixty (60) Days from the Date the City approves the Intermediate Design. Final Design shall include the Contractor's preparation of all Specifications, Drawings, and other Construction Documents setting out in detail:

- A.** The location, size, dimensions and arrangement of the Facilities.
- B.** The performance requirements of all Equipment.
- C.** Construction, Equipment procurement, Installation, and Cutover schedules and plans.
- D.** Systems Integration plans.
- E.** All Design Deliverables.

3.3.4. Design Submission Requirements. All Design submissions (documents, specifications and drawings) from Contractor shall:

- A.** Meet and accord with all Contract Data Requirements List (CDRL) requirements and the Criteria Package;
- B.** Meet all required Codes and Standards (See Document 900, Appendix 26 "Codes & Standards");
- C.** Meet the SFMTA CADD standard;
- D.** Be clearly set out in an editable electronic format -- redlined designs will not be accepted.

3.4. PROJECT CONSTRUCTION.

3.4.1. Contractor shall construct, Install, configure and implement the Project according to the Contract Documents, as such have been amended at the time of the construction, installation or implementation.

3.4.2. The City may exercise Additive Options as provided in the Form 0530.

3.5. SUPERVISION OF THE WORK

3.5.1. Contractor shall be solely responsible to supervise fully and skillfully and coordinate the Work and control the design and construction means, methods, techniques, sequences and procedures in compliance with the Contract Documents. Contractor shall be solely responsible for Contractor's failure to carry out the Work in accordance with the Contract Documents and for the acts, errors and or omissions of Contractor, its Subconsultants and/or Subcontractors, or their agents or employees.

3.5.2. Contractor shall supervise and coordinate the Work of its Subcontractors and Subconsultants and their agents and employees so that information required by one will be furnished by others involved in time for incorporation into the Work in the proper sequence and without delay of materials, devices, or provisions for future Work.

3.5.3. Contractor shall immediately comply with and prosecute orders and instructions including, but not limited to, Change Orders, Field Orders, and Clarifications given by the City in accordance with the terms of the Contract Documents, but nothing herein contained shall be taken to relieve Contractor of any of its obligations or liabilities under the Contract Documents, or of performing its required detailed direction and supervision.

3.5.4. Contractor shall at all times permit the City, its agents and authorized representatives to: (i) view the progress of the design Work; (ii) visit and inspect the Work, the materials and the manufacture and preparation of such materials; (iii) subject the Work to inspection at all such places; and (iv) reject Work if the Work does not conform to the requirements of the Contract Documents. This obligation of Contractor shall include maintaining proper facilities and safe access for such inspection. Where the Contract requires Work to be tested or inspected, it shall not be covered before inspection and approval by the City as set forth in Article 8.

3.5.5. Whenever Contractor desires to perform Work outside Regular Working Hours or hours previously agreed and scheduled by the Parties, Contractor shall give notice to the City of such desire and request and obtain the City's written permission at least 3 business days in advance, or such other period as may be specified, prior to performing such Work. Said advance notice requirement does not apply in the event of an emergency. Contractor may be permitted or required to prosecute the Work at night or on Saturdays and/or Sundays, if at any time the Engineer deems it necessary for the proper progress of the Work. Contractor shall not perform Work on nights, Saturdays, Sundays, holidays unless permitted or required by the Engineer.

3.5.6. Contractor shall, for the duration of this Contract, have adequate workers and equipment available on short notice to protect adjoining property, maintain the Work or to make emergency repairs on Saturdays, Sundays and Holidays or during other than the normal working days. Prior to commencing Work on the Project, Contractor shall provide to the Engineer with names and telephone numbers of at least three (3) persons to call should any such emergency arise, and these persons shall be authorized to perform such work as the Engineer deems necessary.

3.5.7. Contractor acknowledges that it shall perform Work at Sites and on Vehicles that are scheduled to be used in SFMTA transit operations. Contractor shall take great care to ensure that Vehicles and Facilities scheduled for use in transit operations are available for the SFMTA's use when needed by the SFMTA.

3.5.8. If Contractor receives a written notice from the City that a Clarification or Field Order is forthcoming, all Work performed before Contractor receives the Clarification or Field Order shall be coordinated with the City to minimize reperforming Work and avoid duplication effort or wasted effort. All Work performed after receipt of the City's written notice but before receipt of the Clarification or Field Order, and not so coordinated, shall be at Contractor's risk and cost/time exposure.

3.5.9. During all disputes or disagreements with the City, Contractor shall carry on the Work and adhere to the progress schedule required to be submitted

under the requirements of the Contract Documents. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as the City and Contractor may otherwise agree in writing

3.6. CONTRACTOR'S PERSONNEL.

3.6.1. Sufficient Resources. Contractor shall devote sufficient personnel and other resources to the Project to ensure its completion within the Contract Time and within the Contract Sum. Contractor was selected in substantial part based on the specific expertise, experience, and qualifications of its personnel and of Contractor's Team. Contractor shall not reassign personnel or otherwise divert resources assigned to the Project to other contracts or projects without the prior approval of the SFMTA.

3.6.2. Contractor's Project Manager.

A. Contractor agrees to commit and assign a Project Manager, with qualifications as described in specified in RFQ/RFP Section 4.3.1(A), to direct Contractor's Work and to serve as the official contact and spokesperson on behalf of Contractor in matters related to the Project for the Term of this Contract. Contractor's Project Manager shall have signature authority to bind Contractor.

B. Contractor's Project Manager must work in Contractor's Local Office in San Francisco.

C. If Contractor is a joint venture or partnership, it shall designate only one such representative. Contractor will be held liable for the faithful compliance with such instructions.

D. Prior to commencing Work on the Project, Contractor shall inform the City in writing of the names, addresses and telephone numbers of its personnel whom it has authorized to act as its representatives at the Sites.

3.6.3. Contractor's Team. The City reserves the right in its sole discretion to:

A. Reject any member Contractor's Team, including but not limited to Contractor's Project Manager, Design Manager, Construction Manager, Project Quality Manager, Communications Engineer, Test Director, System Integration Engineer, Network Engineer, or California Licensed Professional Engineer;

B. Reject Contractor's request to replace a member of Contractor's Team members if the City believes such replacement will negatively affect the Work.

3.6.4. Key Personnel. Each Key Team Member shall make the Project his or her primary responsibility. Contractor agrees that Key Personnel shall be committed and assigned to work on the Project to the level required by SFMTA for the Term of the Agreement, during which time they shall work at the Contractor's Local Office in San Francisco for as long as may be required by the SFMTA, which shall be determined by the City Representative in his sole discretion. Contractor's Key Personnel are:

Name of Personnel	Title of Personnel
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Name of Personnel	Title of Personnel
Rick Rodriguez	Project Manager
Sean Manjal	Design Manager
Jim Netz	Constructin Manager
Cecil Adams	Project Quality Manager
Graham Buckberger	Communications Engineer
Andrej Davidson	Test Director
Steve Eiserike	System Integration Engineer
Eric Johnson	Network Engineer
Tony Ferruccio	California Lic. Prof. Engineer
Darin Stuart	California Lic. Prof. Engineer

3.6.5. Substitution of Key Personnel.

A. Substitution and Reassignment. Contractor shall not reassign or substitute Key Personnel except for extenuating circumstances, such as the substituted employee's death, illness or separation from employment with Contractor, or with the City's prior approval, which approval will not be unreasonably withheld as long as such substitution will not delay or otherwise harm the Project, which shall be determined by the SFMTA in its sole discretion. If it is necessary to substitute a Key Team Member, Contractor shall propose a replacement in writing to the City's Representative for approval. Contractor shall not reassign or substitute Key Team Members to other projects or duties until the Project is completed, unless Contractor obtains written permission to do so from the SFMTA. The SFMTA shall not unreasonably refuse Contractor's request to assign a Key Team Member to another project or duty, but such reassignment shall not delay or otherwise harm the Project, which determination shall be in the SFMTA's sole discretion. If the SFMTA agrees to allow reassignment or substitute of a Key Team Member, that person must be available to provide services on the Project to the level required by the SFMTA on notice of two (2) business days.

B. Replacement. Contractor shall replace any Key Team Member departing from the Project or departing from his/her assigned role in the Project with an individual of comparable experience on a non-temporary basis within

thirty (30) calendar days of the departure of the Key Team Member, unless the City Representative grants an extension to that time limit in writing. Contractor's failure to replace a Key Team Member may be cause for the City in its sole discretion to suspend invoice payments. Contractor shall not be relieved of its obligation for full performance of the Work as a result of any unfilled position. Contractor shall be held fully responsible for any inefficiencies, schedule delays or cost overruns resulting in whole or in part from any Key Team Member departing from the Project or departing from his/her assigned role in the Project.

C. Reassignment. Upon completion of the Design Phase (4.1), Contractor may request SFMTA authorization to reassign one or more Key Personnel with persons who have the requisite experience and expertise to provide construction services to the Project. The SFMTA shall not unreasonably deny Contractor's requests to substitute Key Personnel from the Design Phase. No less than thirty (30) calendar days prior to start of construction, Contractor shall provide for the SFMTA's consideration and review: (a) an updated organization chart; (b) identify the candidates that it seeks to assign as Key Team Members for construction, and provide those persons' respective qualifications. If the Agency rejects a candidate, Contractor shall within ten (10) working days propose another qualified candidate for SFMTA review and approval. Once accepted by SFMTA as Key Personnel, the candidate shall be subject to the restrictions on reassignment of Key Personnel set out in this Section 3.6. All communications regarding the reassignment of Key Personnel shall be in writing.

D. Continuing Availability. All Key Personnel who participate in the design of the Project and are then reassigned shall be available for consultation on the Project through the completion and acceptance of the Project.

3.6.6. Departure Notice and Corrective Action Plan. Contractor shall advise SFMTA immediately any time a Key Team Member severs employment or otherwise deviates from his or her committed role or time on the Project. Contractor shall provide a corrective action plan to replace that Key Team Member within 30 days of said notice. All candidates to replace a departing Key Team Member must have experience and expertise similar to the Key Team Member he or she would replace.

3.6.7. Reassignment Costs. Contractor shall bear any additional costs incurred in substituting personnel, including Key Personnel. Such costs include relocation expenses, expenses related to recruiting and hiring, **training** and learning on the job.

3.6.8. Liquidated Damages. Contractor acknowledges that the SFMTA's selection of Contractor and the negotiated amount of Contractor's Fixed Fee were based, in part, on the expertise and experience of Contractor's proposed Key Team Members as submitted in the Proposal. Contractor acknowledges and agrees that the replacement of Key Team Members during the course of the Project would be extremely disruptive and damaging to the City, the cost of which would be extremely difficult, if not impossible, to calculate. Contractor, therefore, shall pay to the City a charge of One Hundred Thousand Dollars (\$100,000) for the first Key Team Member whom Contractor replaces without written approval by the City. For each additional Key Team Member

whom Contractor replaces without written approval by the City, Contractor shall pay to the City a charge of Two Hundred Thousand Dollars (\$200,000). Said charges shall not be considered or act as a penalty, but shall fully compensate the City for the additional costs and inefficiencies to the Project that the Parties agree will necessarily arise from the unauthorized departure of a Key Team Member of Contractor. The SFMTA reserves the right to require Contractor to replace or reassign any personnel assigned by Contractor to the Project, including but not limited to Key Team Members. Should the City require Contractor to replace or reassign any of its personnel so that said persons are no longer working on the Project, the liquidated damages provisions of this Section 3.6 shall not apply to those persons. If the SFMTA suspends the Project for a continuous period exceeding six months, then Contractor may reassign Key Personnel without payment of liquidated damages.

3.7. UNFORESEEN OR DIFFERING CONDITIONS.

3.7.1. Under California Public Contract Code section 7104, if any of the following conditions are encountered at a Site, Contractor shall promptly, and before such conditions are disturbed, notify the City in writing of the following:

- A.** Material that Contractor believes may be material that is hazardous waste, as defined in Section 25117 of the Health and Safety Code, that is required to be removed to a Class I, Class II, or Class III disposal site in accordance with provisions of existing Law;
- B.** Subsurface or latent physical conditions at a Site differing materially from those indicated by information about a Site made available to proposers prior to the deadline for submitting proposals;
- C.** Unknown physical conditions at a Site of any unusual nature, different materially from those ordinarily encountered and generally recognized as inherent in the work of the character provided for in the Contract Documents.

3.7.2. Contractor's written notice shall inform the City as to how such Differing Conditions affect its Work and recommend methods to overcome such conditions.

3.7.3. Differing Conditions shall not include:

- A.** All that is indicated in or reasonably interpreted from the Contract Documents or Reference Documents;
- B.** All that could be seen on a Site, by diligent observation prior to the Contractor's submission of its Proposal;
- C.** Conditions that are materially similar or characteristically the same as those indicated or described in the Contract Documents or Reference Documents;
- D.** Conditions where the location of a building component is in the proximity where indicated in or reasonably interpreted from the Contract Documents or Reference Documents.

3.7.4. The City will promptly investigate the conditions reported in Contractor's written notice of Differing Conditions, and will issue a written report of its findings to Contractor.

3.7.5. Only if the City determines, in its sole discretion, that the conditions reported do materially so differ, or do involve hazardous waste (including asbestos), or do cause a decrease or increase in Contractor's scope of Work, will the City issue a Change Order, as provided in Article 6, herein, and/or a time extension as provided in Article 7, as appropriate.

3.7.6. Should Contractor disagree with the City's determination, Contractor shall submit a written Notice of Potential Claim to the City as provided in Article 13 of these General Conditions. In the event of such disagreement, Contractor shall proceed with all Work to be performed under the Contract Documents, and shall not be excused from any scheduled completion date provided for by the Contract Documents.

3.7.7. Contractor shall be responsible for the safety and protection of the affected Site or Work Area for the duration of the City's investigation of potential Differing Conditions.

3.8. MATERIALS AND EQUIPMENT.

3.8.1. Measurements. Contractor shall be solely responsible for all measurements required for proper fabrication, manufacture, construction, installation, configuration and integration of the Work before ordering Equipment or materials or performing construction activities.

3.8.2. Protection of Materials. All materials and equipment shall be delivered, handled, stored, installed, and protected to prevent damage in accordance with best current practice in the industry, manufacturers' specifications and recommendations, and the requirements of the Contract Documents. Contractor shall store packaged materials and Equipment at designated a Site(s) approved by the SFMTA or at an appropriate storage facility approved by the SFMTA. Contractor shall store such materials in their original and sealed containers, marked with the brand and manufacturer's name, until ready for use. Contractor shall deliver materials and equipment in ample time to facilitate inspection and tests prior to installation.

3.8.3. Responsibility for Materials, Tools, Labor and Site Safety. Contractor shall provide and assume full responsibility for all materials, Equipment, labor, transportation, construction equipment, machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, field offices, storage facilities, safety equipment and procedures, and incidentals necessary for the safe construction, installation, configuration, performance, testing, start-up, adjusting and balancing, and completion of the Work, including preparation of operation and maintenance manuals, training personnel for operation and maintenance, Job Site safety, and consultation regarding operations and maintenance in accordance with the Contract.

3.8.4. Water Supply. Where Contractor is performing Work at a Job Site that does not have convenient access to or sufficient supply of water both to support the Work and for potable consumption by Contractor's Personnel,

Contractor shall provide at convenient points ample water supply of satisfactory quality for all operations required under this Contract at no additional cost to the City.

3.8.5. Sanitary Rules. All portions of the Work shall be maintained at all times in neat, clean and sanitary condition. Where Contractor is performing Work at a Job Site that does not have convenient access to existing bathrooms. Toilets shall be furnished by Contractor for the use of Contractor Personnel and City personnel on the Work, and their use shall be strictly enforced. All toilets shall have facilities for hand washing. They shall be properly secluded from public observation, and shall be located, constructed and maintained subject to the approval of the Engineer.

3.8.6. Illumination of Work. When any Work is performed at night, in tunnels, stations, or any other Site where daylight is shut off or obscured, Contractor shall provide artificial light sufficient to prosecute the Work properly and safely and to permit thorough inspection.

3.9. PROVISION OF UTILITIES.

Unless otherwise provided in the Contract Documents, the cost of all utility charges for connection to the Work shall be the responsibility of Contractor and included in the Contract Sum.

3.9.1. Contractor shall be responsible for obtaining temporary power from PG&E for use during construction (on a separate meter). All associated costs shall be the responsibility of Contractor and included in the Contract Sum.

3.9.2. For Sites that require new electrical service, the City will submit the application for new, permanent electric service to PG&E, and pay the associated application fee. The City will be responsible for any fees imposed by PG&E for upgrading the existing service to the Job Sites.

3.9.3. Contractor shall provide all technical information to accompany the City's application to PG&E, as well as any additional information that PG&E may require to implement the new service.

3.10. PERMITS, FEES, REGULATORY APPROVALS.

3.10.1. Except as to FCC 700 and 800 MHz frequency licenses and unless otherwise provided in the Contract Documents, Contractor shall secure and pay for all permits, governmental fees and applicable taxes, including but not limited to sales taxes, licenses, and inspections (other than inspections which are to be performed at the expense of the City, as provided in Article 8, below) necessary for proper execution and completion of the Work, and such costs shall be included in the Contract Sum.

A. Contractor shall coordinate and obtain all permits, approvals, and authorizations of governmental agencies with jurisdiction for the design and construction of the Project prior to starting Work for which permits are required. Contractor shall be solely responsible for obtaining any such regulatory approval, provided, Contractor shall not seek any regulatory approval without first obtaining the approval of the City, which shall not be unreasonably withheld or delayed.

B. Contractor shall consult and coordinate with the City in Contractor's efforts to obtain regulatory and permit approvals. All costs to Contractor associated with applying for and obtaining any necessary regulatory approvals shall be borne by Contractor and are included in the Contract Sum. The City may at its option either join any application by Contractor or independently apply for a required regulatory permit and execute the permit,

C. Contractor shall be solely responsible, at its sole cost and expense, for complying during the Term of the Contract with any and all conditions imposed by regulatory agencies as part of a regulatory approval. Any fines or penalties imposed as a result of the failure of Contractor to comply with the terms and conditions of any regulatory approval shall be paid and discharged by Contractor, and the City shall have no liability, monetary or otherwise, for such fines and penalties.

D. Without limiting any other indemnification provisions of the Contract Documents, Contractor agrees to and shall indemnify the City and all Indemnitees from and against any and all losses which may arise in connection with Contractor's failure to obtain or comply with the terms and conditions of any regulatory approval, to the extent that such losses are not the result of the SFMTA's acts or failure to act.

E. Permits to be secured and paid for by Contractor that may be required to perform the Work include, but are not limited to, the following: (i) hazardous material storage permit issued by the City; (ii) permit for diesel generator issued by the Bay Area Air Pollution Control District; and (iii) permit from the city and/or county Fire Marshall having jurisdiction over a Site(s).

F. Contractor is responsible for obtaining Building Permits through the San Francisco Department of Building Inspections (SFDBI).

3.10.2. Contractor shall keep the permits, an approved set of Drawings and Specifications, and a copy of the Code at a Site readily available for inspection during regular working hours for the duration of the Contract.

3.10.3. Contractor shall coordinate all required inspections and special inspections with the appropriate agency having jurisdiction. Contractor shall provide the Engineer and the City's Testing Agency or special inspector no less than fourteen (14) Days notice of the date and time of an inspection, so that the appropriate Engineers and inspectors can be present at the inspections.

3.10.4. Contractor shall be responsible for preparing and submitting for approval to the appropriate agency having jurisdiction, all shop drawings, product data, and manufacturer's certificates as may be required under the conditions of all applicable permits.

3.10.5. Contractor shall submit to the Engineer prior to Substantial Completion all signed permit documents including but not limited to job cards, permit applications, permit Drawings, permit conditions, and certificates of occupancy.

3.10.6. Under Section 832 of the California Civil Code, Contractor shall provide all notices to third parties and to the City that may be required concerning

lateral and subjacent support relative to the performance of any Work requiring excavation or access to property outside the site.

3.11. DOCUMENTS.

3.11.1. Contractor shall maintain at Contractor's Local Office, a current record copy of all Contract Documents including, but not limited to, Drawings, Specifications, Addenda, Change Orders, RFIs, Clarifications, Field Orders, and approved shop drawings, samples and other submittals, in good order and clearly marked to record changes and selections made during construction.

3.11.2. Record Documents shall be available for inspection by the City at all times. Record Documents bearing the stamp of Contractor's Engineer of Record or other authorized professional engineer shall be delivered to the City prior to final acceptance (Final Completion). Record Documents shall conform to the requirements of the Contract.

3.11.3. So that the City can determine whether Contractor has complied or is complying with the requirements of the Contract Documents that are not readily enforceable by inspection and test of the Work and materials, Contractor shall upon City's request submit properly authenticated documents or other satisfactory proof of its compliance with such requirements with no adjustment to the Contract Sum or Contract Time.

3.12. CONTRACTOR'S DAILY REPORT.

For each Day that it performs construction activities, Contractor shall complete, and submit to the City on the next business day, consecutively numbered daily construction reports stating the Work performance and other information as the SFMTA may require.

3.13. PROGRESS AND SUBMITTAL SCHEDULES.

Contractor shall expediently submit to the City for review all schedules in accordance with the deadlines and requirements set forth in the Contract Documents.

3.14. SUBSTITUTIONS.

3.14.1. Contractor may submit for approval to the City a properly completed request for substitution for each Item, material, article or piece of Equipment that it proposes to substitute in place, and as the equal, of a material, article or equipment that is Specified in the Contract Documents by trade name or by the names of any particular patentee, manufacturer or dealer. The City shall not be required to accept a substitute in place of any specified material and/or Equipment.

3.14.2. The requirements for obtaining approval of substitutions shall be as specified in the Contract Documents (see Document 00816).

3.15. CONTROL AND USE OF SITE(S).

3.15.1. As more specifically provided in Document 00828 (Health and Safety), and notwithstanding any other requirements of this Contract, for purposes of ensuring the safety and protection of persons and property on a Job Site from harm arising out of Contractor's Work on that Site, the City delegates control to

Contractor of each Job Site and Work Area for the duration of time that Contractor is performing Work on said Site

3.15.2. Contractor shall confine its operations at Job Sites to areas permitted by law and the Contract Documents and as directed by the Engineer. Contractor shall not unreasonably encumber a Job Site with materials, tools or equipment. Notwithstanding the designation of Contract limits or the indication of temporary fences or barricades, the provisions of the Contract Documents governing certain portions or phases of the Work may require that certain operations be carried out beyond such designated limits. In all cases, the Work shall be performed solely within the boundaries described in the approved Construction Documents or as otherwise allowed under the Contract Documents. Contractor shall coordinate with the City to confirm that the City has obtained in advance of Contractor's work at a Job Site all necessary permits, rights-of-way, or easements. Contractor shall give proper notice to owners of adjacent to the Work in accordance with and as required by Section 832 of the California Civil Code.

3.15.3. Pumping, draining and control of surface and ground water and excavating or other earthwork shall be carried out so as to avoid endangering the Work or adjacent facility or property, or interrupting, restricting or otherwise infringing or interfering with the use thereof. Contractor shall conform to the California Civil Code and applicable laws and shall obtain all permits necessary to perform grading or excavation or to dispose of surface or ground water or excavated materials at a Site.

3.15.4. Contractor shall not load nor permit any part of any structure to be loaded in a manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it or them.

3.15.5. Contractor shall not unnecessarily interfere with the use of any roadway, walkway or other facility for vehicular or pedestrian traffic, by any party entitled to use it. Wherever such interference becomes necessary and no satisfactory detour route exists, Contractor shall, before beginning the interference, provide a satisfactory detour, temporary bridge, or other proper facility for traffic to pass around or over the interference, and shall maintain it in satisfactory condition as long as the interference continues. Compensation for said Work shall be within the Contract Sum, unless otherwise expressly stipulated in the Supplementary Conditions of the Specifications.

3.15.6. Contractor shall take all reasonable precautions to prevent fires within the Work Area and in the vicinity of the Work Area, and shall be responsible for all damage from fires due directly or indirectly to any fault of Contractor or any of its employees. Contractor shall observe all applicable regulations pertaining to the prevention of fires in areas in which the Work is located or performed.

3.15.7. Contractor shall assume full responsibility and shall promptly settle all claims for damage to a Work Area or a Site, and to adjoining areas and the owners or occupants thereof, resulting from its performance of the Work.

3.16. ACCESS TO WORK.

During the performance of the Work, the City and its authorized representatives or other persons deemed necessary by any of them acting within the scope of the duties entrusted to them, may at any time, and for any purpose, enter upon a Site or Work Area, any other area where part of the Work may be in preparation, the facilities where any part of the Work may be in storage, or the factories where any materials for use in the Work are being, or are to be, manufactured.

3.17. CLEANING UP AND REMOVING DEBRIS.

3.17.1. Contractor shall keep a Site(s) and Work Area(s) and the adjacent areas, including public areas immediately adjacent to a Site such as temporary pedestrian walkways, parking lots, sidewalks, and office and control areas free from accumulation of excess materials, rubbish, graffiti, and debris.

A. Contractor shall perform such clean up and removal regularly and in accordance with the requirements of the Contract Documents.

B. Prior to Substantial Completion, Contractor shall remove from and about each Job Site waste materials, rubbish, Contractor's tools, construction equipment, machinery, and surplus materials and shall perform final cleaning as specified in the Contract Documents. If required by the Engineer, Contractor shall clean the Site again immediately following completion of Punch List Work.

C. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws.

3.17.2. If Contractor fails to clean up as provided in the Contract Documents, the City may do so, and the City at its option will reduce the Contract Sum by the cost incurred in performing such clean up.

3.17.3. Contractor shall salvage and deliver to the City removed equipment, Electronic Waste, appurtenances and other materials that are not reused in the Work and indicated by the City to be salvaged. Contractor shall remove from a Site as its property and dispose of in a legal manner all other equipment, appurtenances and other materials to be removed and not indicated to be salvaged or otherwise claimed by the City. In no case shall Contractor dispose of any Electronic Waste, without the express written permission of the SFMTA and as provided in Document 00807.

3.18. WARRANTY AND MAINTENANCE.

3.18.1. Contractor warrants and guarantees to the City that materials and Equipment provided under the Contract Documents will be new, that the materials and Equipment will be free from defects and of the quality specified. Contractor warrants and guarantees that the materials and Equipment used in the Project will perform and conform to the requirements of the Contract Documents for the intended purposes described in the Contract Documents for a Warranty Period of two (2) years commencing upon the City's Final Acceptance of the Project.

3.18.2. Contractor shall be responsible under the Contract for repair and maintenance of the Replacement Radio System and all components thereof from NTP for Phase 4.1 until Final Acceptance by the SFMTA. Thereafter, Contractor shall be responsible for the maintenance and repair of the Replacement Radio

System and all components thereof as set out in Document 00835 (Warranty Services). Contractor shall provide warranty guarantees and services described in Document No. 00835, compensation for which shall be included in the Contract Sum.

3.18.3. Contractor's warranty excludes damage or defects after Final Completion and Acceptance by the City caused by abuse, modifications to equipment by the City that are not authorized by Contractor, improper or insufficient maintenance, improper operation by the City, or normal wear and tear. Testing shall not be construed as operation.

3.18.4. Manufacturer's warranties shall remain in effect for two years following Final Completion and Acceptance of the Project. Nothing herein is intended to limit any manufacturer's warranty which provides the City with greater warranty rights than set forth in the Contract Documents. Prior to Substantial Completion, Contractor shall deliver to the Engineer all Equipment vendor and manufacturer warranties and guarantees, which must conform to the requirements of the Contract Documents. All vendor and manufacturer warranties for Equipment provided by Contractor to the Project shall pass through to the City, which shall enjoy all rights there under as if it were the original purchaser. Should a manufacturer or vendor refuse or otherwise fail to honor a warranty, Contractor shall stand-in for said manufacturer or vendor and shall make good the warranty. Where other provisions of the Contract Documents call for longer warranty periods, the longer warranty period requirement shall govern as to the Items addressed in those provisions.

3.18.5. The warranty provisions of this Section 3.18 are separate and in addition to the requirements regarding correction of Nonconforming Work and Deficient Work, as described in the General Conditions at Sections 7.8, 7.9, and 7.11 and Document 824.

3.19. TAXES AND POSSESSORY INTEREST.

3.19.1. Taxes. Other than those taxes which this Contract specifically provides are to be paid by the City, the payment of any taxes, including possessory interest taxes and California sales and use taxes, levied upon or as a result of this Agreement, including taxes levied on Equipment procured hereunder, or the services delivered pursuant hereto, shall be the obligation of Contractor. This provision shall not apply to Equipment, software or other material procured by the City from vendors other than Contractor. Contractor recognizes and understands that this Agreement may create a "possessory interest" for property tax purposes. Generally, such a possessory interest is not created unless the Agreement entitles Contractor to possession, occupancy, or use of City property for private gain. If such a possessory interest is created, then the following shall apply:

A. The SFMTA considers Contractor's presence on SFMTA property while performing Work on the Project to be a convenience and service to the Agency. That notwithstanding, however, Contractor, on behalf of itself and any permitted successors and assigns, recognizes and understands that Contractor, and any permitted successors and assigns, may be subject to real property tax assessments on the possessory interest.

B. Contractor, on behalf of itself and any permitted successors and assigns, recognizes and understands that the creation, extension, renewal, or assignment of this Agreement may result in a “change in ownership” for purposes of real property taxes, and therefore may result in a revaluation of any possessory interest created by this Agreement. Contractor accordingly agrees on behalf of itself and its permitted successors and assigns to report on behalf of the City to the County Assessor the information required by Revenue and Taxation Code section 480.5, as amended from time to time, and any successor provision.

C. Contractor, on behalf of itself and any permitted successors and assigns, recognizes and understands that other events also may cause a change of ownership of the possessory interest and result in the revaluation of the possessory interest. (see, e.g., Rev. & Tax. Code § 64, as amended from time to time). Contractor accordingly agrees on behalf of itself and its permitted successors and assigns to report any change in ownership to the County Assessor, the State Board of Equalization or other public agency as required by law.

D. Contractor further agrees to provide such other information as may be requested by the City to enable the City to comply with any reporting requirements for possessory interests that are imposed by applicable law.

E. To the extent allowed by law, the SFMTA will consider Possessory Interest Taxes, if assessed, to be reimburseable as additional expenses or Other Direct Costs.

3.19.2. City is Not Tax Exempt. The City is not exempt from sales and use taxes, which Contractor shall pay and which are included in the Contract Sum.

3.19.3. Survival of Obligations. The requirements of this Contract as to payment of taxes, irrespective of class or type of taxes, shall survive the termination or expiration the Contract.

3.20. INDEMNIFICATION.

3.20.1. General Indemnity. To the fullest extent provided by law and consistent with California Civil Code section 2782, Contractor shall assume the defense of, indemnify and hold harmless the Indemnitees and other parties as may be designated by the City, and all of their officers, agents, members, employees, authorized representatives, or any other persons deemed necessary by any of them acting within the scope of the duties entrusted to them, from all claims, suits, actions, losses and liability of every kind, nature and description, including but not limited to attorney’s fees, directly or indirectly arising out of, connected with or resulting from the performance of the Work. Other parties shall be indemnified by Contractor against Contractor's negligent acts or omissions on a proportional basis, each party bearing liability in proportion to its degree of fault. Where a loss is caused by the sole negligence or intentional tort of an Indemnitee, the foregoing indemnification shall not be valid as to the person or entity who committed the negligent act or intentional tort.

3.20.2. Hazardous Waste. Contractor acknowledges that any claims, demands, losses; damages, costs, expenses, and legal liability that arise out of, result from, or are in any way connected with the release or spill of any legally designated hazardous material or waste or contaminated material as a result of the Contractor's negligent acts or omissions while performing the work under this Contract are expressly within the scope of the indemnity described in the foregoing paragraph, and that the costs, expenses, and legal liability for environmental investigations, monitoring, containment, removal, repair, cleanup, restoration, remedial work, penalties, and fines arising from the violation of any local, state, or federal law or regulation, attorney's fees, disbursements, and other response costs are expressly within the scope of said indemnity.

3.20.3. Patent and Copyright Infringement. As more specifically provided in Section 3.22, below, Contractor shall indemnify, defend and hold harmless the City and Indemnitees for any claim or action alleging that any process utilized, or Software or Equipment provided by Contractor in Contractor's performance of the Project violates or infringes upon any copyright or patent or otherwise violates or infringes upon a third party's intellectual property rights.

3.20.4. Duty to Defend. Upon Contractor's awareness of any claim, threatened or pending action, whether or not such awareness is gained from the City or other means, , Contractor shall defend any action, claim or suit asserting a claim covered by the provisions of this Section 3.20. Contractor shall pay all costs that may be incurred by an Indemnitee, including reasonable attorney's fees.

3.20.5. Insurance Does Not Limit Liability. No insurance policy covering Contractor's performance under this Agreement shall operate to limit Contractor's liabilities under this Agreement. Nor shall the amount of insurance coverage operate to limit the extent of such liabilities.

3.20.6. City's Right to Settle Claims. In the event that Contractor and its insurance carrier(s) in bad faith refuse to negotiate and compensate a third party or parties for property damage or personal injuries which arise out of Contractor's performance of the Work, the City shall have the right to estimate the amount of damages and to pay the same, and the amount so paid shall be deducted from the amount due Contractor under this Contract, or an appropriate amount shall be retained by the City until all suits or claims for said damages shall have been settled or otherwise disposed of and satisfactory evidence to that effect shall have been furnished to the City.

The provisions of this Section 3.20 shall survive Final Completion and termination of the Contract.

3.21. LIMITS OF LIABILITY .

3.21.1. Total Liability. Except as expressly provided for herein and as excepted under Section 3.21.4, the liability of the Contractor and the liability of the City under this Agreement shall not exceed the total Contract Sum, as that amount may be amended from time to time by lawful modification of the Contract.

3.21.2. Liquidated Damages. See Section 8.5.

3.21.3. Special Damages.

A. City's Liability. Notwithstanding any other provision in this Contract, in no event shall the City, its boards and commissions, and any of their officers, agents, members, employees, and authorized representatives be liable, regardless of whether any claim is based on contract, tort, strict liability or otherwise, for any type of special, consequential, indirect or incidental damages including, but not limited to lost profits, arising out of or in connection with this Contract or the Work performed in connection with this Contract. This limit of liability applies under all circumstances including but not limited to the breach, completion, termination, suspension, cancellation or recession of the Work of this Contract, negligence or strict liability by the City, its boards and commissions, and their officers, agents, members, employees, and authorized representatives, irrespective of whether the City has been provided notice of the possibility of such damages.

B. Contractor's Liability. Except as expressly otherwise provided herein and elsewhere in the Contract, Contractor shall not be liable to the City, regardless of whether any claim is based on contract, tort, strict liability or otherwise, for any type of special, consequential, indirect or incidental damages arising out of or in connection with this Contract or the services performed in connection with this Contract, irrespective of whether the Contractor has been provided notice of the possibility of such damages.

3.21.4. Exclusion from Liability Limitations. The limits of liability described in this Section 3.21 shall not apply to or limit: (i) Contractor's obligation to pay Liquidated Damages as set forth in the Contract Documents; (ii) Contractor's liability for fraud, willful misconduct or illegal or unlawful acts; (iii) Contractor's obligations to defend and indemnify and Contractor's liability for third party claims; (iv) Contractor's liability for any type of damage to the extent such damage is required to be covered by insurance as specified herein where such insurance fails or the insurer denies coverage (v) Contractor's liability for damages expressly provided for in the Contract Documents; (v) Contractor's liability for statutory damages specified in the Contract Documents; (vi) Contractor's obligation to indemnify and defend City for intellectual property infringement (as provided in Section 3.22, below); (vii) treble damages for false claims or other punitive damages; or (viii) wrongful death caused by Contractor.

3.21.5. Survival. The provisions of this Section 3.21 shall survive Final Completion and termination of the Contract.

3.22. COPYRIGHTS AND PATENTS; INDEMNITY FOR INFRINGEMENT.

3.22.1. In addition to the provisions applicable to patented or copyright protected Equipment, Software and processes that are set out in Document 00823 ("Software and Technology Procurement"), Contractor shall be responsible at all times for compliance with applicable patents, copyrights, trademarks, and/or other intellectual property rights held by others encompassing, in whole or in part, any invention, design, process, product, device, material, article, or arrangement used, directly or indirectly, in the performance of the Work or incorporated into the Work.

3.22.2. Contractor shall pay, and include in the Contract Sum, all royalties and license fees and assume all costs incident to the use in the performance of

the Work or the incorporation into the Work of any invention, design, process, product, material, device, Equipment, Software, article or arrangement which is the subject of a patent right, copyright, trademark, and/or other intellectual property right held by others.

3.22.3. Contractor shall save, defend, hold harmless, and fully indemnify the Indemnitees, and all of their officers, agents, members, employees, authorized representatives, or any other persons deemed necessary by any of them acting within the scope of the duties entrusted to them, from all damages, claims for damage, costs, or expenses in law or equity, including attorney's fees and costs for the actual or alleged unauthorized use or infringement of any patent right, copyright, trade secret, trade name, trademark, service mark, or any other proprietary right in consequence of the use by the City, or any of its boards, commissions, officers, or employees, authorized representatives, or any other person deemed necessary by any of them acting within the scope of the duties entrusted to them of designs, plans, processes, firmware, Software, Equipment, and other proprietary intellectual property to be supplied or provided to the City by Contractor or to be utilized by Contractor in the performance of the Project. Contractor's duty to defend and indemnify the City and Indemnitees described herein shall arise irrespective of whether Contractor is not the licensee, patentee or assignee or does not have the lawful right to sell or relicense the same. Said duty to defend arises upon notice of any claim, irrespective of the validity of said claim or Contractor's denials or dispute of said claim.

3.22.4. If the City is enjoined from the operation or use of the Work, or any part thereof, as a result of any suits or claims for infringement or unauthorized use of a patent right, copyright, trademark, and/or other intellectual property right for Items provided by Contractor for the Project, Contractor shall, at its sole expense and at no cost to the City, take reasonable steps to procure the right to operate or use the Work. If Contractor cannot so procure such right within a reasonable time, Contractor shall promptly, at Contractor's sole expense and at no cost to the City, (1) modify the Work, consistent with the applicable requirements of the Contract Documents, so as to avoid infringement of any such intellectual property right, or (2) provide replacement Items or Work that meets applicable requirements of the Contract Documents and does not infringe or violate any such intellectual property right.

3.22.5. Contractor's infringement of a third party's intellectual property rights, if not the basis for indemnification under the law, shall nevertheless be considered a material breach of contract. Contractor shall upon notice of such breach immediately take the steps described in Section 3.22.4, above, to remedy the breach. Failure by Contractor to remedy said breach within the Project schedule or other lesser reasonable time as the City may require shall constitute an event of default.

3.22.6. Contractor shall inform the City immediately upon discovery if any specification or requirement set out in the Design Criteria Package requires the use of material(s), including but not limited to software, firmware, designs and plans, that is proprietary to an entity other than Contractor or otherwise requires a license or other permission to use said material(s). The cost of said license shall be borne by Contractor.

3.22.7. Sections 3.22.3 and 3.22.4, above, shall not apply to any suit, claim or proceeding based on infringement or violation of a patent right, copyright, trademark, and/or other intellectual property right (i) relating solely to a particular process or product of a particular manufacturer specified by the City and not provided to the Project, offered or recommended by Contractor or (ii) arising from modifications to the Work by the City or its agents after Final Completion and Acceptance of the Project.

3.22.8. The provisions of this Section 3.22 are in addition to all other hold harmless and indemnity clauses in the Contract Documents, are not limited in any way by any other provision of the Agreement, and shall survive Final Completion and termination of the Contract.

3.23. INDEPENDENT CONTRACTOR; PAYMENT OF EMPLOYMENT TAXES AND OTHER EXPENSES.

3.23.1. Independent Contractor. Contractor or any agent or employee of Contractor shall be deemed at all times to be an independent contractor, not an employee or agent of the City, and Contractor is wholly responsible for the manner in which it performs the services and work requested by the City under this Agreement. Contractor or any agent or employee of Contractor shall not have employee status with City, nor be entitled to participate in any plans, arrangements, or distributions by City pertaining to or in connection with any retirement, health or other benefits that the City may offer its employees. Contractor or any agent or employee of Contractor is liable for the acts and omissions of itself, its employees and its agents. Contractor shall be responsible for all obligations and payments, whether imposed by federal, state or local law, including, but not limited to, FICA, income tax withholdings, unemployment compensation, insurance, and other similar responsibilities related to Contractor's performing services and work, or any agent or employee of Contractor providing same. Nothing in this Agreement shall be construed as creating an employment or agency relationship between the City and Contractor or any agent or employee of Contractor. Any terms in this Agreement referring to direction from City shall be construed as providing for direction as to policy and the result of Contractor's work only, and not as to the means, methods, sequences and techniques by which such a result is obtained. City does not retain the right to control the means or the method by which Contractor performs work under this Agreement.

3.23.2. Payment of Employment Taxes and Other Expenses. Should the City, in its discretion, or a relevant taxing authority such as the Internal Revenue Service or the State Employment Development Division, or both, determine that Contractor is an employee for purposes of collection of any employment taxes, the amounts payable under this Agreement shall be reduced by amounts equal to both the employee and employer portions of the tax due (and offsetting any credits for amounts already paid by Contractor which can be applied against this liability). City shall then forward those amounts to the relevant taxing authority. Should a relevant taxing authority determine a liability for past services performed by Contractor for City, upon notification of such fact by City, Contractor shall promptly remit such amount due or arrange with City to have the amount due withheld from future payments to Contractor under this Agreement (again, offsetting any amounts already paid by Contractor which can be applied as a

credit against such liability). A determination of employment status pursuant to the preceding two paragraphs shall be solely for the purposes of the particular tax in question, and for all other purposes of this Agreement, Contractor shall not be considered an employee of City. Notwithstanding the foregoing, should any court, arbitrator, or administrative authority determine that Contractor is an employee for any other purpose, then Contractor agrees to a reduction in City's financial liability so that City's total expenses under this Agreement are not greater than they would have been had the court, arbitrator, or administrative authority determined that Contractor was not an employee.

3.23.3. Survival. The provisions of this Section 3.23 shall survive expiration or termination of the Contract.

3.24. RESPONSIBILITY FOR EQUIPMENT.

The City shall not be responsible for any damage to persons or property as a result of the use, misuse or failure of any equipment used by Contractor, or by any of its employees, even though such equipment be furnished, rented or loaned to Contractor by the City. The provisions of this Section 3.24 shall survive expiration or termination of the Contract.

3.25. COMPLIANCE WITH LAWS.

3.25.1. Contractor shall keep itself fully informed of and shall strictly comply with all laws, ordinances, regulations and orders of any properly constituted authority affecting this Contract, the Work and the performance of the Work, the completed Project, and any persons connected with the Work, and shall protect and indemnify the City, the Agency, Department, and their officers, employees and agents against any claim or liability arising from or based on the violation of any such law, ordinance, regulation or order, whether by Contractor itself or by its employees or agents. Persons authorized by the City may at any time enter upon any part of the Work to ascertain whether Contractor is complying with such laws, ordinances, rules or orders.

3.25.2. All construction, materials and Equipment provided to the Project by Contractor shall be in full accordance with the latest Laws and requirements, or the same as may be amended, updated or supplemented from time to time, of the Code specified in the Contract Documents, Americans with Disability Act Accessibility Guidelines, CAL-OSHA, the State Division of Industrial Safety of the Department of Industrial Relations, the California Energy Commission, the Division of the State Architect – Access Compliance, the Public Utilities Commission of the State of California, the State Fire Marshal, the National Fire Protection Association, the San Francisco Department of Public Health, the Federal Communications Commission, the Federal Transportation Agency, and other applicable state and federal laws and regulations, and of other bodies or officials having jurisdiction or authority over same, and they shall be observed and complied with by Contractor and any and all persons, firms and corporations employed by or under it. Authorized persons may at any time enter upon any part of the Work to ascertain whether such laws, ordinances, regulations or orders are being complied with. No additional costs will be paid or extensions of time granted as a result of such compliance, subject to the exceptions set out herein. See also, Section 3.2.8 (Code Compliance).

ARTICLE 4 -- SUBCONTRACTORS

4.1. SUBCONTRACTING.

Contractor shall not subcontract any part of the Work other than to those Subcontractors and Subconsultants specifically listed in the Contractor's Proposal without the written approval of the SFMTA. Any assignment, transfer, change, substitution or other subcontract shall be void.

4.2. QUALIFIED SUBCONTRACTORS.

Contractor shall not employ a Subconsultant, Subcontractor, Supplier or other person or entity that is currently debarred from contracting by any public agency or that the City has determined unqualified or non-responsible. The City may give written notice of such determination prior to award of the Contract or at any time during the Contract Term, and upon receipt thereof, Contractor shall provide replacement with a qualified person or entity. The City shall have the right of approval, which approval shall not be unreasonably withheld, and shall not be responsible for any additional costs to Contractor arising out of the employment or substitution of such replacement person or entity. Contractor shall not replace a Subconsultant or Subcontractor without the written permission of the SFMTA. As to those portions of the Work that constitute a public work or construction, Contractor shall comply with all provisions of the Subletting and Subcontracting Fair Practices Act, California Public Contract Code sections 4100-4114. Any subcontracting agreement for Work under this Contract that is made in violation of the requirements of this Contract shall confer no rights on any party and shall be null and void.

4.3. SUBCONTRACTUAL RELATIONS.

Contractor shall have an appropriate written agreement specifically binding each Subconsultant, Subcontractor or Supplier to Contractor by the applicable terms and conditions of the Contract Documents, in the same manner Contractor is bound to the City. Each subcontract agreement shall preserve all rights of the City with regards to the Work to be performed by the Subconsultant, Subcontractor or Supplier. All Subconsultants, Subcontractors and Suppliers shall have similar agreements with Lower-Tier Subconsultants, Subcontractors and Lower Tier Suppliers. All Subconsultants, Subcontractors and Suppliers shall be given copies of the Contract Documents to which the Subconsultant, Subcontractor or Supplier will be bound, and upon written request of the Subconsultant, Subcontractor or Supplier, shall have identified written terms and conditions of their proposed subcontract agreement that vary from the Contract Documents. Subconsultants, Subcontractors and Suppliers shall fulfill the same requirements toward their respective proposed Lower-Tier Subconsultants, Subcontractors and Lower-Tier Suppliers.

4.4. SUBCONTRACTING, SUCCESSORS AND ASSIGNS.

4.4.1. Contractor shall constantly give its personal attention to the faithful prosecution of the Work. Contractor shall keep the Work under its personal control and shall not assign by power of attorney or otherwise, nor subcontract the whole or any part thereof, except as provided in the Contract. Contractor shall be fully responsible for the performance of its Subcontractors, Subconsultants, vendors and Suppliers.

4.4.2. All transactions with Subcontractors will be made through Contractor, and no Subcontract shall relieve Contractor of any of its liabilities or obligations under the Contract Documents.

4.4.3. Contractor shall not sublet or subcontract any portion of the Work that constitutes a public work or construction in excess of one-half (1/2) of one (1) percent of the total original bid when no subcontractor was designated in the original bid, nor shall any subcontractor assign or transfer its subcontract or permit the same to be performed by any other Contractor, except with the written approval of the SFMTA and subject to the provisions of the Subletting and Subcontracting Fair Practices Act (California Public Contract Code sections 4100-4114) and the applicable provisions of the Administrative Code of the City and County of San Francisco. This Section 4.4.3 shall not apply to design work assigned to a Subconsultant.

4.4.4. When a Subconsultant or Subcontractor fails to prosecute a portion of the Work in a manner satisfactory to the City, Contractor shall remove such Subconsultant or Subcontractor immediately upon written request of the City, and shall request approval of a replacement Subcontractor to perform the Work, with no adjustment to the Contract Sum.

4.4.5. Contractor shall not assign all or any part of its rights, obligations or interests in and to the Contract Documents without the prior written approval of the City, which the City may withhold in its sole and absolute discretion.

4.4.6. If requested by the City Representative, Contractor shall provide the SFMTA a copy of any contract that it will enter or has entered into for subcontracting or assigning any portion of the Work, and will also provide to the City Representative any information that the SFMTA may request to enable SFMTA to determine the responsibility and standing of the proposed subcontractor or assignee. No subcontract or assignment will be approved unless the original Contract between Contractor and the SFMTA is made a part thereof, nor unless it appears to the SFMTA that the proposed subcontractor or assignee is in every way reliable and responsible and fully able to perform the portion of the Work covered by the proposed subcontract or assignment, and to complete said Work in accordance with the Contract Documents.

4.4.7. Should the SFMTA determine that the subcontractor proposed for any portion of the Work has not the necessary experience or financial qualifications to perform said portion of the Work, or that subcontractor does not and cannot obtain in due time the necessary equipment to perform said portion of the Work, or is otherwise unacceptable, Contractor shall substitute an subcontractor acceptable and approved by the SFMTA or shall perform said Work without subcontracting it, subject to SFMTA approval

4.4.8. No subcontract or assignment shall relieve Contractor or his sureties of any liabilities or obligations under this Contract. No assignment by Contractor of this Contract or any part thereof, or of the funds to be received there under by Contractor, will be recognized unless such assignment has had the approval of the SFMTA and the surety has been given due notice of such assignment in writing. No assignment will receive such approval unless the instrument of assignment contains a clause to the effect that it is agreed that the funds to be paid the assignee under the assignment are subject to a prior lien for services rendered or materials supplied for the performance of the Work called for in said contract in favor of all persons, firms, or corporations rendering such services or supplying such materials.

4.5. ASSIGNABILITY OF SUBCONTRACTS.

4.5.1. All subcontracts shall provide that they are freely assignable to the City or the City's designee under any of the following conditions:

- A.** The City terminates the Contract under provisions of Article 14;
- B.** The City requests such assignment; and
- C.** The surety providing the performance bond for the Project fails to timely fulfill its obligations under the performance bond.

4.5.2. The City will notify the Subconsultants and Subcontractors, Lower-Tier Subconsultants and Subcontractors, and Suppliers in writing of those agreements the City wishes to have assigned.

ARTICLE 5 -- CONSTRUCTION BY CITY OR BY SEPARATE CONTRACTORS

5.1. CITY'S RIGHT TO PERFORM CONSTRUCTION AND TO AWARD SEPARATE CONTRACTS.

5.1.1. The City reserves the right to perform other or additional work within or adjacent to the limits of the Work at any time during the Contract by itself or by the use of other forces or contractors. Should the performance of such other or additional work not indicated in the Contract Documents or not being performed at the time of execution of the Contract materially increase Contractor's costs, then Contractor may be granted an adjustment in the Contract Sum or Contract Time, subject to Contractor's right to make a Claim as set forth in Article 13. The City shall require its separate contractors to cooperate and coordinate their activities with Contractor so as to facilitate progress of the Work.

5.1.2. If the City gives Contractor written notice to vacate a location so that other work may be performed by other forces or contractors at the location(s) where Contractor is already performing Work, Contractor shall promptly suspend Work at that location and clean up and demobilize its operations from the location to the extent necessary as determined by the City to allow the City and/or other forces or contractors to perform their work. Contractor shall provide the Engineer written notice when cleanup and demobilization has been completed. The Engineer will issue to the other forces or contractors a notice to proceed with their work. After the date of said notice to proceed, Contractor shall allow proper and

safe access to the Work at the subject location and shall schedule and coordinate its Work with the other contractors' work.

5.1.3. Contractor shall be responsible for performing all modification, cutting, fitting and patching of the Work that may be required to make all parts fit together or to receive the work of other contractors, such as utility companies, so that the completed Project conforms to the Criteria Package requirements.

5.1.4. Contractor shall not damage or endanger a portion of the Work, or fully or other partially completed construction of the City or separate contractors, such as utility companies, by excavation or by cutting, patching or otherwise altering such construction. Contractor shall not cut or otherwise alter such construction by the City or separate contractor except with the written consent of the City. Contractor shall not withhold from the City or the City's separate contractor consent to cut or otherwise alter the Work.

5.1.5. If Contractor requires access to a location where the City's forces or another City contractor is performing work, Contractor shall request such access in writing from the Engineer. The Engineer will provide written notice to Contractor when the work of other forces or contractors at the subject location is completed, and upon receipt of such notification, Contractor shall have full access and shall commence or resume its operations in that location.

5.1.6. If Contractor believes it is entitled to an extension of the Contract Time caused by its obligations under this Section 5.1, it shall comply with the notification requirements of Section 7.7.

5.1.7. When it is necessary for Contractor and another contractor or utility owner to work in the same location at a Site at the same time, each party shall assume the following mutual responsibilities for the benefit of the other party at no additional cost to the City and no adjustment to the Contract Sum:

A. Both parties shall execute identical agreements mutually indemnifying each other from any loss, damage, or injury that may be incurred as a result of the performance of work by the other while both are performing work in the same location;

B. Both parties shall add the other party as an additional insured under their respective liability policies;

C. The party seeking to use portions of the Work Area of the other party to perform its work shall pay all direct costs incurred by the other party to accommodate its operations; and

D. If Contractor claims that delay or additional cost is involved because of such action by the City, Contractor shall make such Claim by the procedures as provided in Section 13.2.

5.1.8. The City shall not be a party to any of the agreements between multiple contractors.

5.2. COORDINATION.

5.2.1. Contractor shall ensure that the execution of the Work properly coordinates with work of other contractors and the City at a Site, and shall

cooperate with such other contractors to facilitate the progress of the Work in such a manner as the City may direct.

5.2.2. Notice of Conflicting Conditions: Where Contractor's Work is adjacent to or placed on top of that of another contractor, Contractor shall examine the adjacent work and substrate and report in writing to the City any visible defect or condition preventing the proper execution or increased cost of its Contract. If Contractor proceeds without giving notice, it shall be held to have accepted the work or material and the existing conditions, and shall be responsible for any defects in its own Work consequent thereon, and shall not be relieved of any obligation or any guarantee because of any such condition or imperfection. This provision shall be included in any and all other contracts or subcontracts for Work to be performed where such a conflict could exist. Provision applies only to patent or visible defects – Contractor is not responsible for latent defects of others. Contractor shall report to the City latent defects in another contractor's work promptly upon discovery.

5.2.3. Contractor shall notify the City promptly in writing when another contractor working at a Site fails to coordinate its work with the Work of this Contract as directed.

5.2.4. Any difference or conflict that may arise between Contractor and the other contractors or City forces in regard to their work shall be adjusted as determined by the City.

5.2.5. At any time during the progress of the Work, the City may, by providing reasonable notice, require Contractor to attend any conference of any or all of contractors engaged in the Work or other work at a Site.

5.2.6. If the City determines that Contractor is failing to coordinate its Work with the work of other contractors as directed, the City may upon three business days' written notice:

A. Direct others to perform portions of the Contract and charge the cost of Work against the Contract Sum; or

B. Terminate any and all portions of the Contract for Contractor's failure to perform in accordance with the Contract.

ARTICLE 6 -- CLARIFICATIONS AND CHANGES IN THE WORK

6.1. GENERALLY.

6.1.1. The City, at any time between the Notice to Proceed and Final Completion, may in writing order additions, deletions, or revisions in the Work, within the general scope of the Contract and Contractor shall promptly comply with such written orders and proceed with the Work, which shall be performed under the applicable requirements of the Contract Documents. For the purposes of this Article, changes are considered within the "general scope" if the work to be performed is of a category described in the Contract Documents and is necessary to meet the System performance requirements set out in the Design Criteria.

6.1.2. Contractor shall not be entitled to an increase in the Contract Sum or an extension of the Contract Time if Contractor performs work that the Contract Documents do not require.

6.1.3. The procedures set forth in this Article 6 are intended to ensure that when Clarifications and Changes in the Work are proposed, Contractor provides the City with its best estimate of the costs and impacts associated with each Clarification and/or Change, so that the City may evaluate each potential Change and proceed on an informed basis. The City also intends that the Clarification and Change Order procedures (including the use of Unilateral Change Orders and Force Account) facilitate payment to Contractor of additional, undisputed amounts.

6.1.4. Failure by Contractor to comply with the procedures of this Article, including the failure to provide sufficient information and/or documentation to the City at the time of any Clarification or Proposed Change Order shall constitute a waiver of any subsequent claim by Contractor arising out of such Clarification or Change Order.

6.2. REQUESTS FOR INFORMATION, CLARIFICATIONS AND FIELD ORDERS.

6.2.1. Should there appear to Contractor to be conflicting requirements, ambiguity or other discrepancy in the Criteria Package, should questions arise as to the meaning or intent of the Contract Documents, or should the City's comments on Submittals returned to Contractor appear to Contractor to change the requirements or scope of the Contract Documents, Contractor shall submit a RFI to the City within fifteen (15) Days of discovery. Contractor shall coordinate and schedule its Work to provide the City sufficient time to issue a written reply before proceeding with the affected Work.

6.2.2. The City shall issue a reply to the RFI within fifteen (15) Days of receipt of the same. The reply may include written Clarifications as deemed by the City to be necessary and consistent with the Contract Documents or a Field Order requiring minor changes in the Work. If additional time is needed to issue the reply, the City will, within the fifteen (15) Day reply period, notify Contractor of the longer reply period.

6.2.3. Clarifications of the Contract Documents and Field Orders by the City shall be binding on Contractor and shall be promptly executed by Contractor. The City's right to Clarify any element of the Contract Documents shall not be construed to entitle Contractor to a modification of the Contract Sum or a change in the Contract Time.

6.3. PROPOSED CHANGE ORDERS.

6.3.1. Proposed Change Order Initiation. The City may initiate a change in the Work by issuing a Proposed Change Order ("PCO"). A PCO will include a detailed description of the proposed additions, deletions or revisions and will request from Contractor a quotation of cost and time for designing and completing the proposed changes.

6.3.2. PCO Quotation Time Period. Contractor shall submit a PCO cost proposal and PCO time adjustment proposal, if applicable, to the City within 10

days after receipt of a PCO. If Contractor fails to submit a PCO cost proposal and/or PCO time adjustment proposal within the 10-day period, or if the price or time adjustment cannot be agreed upon, the City may either direct Contractor to proceed with the Work on a Force Account basis or issue a Unilateral Change Order instructing Contractor to proceed with the PCO Work based on the City's estimate of the cost and/or time adjustment.

6.3.3. PCO Cost Proposal Requirements. With each PCO, Contractor shall provide 2 copies of a PCO cost proposal. A PCO cost proposal shall include a complete itemized breakdown of labor, material, and equipment, all applicable taxes, insurance, bonds, and markup for overhead and profit for both additions and deletions on a form supplied by the City. The same shall be required for cost proposals submitted by a Subcontractor and Subconsultant, which shall be furnished on the same form as required for Contractor. At a minimum, Contractor shall provide the following documentation to the City in support of Contractor and Subcontractor cost proposals:

- A.** Design services breakdown by employees and agents of Contractor, Designer, Subconsultants, and special contractors, salary rates, and estimated hours;
- B.** Material quantities and type of products;
- C.** Labor breakdown by trade classification, wage rates, and estimated hours;
- D.** Equipment breakdown by make, type, size, rental rates, and equipment hours; and
- E.** Taxes, insurance and bonds.

6.3.4. PCO Time Adjustment Proposal Requirements. If Contractor asserts it is entitled to an adjustment in Contract Time due to the PCO Work, Contractor shall submit a CPM time impact evaluation with the PCO. The CPM time impact evaluation shall utilize sub-network or fragmentary network, and shall include a written narrative and a schedule diagram or other written documentation acceptable to the City, showing the detailed work activities involved in a change that may affect the Contract Time and impact of the change on other Work and activities of the proposed schedule adjustment. This sub-network shall be tied to the complete progress schedule network with appropriate logic so that a true analysis of critical path can be made. Failure to comply with the requirements set forth in this Section 6.3 shall constitute a waiver of any claim for delay, disruption, extended overhead and other associated costs or damages.

6.4. CHANGE ORDERS.

6.4.1. Execution of Change Orders. When the City and Contractor agree on the total cost and time of a PCO, the City will prepare for Parties' signatures a Change Order to formally implement the changed Work. All Change Orders must be in writing signed by persons with the authority to represent and bind each respective Party. No oral instructions of any person whosoever shall in any manner or degree modify or otherwise affect the terms of the Contract Documents.

6.4.2. Release of Claims. In executing an agreed Change Order, Contractor shall release the City from claims for additional compensation or time relating to the undisputed amount of the change in the Work. If Contractor fails to provide timely documentation of delay to the City as described in Sections 6.3 and 7.7 which shall be sufficient to entitle Contractor to a time extension pursuant to Section 7.7, Contractor shall execute the Change Order without being granted any extension of time. Contractor shall not condition or qualify any agreed Change Order with a reservation of rights to seek at a later time additional Contract Amount or Time for the changed Work addressed in the Change Order.

6.4.3. Change Order is Not a Release. Change Orders issued under this Article or extensions of Contract Time made necessary by reason thereof shall not in any way release any guarantees or warranties given by Contractor under the Contract, nor shall they relieve or release Contractor's sureties of bonds executed under such provisions. The sureties, in executing such bonds, shall be deemed to have expressly agreed to any such Change Orders and to any extension of Contract Time made by reason thereof. Contractor shall be responsible for giving any required notice of any change affecting the Work, Contract Sum or Contract Time to its sureties by the provisions of any bond.

6.5. UNILATERAL CHANGE ORDERS.

6.5.1. General. When the City and Contractor are unable to agree on the cost or time required to complete the change in the Work described in a PCO, the City may issue a Unilateral Change Order instructing Contractor to proceed with a change in the Work based on the City's estimate of cost and time to perform the change in the Work. Upon receipt of a Unilateral Change Order, Contractor shall proceed with the ordered Work. The City may issue a Unilateral Change Order compelling Contractor to perform changed Work with no adjustment in the Contract Sum or Contract Time if City determines that such action is necessary for Contractor to meet the requirements of the Contract Documents.

6.5.2. Protest. Should Contractor disagree with any terms or conditions set forth in a Unilateral Change Order, Contractor shall submit, within fifteen (15) days of receipt of the Unilateral Change Order, a Notice of Potential Claim in conformance with the requirements of Section 13.2. If a Notice of Potential Claim is not submitted as so required, Contractor waives all rights to an adjustment in the Contract Sum or the Contract Time for said Work, except as specified in the Unilateral Change Order at issue.

6.6. COST OF THE CHANGE ORDER WORK

6.6.1. Direct Cost Defined. Direct Cost shall mean the sum of the following directly required for the performance of the Work under a Change Order.

A. Construction Labor. Labor rates for Construction Work shall not exceed those prevailing wages required to be paid under the Contract Documents. (Prevailing Wages applicable in San Francisco can be obtained through the City's Office of Labor Standards Enforcement.) The costs for all supervision, including general superintendents and foremen, shall be in the markup defined herein. Working foremen will be considered a direct cost of the Construction Work only if the individual is on a Site physically performing Construction Work under the Change Order.

B. Calculation of Labor Costs. Labor burden shall include only fringe benefits by governing construction trade organizations, Federal Insurance Contributions Act, Federal and State Unemployment taxes, and net actual premiums paid for public liability, worker's compensation, property damage, and other forms of insurance required by the City. No other costs shall be included as labor burden.

1. For electrical work, labor productivity rates shall be based on the most current edition of "N.E.C.A." Column 3, with a 10 percent reduction.

2. For mechanical work, labor productivity rates shall be based on the most current edition of "M.C.A.", with a 20 percent reduction.

C. Design Professional Services. Payroll costs for Contractor's employees, Subconsultants, and special contractors (including but not limited to testing laboratories, environmental Contractors and surveyors) and their employees and agents who provide Design Professional services specifically related to the Work shall not exceed the salary rates on which Contractor's Proposal is based. In lieu of salary rates, Contractor may use its catalog labor rates for pricing its labor for Change Order Work for Design Professional Services, based on an hourly rate with a three hour minimum. Daily rates provided in Contractor's catalogs are the rate for 8 hours.

D. Materials. Adjustments to the Contract Sum on Change Orders shall be made only for those materials Furnished by Contractor and directly required for performing the Change Order. The cost of such material may be determined by reference to catalog prices to the extent allowed under applicable FTA procurement requirements and guidelines, and shall include all costs, excluding sales tax, to the purchaser, whether Contractor, Subcontractor or Lower-Tier Subcontractor, from the Supplier thereof, and may include the cost of transportation, but delivery charges will not be allowed unless the delivery is specifically required for the Change Order. If a trade discount by an actual Supplier is available to Contractor, it shall be credited to the City. If the materials are obtained from a Supplier or source owned wholly or in part by Contractor, payment thereof shall not exceed the current wholesale price for the materials as determined by the City. The term "trade discount" includes the concept of cash discounting.

1. For general construction and concrete work, material costs shall be based on the most current Lee Saylor Book, with a 20 percent reduction for labor figures.

2. For electrical work, material costs shall be based on the most current Biddle Book, end column, with a 10 percent reduction.

3. For mechanical work material costs shall be based on the most current Reeves Manual, with a 30 percent reduction.

E. Equipment.

1. Adjustments to the Contract Sum shall will be made at the lesser of the rental rates listed for such construction equipment as

specified in the current edition, at the time of the Change Order, of "Rental Rates and Specifications", published by Associated Equipment Distributors, or the State of California, Department of Transportation publication entitled "Equipment Rental Rates and General Prevailing Wages." Such rental rates will be used to compute payments for construction equipment, whether the construction equipment is under Contractor's control through direct ownership, leasing, renting, or other method of acquisition. Daily, weekly, or monthly rates shall be used, whichever are lower. Hourly rates including operator shall not be used. Unless otherwise specified, manufacturer's ratings and manufacturer-approved modifications shall be used to classify equipment for determination of applicable rental rates. If, however, construction equipment of unwarranted size or type and cost is used, the cost shall be calculated at the rental rate for construction equipment of proper size and type.

2. Adjustments to the Contract Sum shall be based on the actual time the equipment is in productive operation on the Work under the Change Order. In computing the hourly rental rate of equipment, any time less than 30 minutes shall be considered one-half hour. No payment will be made for time while equipment is inoperative due to breakdown or for non-work days. In addition, the rental time shall not include the time required to move the equipment to and from a Site. Loading and transportation costs will be paid, in lieu of rental time, only if the equipment does not move under its own power and is utilized solely for the Work of the Change Order. No mobilization or demobilization costs or time will be allowed for equipment already on a Site.

3. Individual pieces of equipment having a replacement value of \$1,500 or less shall be considered to be small tools or small equipment, and no payment will be made since the costs of these tools and equipment are included as part of Contractor's markup for overhead and profit, and are included in the Contract Sum.

4. The Contract Sum includes full compensation to Contractor for the use of equipment as set forth herein and shall constitute full compensation to Contractor for the cost of fuel, power, oil, lubricants, supplies, small equipment, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance, labor (except for equipment operators), and any and all costs to Contractor incidental to the use of the equipment.

5. Costs of all unlisted major equipment and material shall be based on vendor's invoices. Copies of all invoices shall be provided as supporting documentation.

6.6.2. Costs Included as Part of Markup for Overhead and Profit. All Change Order costs not specifically listed in Section 6.6.1 as direct costs shall be included in the markup for overhead and profit. No separate allowance or itemization for overhead costs shall be allowed. The following is a list, not intended to be comprehensive, of the types of costs that are included in

the markup for overhead and profit for all Change Orders including Force Account Work:

A. Field and home office personnel including, but not limited to, principals, project managers, superintendents, supervisory foremen, estimators, project engineers, detailers, draftspersons, schedulers, Contractors, watchpersons, payroll clerks, administrative assistants, and secretaries.

B. All field and home office expenses including, but not limited to, field trailers, parking, storage sheds, office equipment and supplies, telephone service at a Site, long-distance telephone calls, fax machines, computers and software (used to support and not installed to the Work), internet and e-mail services, temporary utilities, sanitary facilities and services, janitorial services, small tools and equipment with a cost under \$1,500 each, portable scaffolding, blocking, shores, appliances, job vehicles, security and fencing, conformance to all regulatory requirements including compliance with safety regulations, safety programs and meetings, cartage, warranties, record documents, and all related maintenance costs.

C. Administrative functions including, but not limited to, reviewing, coordinating, distributing, processing, posting, recording, estimating, negotiating, scheduling, schedule updating and revising, expediting, surveying, engineering, drawing, detailing, revising shop drawings, preparing record drawings, carting, cleaning, protecting the Work, and other incidental Work related to the Change Order.

D. Travel and subsistence expenses of Contractor's employees and agents, the Designer and Subconsultants and their employees and agents necessarily incurred in discharge of their duties connected with the Work.

E. All other costs and taxes required to be paid but not included under Direct Costs, as defined in Section 6.6.1.

6.6.3. Contractor's Markup for Overhead and Profit. The following limitations shall apply to Contractor's markup for overhead and profit on all Change Orders:

A. There shall be no additional mark-up for work performed directly by the Contractor.

B. For Work performed by a Subcontractor or Subconsultant, the markup shall be negotiated as a lump sum fixed amount not to exceed a maximum of ten (10) percent of Subcontractor's or Subconsultant's direct costs as defined herein. For the purposes of this Article 6.6, any cardinal changes outside of the, general scope as defined in Section 6.1.1 above of this Contract shall be a mutually agreeable, negotiated price based on application of Contractors commercial customary burdens and reasonable profit.

C. For Construction Work performed by a Lower-Tier Subcontractor, Subconsultant or Supplier, the markup shall be negotiated as a lump sum fixed amount not to exceed a maximum of ten (10) percent of the Subcontractor's, Subconsultant's, or supplier's direct costs, as defined herein. Contractor, Subcontractor, or Subconsultant shall each receive a lump sum fixed amount as

markup not to exceed 5 percent on the total cost of their respective Lower-Tier Subcontractors, Subconsultants or Suppliers.

D. In no case shall the sum of the individual markups applied to Subcontractor's Change Orders exceed 25 percent, regardless of the number of Subcontractor and Subconsultant tiers involved in performing the Construction Work.

E. For Change Orders that result in a net decrease in direct costs for Construction work performed by Contractor, Subcontractor or Subconsultant, the City shall receive a credit based on the actual net decrease in direct costs plus 10 percent of the direct cost credit amount. Neither Contractor nor the Subcontractor or Subconsultant shall receive a markup on their respective Lower-Tier Subcontractors or Subconsultants to administer the credit Change Order.

F. When both additions and credits are involved in any one Change Order, Contractor's markup shall be computed on the basis of its direct costs and labor productivity for the net change in the quantity of the Construction Work. For example, if a Change Order adds 14 units on one Drawing and deletes 5 units on another Drawing, the markup shall be based on the net addition of 9 units.

6.6.4. Bond and Insurance Costs. The SFMTA shall compensate Contractor only for the actual additional cost of insurance and bond premiums, if any, with no markup for overhead and profit, that arise due to a Change Order.

6.6.5. Assignment and Costs of Subcontractors. Contractor shall be solely responsible for determining which of its Subcontractors and Subconsultants, and Lower-Tier Subcontractor and Subconsultants, are assigned Work under Change Orders. No additional compensation will be provided Contractor for the cost of its Subcontractors and Subconsultants, and Lower-Tier Subcontractors and Subconsultants, to review, post, coordinate, and perform related tasks to administer Change Orders which do not result in direct cost charges from such Subcontractor or Subconsultant, or Lower-Tier Subcontractor or Subconsultant. Such costs shall be considered normal business costs, which are contractually determined between Contractor and its Subcontractors, Subconsultants and Lower-Tier Subcontractors and Subconsultants prior to Proposal, and such costs shall be included in the Contract Sum.

6.6.6. Adjustment of Final Quantities . Prior to or as part of Final Acceptance and close-out of the Contract, the parties shall review the Mobile Equipment and Spares Quantities actually provided and shall adjust the Contract Sum to reflect the Mobile Equipment actually installed and Spares provided based on the unit prices listed in Document 0530.

6.6.7. Records. Contractor shall maintain its records in such a manner as to provide a clear distinction between the direct costs of Change Orders and the cost of original Contract Work. This requirement pertains to all types of Change Orders, as well as the additions, deletions, revisions, and Claims initiated by Contractor.

6.6.8. Escrow Documents. Contractor shall retain in escrow as provided in Documents 01001 and 01001-A the documents and materials that Contractor

relied upon to develop its cost proposal for those portions of the Work that constitute construction, which is the erection, building, and/or renovation of facilities, as defined in San Francisco Administrative Code section 6.1(J). Contractor shall also retain in escrow the cost and price documents presented to the SFMTA to justify the Contract Sum and to establish that the price for Work under this Contract is fair and reasonable.

6.7. FORCE ACCOUNT WORK.

6.7.1. General. When additions, deletions, or revisions in the Work are to be paid for on a Force Account basis, all direct costs described in Section 6.6.1 necessarily incurred and paid by Contractor shall be subject to the approval of the City and adjustments to the Contract Sum or Contract Time will be determined as set forth herein.

A. If the City provides conceptual drawings and/or performance based specifications for Force Account Work, Contractor shall be responsible for developing a design proposal for integrating, interfacing and incorporating such Work in the Project for acceptance by the City.

B. The City will direct Contractor to proceed with the Work on a Force Account basis, and the City will establish a “not to exceed” budget.

C. All requirements regarding direct costs and markup for overhead and profit provided in Section 6.6 shall apply to Force Account Work. However, only actual, necessary costs verified by the City shall be included and compensated.

D. Contractor shall be responsible for all costs related to the documentation, data preparation, and administration of Force Account Work. Compensation for such costs shall be fully covered by the markup for overhead and profit markup, with no adjustment to the Contract Sum.

6.7.2. Notification and Verification. Contractor shall notify the City in writing at least 24 hours in advance of its schedule before proceeding with the Force Account Work. All Force Account Work shall be documented and approved in advance in writing by the City. The Contract Sum shall not be adjusted for Force Account Work if Contractor fails to provide timely notice to the City before commencing the Force Account Work, unless the Work at issue will result in a reduction in the Contract Sum, in which case the Contract Sum will be adjusted by an amount determined to be equitable by the City. In addition, Contractor shall notify the City when the cumulative costs incurred by Contractor for the Force Account Work equal 80 percent of the budget pre-established by the City. The Contract Sum will not be adjusted for Force Account Work exceeding the “not to exceed” budget amount if Contractor fails to provide the required notice before exceeding 80 percent of the Force Account budget.

6.7.3. Reports. Contractor shall diligently proceed with the approved Force Account Work and shall submit to the City no later than 12:00 p.m. of the day following performance of Force Account Work a daily Force Account report on a form to be provided by the City. The report shall provide an itemized, detailed account of the daily Force Account labor, material, and equipment, including names of the individuals, hours worked, task performed, and the specific pieces of

equipment identified by manufacturer's model type and serial number. Contractor's authorized representative shall complete and sign the report. Contractor shall not be compensated for Force Account Work for which said timely report is not completed and submitted to the City.

6.7.4. Records. Contractor shall maintain detailed records of all Work done on a Force Account basis. Contractor shall provide a weekly Force Account summary indicating the status of each Force Account Work directive in terms of actual costs incurred as a percent of the budget for the respective Force Account Work directive and the estimated percentage completion of the Force Account Work.

6.7.5. Agreement. If Contractor and the City reach a negotiated, signed agreement on the cost of a Change Order while the Work is proceeding on a Force Account basis, Contractor's signed written reports shall be discontinued and all previously signed reports shall become invalid.

ARTICLE 7 -- CONTRACT TIME AND PROJECT COMPLETION

7.1. CONTRACT TIME.

7.1.1. Contractor shall fully complete the Project, including all Punch List Work, within One Thousand Two-Hundred (1200) Days from Contractor's receipt of NTP for Phase 4.1.

7.1.2. Contractor shall bring the Project to Substantial Completion within One Thousand One Hundred Ten (1110) Days from receipt of NTP for Phase 4.1.

7.1.3. Contractor shall complete all Punch List Work within ninety (90) Days from the date the City issues a Notice of Substantial Completion to Contractor, unless otherwise agreed by approved Contract Modification.

7.1.4. The Project will proceed in Phases. The SFMTA will issue a separate Notice to Proceed ("NTP") to commence the Work of each Phase with a separate time limit in which Contractor should complete the Work of each Phase, as set out below. With possible limited exception of minor Punch List Work and Phase 4.3, the SFMTA will not issue notice to proceed with a Phase unless Contractor has completed the Work of the preceding Phase. Contractor shall perform the Work in accordance with the Project Schedule.

7.2. PHASE 4.1: DESIGN ENGINEERING.

7.2.1. Contractor shall have Three-Hundred and Thirty (330) Days from the date the SFMTA issues NTP for Phase 4.1 to complete both the Intermediate Design and Final Design of the Project. Said time limit includes time required for the City's review of Contractor's designs, and time for Contractor to incorporate the City's responses into the Project Design.

7.2.2. Within five (5) Days of receipt of NTP for Phase 4.1, Contractor shall commence design engineering for the Project as set forth in the Contract Documents, including establishment and staffing of the local Project Office. Contractor shall review the existing conceptual and preliminary design work and functional specifications set out in Document 900, and Contractor shall then

complete the Intermediate Design (65% Design completion). (See Section 3.3.) Following the SFMTA's review and acceptance of the Intermediate Design, Contractor shall complete the Final (100%) Design.

7.2.3. Phase 4.1 shall be considered completed upon the SFMTA's acceptance of all of the following Milestones of the Intermediate and Final Design Phases:

Document 900, Appendix 12 § 1.17: CDRL Items 12-1-1 through 12-1-9;

Document 900, Appendix 12 § 2.19: CDRL Items 12-2-1 through 12-2-18;

Document 900, Appendix 12 § 3.5: CDRL Items 12-3-1 through 12-3-27;

Document 900, Appendix 12 § 4.10: CDRL Items 12-4-1 through 12-4-6;

Document 900, Appendix 12 § 5.17: CDRL Items 12-5-1 through 12-5-27;

Document 900, Appendix 12 § 6.7: CDRL Items 12-6-1 through 12-6-3;

Document 900, Appendix 12 § 9.7: CDRL Items 12-9-1 through 12-9-9, and CDRL 12-9-14, and CDRL 12-9-17

7.3. PHASES 4.2 AND 4.3.

Contractor shall have Two-Hundred Seventy (270) Days from SFMTA's issue of NTP for Phase 4.2 to complete all Work in Phases 4.2 and 4.3.

7.3.1. Phase 4.2: System Development, Factory Testing, and Site Construction. Upon receipt of NTP for Phase 4.2, Contractor shall commence development, customization, configuration, necessary long lead item procurement of Equipment, and fabrication of materials for all Equipment and Software, and finalization of all test plans and procedures as described in the Design Criteria. Phase 4.2 shall include construction at all communications sites (above and below ground), installation of underground transmission lines, component testing, device testing, module testing, and factory acceptance testing of all subsystems. Phase 4.2 includes System Development, Factory Testing, and Site Construction, as defined in the Design Criteria, including incorporating responses to all of the SFMTA's comments on Contract Deliverable Requirements List (CDRL) submittals. Phase 4.2 shall be considered completed upon the SFMTA's acceptance of all the following Milestones:

A. Integrated System Test Plan, Test Procedures, Cutover Plan, and all CDRL items listed in Document 0900, Appendix 12 § 7.11;

B. All Construction Work (above and below ground) as specified in Document 0900, Appendix 12 § 5;

C. Installation and testing of all in-building transmission lines;

D. Stationary Equipment procurement;

E. Factory acceptance testing including all pre-requisite testing, in accordance with the Integrated System Test Plan specified in Document 900, Appendix 12 § 7.

7.3.2. Phase 4.3: Equipment Installation, System Configuration, and Training Program Planning. Upon receipt of NTP for Phase 4.3, Contractor shall deliver, install, configure, and test all Stationary Equipment at the SFMTA and City sites. The Training Plan shall be finalized, including the Draft Training Schedule, Draft Training Manuals, and Draft Training Agendas. Contractor shall complete Phases 4.2 and 4.3 in their entirety based on the acceptance criteria listed above within Two-Hundred Seventy (270) Days from SFMTA's issue of NTP for Phase 4.2. The SFMTA may, in its sole discretion, issue a limited NTP for Phase 4.3 prior to Contractor's completion of Phase 4.2, if Contractor is successfully completing the Work of Phase 4.2. The SFMTA's refusal to provide NTP for Phase 4.3 prior to completion of Phase 4.2 shall not extend the period in which Contractor must complete the Work of Phases 4.2 and 4.3. The SFMTA's refusal to issue NTP for Phase 4.3 due to Contractor's failure to complete of Phase 4.2 Work shall not be a basis for Contractor to seek a Change Order or otherwise claim delay on the part of the City. Phase 4.3 shall be considered completed upon the SFMTA's acceptance of all of the following Milestones:

- A.** All Stationary Equipment installed, configured, and functionally tested at all City sites
- B.** Training Plan (Final) CDRL 12-8-1
- C.** Training Schedule (Draft) CDRL 12-8-2
- D.** Training Manuals and Agendas (Draft) CDRL 12-8-3.

7.4. PHASE 4.4: INTEGRATED SYSTEM TESTING.

7.4.1. Contractor shall have Sixty (60) Days from SFMTA's issue of NTP for Phase. 4.4 to complete Phase 4.4.

7.4.2. Upon receipt of NTP for Phase 4.4, Contractor shall commence the remainder of integrated system testing including but not limited to the Radio Coverage Acceptance Test, the Field Performance Test, and the Mini-Fleet Test as described in the Design Criteria for the Project. Phase 4.4 shall also include finalization of all training documentation as described in the Design Criteria. Phase 4.4 shall be considered completed upon the SFMTA's acceptance of all of the following Milestones:

- A.** Radio Coverage Acceptance Test report
- B.** Field Performance Test report
- C.** Mini-Fleet Test report
- D.** Training Schedule (Final) CDRL 12-8-2
- E.** Training Manuals and Agendas (Final) CDRL 12-8-3
- F.** Database Dictionary and User Manuals CDRLs 12-9-18 through 12-9-22.

7.5. PHASE 4.5: TRAINING, SYSTEM CUTOVER AND AVAILABILITY DEMONSTRATION.

7.5.1. General Conditions Contractor shall have Three Hundred (300) Days to complete Phase 4.5, including the 720-hour System Availability Test described in the Design Criteria.

7.5.2. Upon receipt of Phase 4.5 NTP, Contractor shall begin training of SFMTA staff, installation of mobile equipment on SFMTA's fleet of revenue and non-revenue vehicles, and distribution of portable equipment. Phase 4.5 shall also include delivery of all as-built versions of maintenance manuals and as-built system documentation. Phase 4.5 shall conclude with the System Availability Test and submittal of the test report to SFMTA. Phase 4.5 shall be considered completed upon the SFMTA's acceptance of all of the following Milestones:

- A.** Completion of the training program
- B.** Installation of mobile equipment in all revenue and non-revenue vehicles
- C.** Configuration and distribution of all portable equipment
- D.** All as-built hardware documentation, software documentation, and maintenance manuals (CDRLs 12-9-10 through 12-9-13)
- E.** Delivery of all Program Source Code (CDRL 12-9-15) and execution of the Software Escrow Agreement (CDRL 12-9-16)
- F.** System Availability Test report.

7.6. PROGRESS AND COMPLETION.

7.6.1. Contractor shall commence the Work of the Contract within five (5) Days from the start date established in the first Notice to Proceed (to commence design Work) issued by the City, and shall diligently and continuously prosecute the Work to the completion of the Project.

7.6.2. Prior to the commencement of any construction, erection, or installation work on any Job Site, Contractor shall notify the Engineer in writing, not less than fifteen (15) Days in advance, of the actual date Work will begin under the Contract. Said notice shall contain information as to the time and Job Site at which Contractor wishes to commence the Work, and the nature of the Work to be done. Similar notice shall be given by Contractor before commencement of any separate portion of the Work that requires the presence of Contractor on property owned by a City department other than the SFMTA or owned by a third party.

7.6.3. The continuous prosecution of the Work by Contractor shall be subject only to the delays defined in Section 7.7. The start of Work shall include attendance at a Project Startup Meeting; joint survey and documentation of existing conditions, if required by the Contract Documents; preparation and submittal of Construction Documents, shop drawings, equipment lists, Schedule of Values, progress schedule, submittal schedule, and requests for substitutions; and other similar activities.

7.6.4. The Work shall be brought to Substantial Completion, Punch List Completion, and Final Completion, as determined by the City, in the manner provided for in the Contract Documents within the limits of Contract Time set out in Section 7.1, above, from and after the official start dates established in the written Notices to Proceed.

7.6.5. Contractor shall not issue a Notice of Substantial Completion before obtaining all required authorizations necessary to operate, regulatory approvals and a Temporary Certificate of Occupancy, if the authority having jurisdiction over the Work requires such Temporary Certificate of Occupancy.

A. During the time between Substantial Completion and Final Completion, Contractor shall complete the Punch List and Testing Work, but Contractor shall not disrupt the City's Partial Utilization of the Project.

B. The Contract Time may be changed only by a Change Order. Claims for adjustment of the Contract Time or Milestones shall be subject to the notice and documentation requirements of Article 13.

7.6.6. Contractor shall at all times keep readily available sufficient material and employ sufficient supervision and workers to prosecute the Work at the rate necessary to reach completion of the Project within the time required by the Contract Documents. Contractor shall not start the Work of any Phase unless it has sufficient personnel, tools, Equipment and materials available for the Phase to allow diligent and continuous prosecution of the Work.

7.6.7. If, in the opinion of the City, Contractor has fallen behind schedule according to Contractor's most current and City-approved update of the progress schedule, and is not entitled to an extension of time as provided in the Contract Documents, Contractor shall take some or all of the following steps to improve its progress, with no adjustment to the Contract Sum, and shall submit operational plans to the City to demonstrate the manner in which the desired rate of progress will be regained:

A. Increase design and/or construction manpower in such quantities, disciplines and crafts as will substantially eliminate the backlog of Work;

B. Increase, when permitted in writing by the City, the number of working hours per shift, shifts per working day, working days per week, or the amount of construction equipment or any combination of the foregoing, sufficient to substantially eliminate the backlog of Work;

C. Reschedule activities to achieve maximum practical concurrence of accomplishment of activities;

D. Expedite delivery of materials and Equipment such as by airfreight;

E. Accelerate the priority of manufacture, fabrication and shipment preparation of Work on order with Supplier(s) should such priority lists exist as a normal course of its business; and

F. any other means deemed appropriate by the City.

7.6.8. Where the Project is delayed but the Contractor is not at fault, the City may direct Contractor by change order or other Contract modification to take steps enumerated in Section 7.6.7 to accelerate the Work for the convenience of the City. In such cases, the City shall compensate Contractor for the reasonable costs of said acceleration and the Contract Sum shall be adjusted accordingly.

7.6.9. Should Contractor at any time during the progress of Work, refuse, neglect, or be unable for avoidable reasons to supply sufficient resources (such as labor, personnel, materials, Equipment) to prosecute the Work continuously and at the rate necessary to complete the Work within the specified limits of Contract Time, in accordance with the currently accepted progress schedule update, the City shall have the right to terminate this Agreement as set forth in Article 14 of these General Conditions, or the City may give Contractor written notice specifying the default and requiring its correction.

7.7. DELAYS AND EXTENSIONS OF TIME.

7.7.1. Unavoidable Delays. Under Section 6.22(H) of the San Francisco Administrative Code and for the purposes of the Contract Documents, the term Unavoidable Delay shall mean an interruption of the Work beyond the control of Contractor that could not have been avoided by Contractor's exercising care, prudence, foresight, and diligence. Moreover, in accordance with the progress schedule requirements of the Contract Documents, Contractor shall demonstrate that the Unavoidable Delay actually extends the most current Substantial Completion date. Delays attributable to and within the control of a Subconsultant, Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

A. Contractor will be entitled to a non-compensable extension of the Contract Time only for the following types of Unavoidable Delay: acts of God; acts of the public enemy; adverse weather conditions; fires; floods; windstorms; hurricanes, tornadoes; earthquakes; wars; riots; insurrections; epidemics; quarantine restrictions; strikes; lockouts; sit-downs; slowdowns; other labor trouble; labor shortages; inability of Contractor to procure labor or materials not caused by Contractor's lack of due diligence and planning; material shortages; fuel shortages; freight embargoes; accidents; acts of a government agency; priorities or privileges established for the manufacture, assembly or allotment of materials by order, decree, or otherwise of the United States or by any department, bureau, commission, committee, agent or administrator of any legally constituted public authority; and inability to procure or failure of public utility service.

B. Whenever Contractor has knowledge that any actual or potential labor dispute is delaying or is threatening to delay the timely performance of its Contract, Contractor shall immediately give written notice thereof, including all relevant information with respect thereto, to the City.

C. In addition, Contractor shall take all appropriate measures to eliminate or minimize the effect of such labor dispute on the current, City-approved progress schedule, including but not limited to such measures as: promptly seeking appropriate injunctive relief; filing appropriate charges with the National Labor Relations Board under the applicable provisions of the Labor

Management Relations Act of 1947, as amended; filing appropriate damage actions; taking such measures as establishing a reserved gate, as appropriate; if reasonably feasible, seeking other sources of supply or service; or any other measures that may be appropriately utilized as deemed by the City to limit or eliminate the effect of the labor dispute on the Work. To the extent Contractor fails to initiate appropriate measures, it is not entitled to an extension of Contract Time. In addition, any delay impact caused by said failure on the progress schedule will be considered a Contractor-caused delay under any and all applicable provisions of the Contract Documents.

D. Contractor shall be entitled to a compensable extension of Contract Time, accomplished by an adjustment to the Contract Sum for an Unavoidable Delay caused by a Change Order initiated or caused by the City, provided such Unavoidable Delay is critical, extends the most current Substantial Completion date, and is not concurrent with a Contractor-caused delay or other type of Unavoidable Delay as previously defined. All other types of Unavoidable Delay shall not entitle Contractor to a compensable time extension.

E. Contractor shall not be entitled to a Contract Time extension in the event a City-caused delay is concurrent with a Contractor-caused delay.

7.7.2. Avoidable Delays. The term "Avoidable Delay" shall include but is not limited to the following:

A. Any delay which could have been avoided by the exercise of due care, prudence, foresight and diligence on the part of Contractor including rescheduling the Work or organizing the Work (including procuring materials and Equipment) so that the critical path is not impacted by the delay or such impacts are minimized;

B. Any delay in the prosecution of parts of the Work, which may in itself be Unavoidable, but which does not necessarily prevent or delay the prosecution of other parts of the Work, nor delay the specified Substantial Completion date;

C. Any delay caused by the untimely review by Contractor of the Criteria Package or other Contract Documents.

7.7.3. Adverse Weather Delays.

A. Adverse weather shall not be a prima facie reason for the granting of a time extension, and Contractor shall make every effort to continue work under prevailing conditions. Such efforts by Contractor shall include, but are not limited to, providing temporary gravel roads; installing a rain dewatering system; protecting interior and exterior areas exposed to rain, wind, and extreme temperatures; and providing temporary heat where required for Work to proceed without delay.

B. The City may classify an adverse weather day as a non-compensable Unavoidable Delay, provided Contractor made efforts to work during adverse weather and to avoid the impacts of adverse weather to its schedule. If such an event occurs, and Contractor is prevented by adverse weather or conditions from proceeding with at least 75 percent of the scheduled labor, material and equipment resources for at least 5 hours per work day on

activities shown as critical on the most current and City-approved progress schedule update, the delay will be classified as an Unavoidable Delay, and Contractor will be granted a non-compensable time extension.

C. Regardless of the type and severity of the adverse weather, the Contract Sum shall include, without adjustment thereto, all costs that may be incurred by Contractor to make efforts to mitigate the impacts of adverse weather to its schedule during the Contract Time.

D. Adverse weather shall mean rain, windstorm, flood, or other natural phenomenon occurring at a Site which exceed the anticipated number of days of inclement weather as provided herein and which are proven by Contractor to be substantially detrimental to the progress of the Work. Contractor shall plan the Work to allow for the following number of days of inclement weather during normal working hours:

Month	Rain Days
January	3
February	3
March	2
April	1
May	0
June	0
July	0
August	0
September	0
October	1
November	1
December	3

E. Contractor's progress schedule shall incorporate prudent allowance for the anticipated number of days of inclement weather specified herein.

F. The Contract Time allowed for completion of Work specified in Section 7.1, above, is predicated on the anticipated number of Days of inclement weather specified herein.

G. Contractor shall not be entitled to receive a time extension related to weather until the anticipated number of days specified herein for the month of occurrence of the inclement weather event has been exceeded.

H. In the event that there are months with less than the anticipated number of inclement weather days specified herein, the City reserves the right to transfer the unused inclement weather days to other months of the Contract Time for which Contractor has requested a time extension because of adverse weather.

7.7.4. Notice of Delay.

A. Under Section 6.22(H) of the San Francisco Administrative Code, Contractor shall promptly notify the City in writing of all anticipated delays in the prosecution of the Work and, in any event, promptly upon the occurrence of a delay. The City may take steps to prevent the occurrence or continuance of the delay, and the City may determine to what extent any Milestone or Substantial Completion is delayed thereby.

B. Said notice shall constitute an application for an extension of time only if it requests such time extension in writing that sets forth Contractor's estimate of the additional time required together with a full recital of the causes of Unavoidable Delays relied upon, and meets all requirements for a Notice of Potential Contract Claim as set forth in Section 13.2.1, including the requirement that such Notice be submitted to the City within seven (7) Days of the event which Contractor contends affected the performance of the Work.

C. The City's determination of whether an extension of time will be granted will be based on Contractor's demonstration to the City's satisfaction that such Unavoidable Delays will extend Contractor's current critical path on the current, City-approved updated progress schedule or require the formulation of a new extended critical path.

D. If Contractor does not submit a Notice of Potential Contract Claim as set forth in Section 13.2.1, Contractor thereby admits the occurrence had no effect on the length of its duration of Work, waives any Claim based on the occurrence, and stipulates that no extension of time is necessary. Contractor understands and agrees that in failing to provide timely notice, no extension of time or adjustment of the Contract Sum will be granted by the City.

7.7.5. Extensions of Time.

A. In the event it is deemed necessary by the City to extend the time for completion of the Work to be done under these Contract Documents beyond the specified limits of Contract Time specified in the Contract Documents, such extensions shall in no way release or reduce any guarantees or warranties given

by Contractor under the provisions of the Contract Documents and shall extend said warranties so that the City enjoys the full benefit of them as if no delay had occurred.,

B. An extension of time shall not relieve or release the sureties on the bonds executed under the Contract Documents.

C. The sureties in executing such bonds shall be deemed to have expressly agreed to any such extension of time.

D. The length of any extension of time shall be limited to the extent that the commencement, prosecution and completion of the Work are delayed by the event as determined by the City in accordance with Section 6.22(H) of the San Francisco Administrative Code.

E. Extensions of time that cumulatively extend the Contract Time in excess of twenty (25) percent of the original Contract Time shall be subject to the approval of the SFMTA Board of Directors. The authority of the Executive Director or his designee to approve change orders is subject to modification by the SFMTA Board of Directors.

F. In no event shall such extensions of Contract Time be granted subsequent to the date of Final Completion.

G. Granting of an extension of Contract Time because of Unavoidable Delays shall in no way operate as a waiver on the part of the City of the right to collect liquidated damages for other delays or to collect other damages or to pursue other rights and interests to which the City is entitled.

H. Should Contractor, any Subcontractor or Subconsultant of any tier, or any Supplier of any tier seek an extension of Contract Time for the completion of the Work under the provisions of this Section 7.7, Contractor and its Subcontractor, Subconsultant or Supplier shall submit justification for the extension of the time requested and otherwise comply with all provisions of the Contract Documents with respect to requests for extensions of time.

I. Neither this Section 7.7, nor any other provision of the Contract Documents, is intended by the parties to be contrary to any express provision of law. The parties specifically agree, acknowledge and warrant that neither this provision nor any other provision of the Contract Documents has for its object, directly or indirectly, the exemption of the City, the Engineer, the City's contractors, and their respective directors, officers, members, employees, and authorized representatives from responsibility of their own sole negligence, violation of law or other willful injury to the person or property of another.

7.8. SUBSTANTIAL COMPLETION.

7.8.1. Contractor shall notify the City in writing when Contractor considers that the Work has passed all reliability tests and has otherwise reached Substantial Completion. In the written notification, Contractor shall request that the City inspect the Work and related documentation, and prepare a Notice of Substantial Completion. Concurrently, Contractor shall issue to the City a Punch List of uncompleted and/or Nonconforming Work. Contractor's completion of start-up services and submittal of warranties, guarantees, and record documents

to the SFMTA shall be a condition precedent to requesting an inspection for Substantial Completion.

7.8.2. Within five (5) working days from receipt of Contractor's written notification, the City will make an inspection and review all reports to determine whether the Work is Substantially Complete. If the City determines that the Work is not Substantially Complete, the City will provide Contractor with a Deficiency List that lists all Items that shall be corrected or completed before the City considers the Work Substantially Complete.

7.8.3. Once Contractor has completed all items on the Deficiency List, Contractor shall request a second inspection by the City to verify that the Work is Substantially Complete. If the City determines that the Work is still not Substantially Complete, the City will follow the same procedure as for the first inspection, and Contractor shall reimburse the City (or the City at its option may assert a credit against and deduct against any sum due Contractor) for costs incurred by the City and its Contractors related to all inspections subsequent to the first inspection necessary to achieve Substantial Completion.

7.8.4. When the City determines that the Work is Substantially Complete and all above requirements have been met, the City will issue a Notice of Substantial Completion.

7.8.5. The City's determination of Substantial Completion will not be unreasonably withheld provided that the Work is completed in accordance with the Contract Documents and Contractor obtains a temporary certificate of occupancy from the City's Department of Building Inspection or other regulatory agency having jurisdiction over the Work or its testing or authorization to operate in the event that such temporary occupancy permit or other permit or authorization is necessary for the City to utilize the Work for the purposes for which it is intended.

7.8.6. At the time of delivery of the Notice of Substantial Completion, the City will deliver to Contractor (i) a Punch List identifying deficient items to be corrected by Contractor prior to Punch List Completion; and (ii) a written determination as to the division of responsibilities pending final acceptance between the City and Contractor regarding close-out requirements, as provided in Document 00818 (Contract Closeout Procedures and Criteria).

7.9. PUNCH LIST COMPLETION.

7.9.1. When Contractor considers all Punch List Work complete, including all unfinished and/or Nonconforming items of Work on the Punch List, Contractor shall notify the City in writing.

7.9.2. Within seven (7) Days of receipt of Contractor's written notice, the City will verify whether all Punch List items are completed. If the City finds that any of the Punch List items are not complete, the City will notify Contractor in writing and identify the deficient items. Contractor shall promptly take actions necessary to complete such deficient Punch List items.

7.9.3. Once Contractor completes all items on the Punch List, Contractor shall notify the City in writing and request a second inspection. If the City finds the Punch List Items are still not complete, Contractor shall be responsible for all

costs for conducting such inspections following the first inspection incurred by the City and its Contractors before Completion of the Punch List Work. Contractor shall pay all such costs of the City and its Contractors for conducting such additional inspections to the City within thirty days from the date of invoice by the City. In the alternative, the City at its option may assert a credit against and deduct it from any sum due Contractor.

7.9.4. After Contractor has completed all Punch List Items to the City's satisfaction, and satisfied all other requirements for Punch List Completion set forth in the Contract Documents (e.g., requirements set forth in Document 0818 Contract Closeout Procedures and Criteria") the City will issue a written notice of Punch List Completion.

7.10. PARTIAL UTILIZATION.

7.10.1. Contractor understands and agrees that roll out and cutover from the SFMTA's existing radio communications system to the Replacement Radio System will be accomplished in stages. Contractor understands and agrees that in order to maintain radio and data communications as Contractor progresses and completes the Project, the SFMTA must utilize Equipment and portions of the Replacement Radio System prior to Substantial Completion and prior to Final Acceptance.

7.10.2. For Phase 4.1 (System Design), and Phase 4.2 (primarily system development, factory testing equipment procurement and Site construction), the SFMTA should not have need for Partial Utilization.

In Phase 4.3 (installation of System, Stationary Equipment and some Mobile Equipment, and preliminary functional tests) the SFMTA may need Partial Utilization of certain delivered antenna equipment and network equipment that will be integrated with the existing SFMTA radio system while the Replacement Radio System is in the installation process. During Phase 4.1, as part of the System design process, the Parties shall meet and confer to confirm the specific Equipment for which the SFMTA will require Partial Utilization. At the end of Phase 4.3, the Parties anticipate that both the existing SFMTA radio communications system and the Replacement Radio System will be separately operational, and SFMTA will use the existing infrastructure, except for the Equipment to be identified for Partial Utilization as described above. During Phase 4.3, except for the antenna equipment and network equipment, the SFMTA should not need Partial Utilization, and the Replacement Radio System at that time will be used primarily for Test and Conditional Acceptance purposes.

For Phase 4.4 (System Performance Testing), Upon the SFMTA's Conditional Acceptance of the Mini-Fleet Test Report (in Phase 4.4.3), the SFMTA shall have Partial Utilization to the entire Replacement Radio System as the elements and Equipment of the System are installed.

7.10.3. When Contractor believes that part of the Project is sufficiently complete for SFMTA use, Contractor shall notify the City in writing and request a joint inspection of that part of the Work. Within seven days from receipt of

Contractor's written notification, Contractor and the City shall jointly inspect the portion of the Work to be used by the SFMTA in order to determine and record its status of completion.

7.10.4. The Partial Utilization by the SFMTA of Equipment or any portion of the Project prior to Final Acceptance by the SFMTA shall be at Contractor's sole risk. Partial utilization by the City of the Project or any part thereof shall in no case be construed as constituting completion or City's acceptance of Nonconforming Work. Such use shall neither relieve Contractor of any of its responsibilities and obligations under the Contract Documents, nor act as a waiver by the City of any of the conditions thereof.

7.10.5. Contractor shall perform final cleaning of the part of the Project to be partially utilized as specified in the Criteria Package when directed to do so by the City.

7.11. FINAL COMPLETION.

7.11.1. When Contractor considers all Work complete, including all closeout requirements (see Document 000818 ("Contract Closeout Procedures and Criteria")), Contractor shall notify the City in writing.

7.11.2. Within two business days of receipt of Contractor's written notice, the City will verify whether all Testing and other remaining closeout requirements are completed. If the City finds that any of the Testing or other closeout items is not complete, the City will notify Contractor in writing and identify the deficient items. Contractor shall promptly take actions necessary to complete such deficient closeout items.

7.11.3. When Contractor has completed all deficient (Punch List) Items, Contractor shall so notify the City in writing and request a second inspection. If the City finds the closeout items are still not complete, Contractor shall be responsible for all costs for conducting such additional inspections incurred by the City and its Contractors before Final Completion. Contractor shall pay all such costs of the City and its Contractors for conducting such additional inspections to the City within thirty days from the date of invoice by the City. In the alternative, the City at its option may assert a credit against of said amount and deduct it from any sum due Contractor.

7.11.4. After Contractor has completed all Punch List items to the City's satisfaction and delivered all close-out requirements in accordance with the Contract Documents, the City may issue a written certificate of acceptance as provided by Section 6.22(K) of the San Francisco Administrative Code.

ARTICLE 8 -- LIQUIDATED DAMAGES, DELAY AND NONCONFORMING WORK

8.1. LIQUIDATED DAMAGES FOR DELAY.

8.1.1. Determination of Damages.

A. Contractor's completion of the Work within the approved project schedule and the specified limits of Contract Time established for Substantial

Completion and Final Completion are material requirements of this Contract. The actual amount of the damages that the City would suffer if the Work were not completed within the specific limits of Contract Time in which Contractor shall complete, respectively, Substantial Completion and Final Completion of the Project, as those time limits are set out below, is dependent upon many circumstances and conditions. From the nature of the Project and the operating requirements of the SFMTA, it is and would be impracticable and extremely difficult to determine the actual damages that the SFMTA would sustain due to Contractor's delay of Substantial Completion and/or Final Completion.

B. Damages which the City would suffer in the event of Contractor's delay to Substantial Completion and/or Final Completion include, but are not limited to: the loss of use and benefit suffered by the public within the City and County of San Francisco by reasons of the delay in the completion of the Project to serve the public at the earliest possible time; risks and costs associated with the continued use of the SFMTA's existing radio and data communications systems (or portions thereof); expenses of prolonged employment of consultant engineers and project managers; the prolonged assignment to the Project of City engineers and managers to the detriment of other City projects; and, additional costs of administration, inspection and supervision of the Project.

8.1.2. Fair Measure of Damages. It is understood and agreed by Contractor and City that if the Project is not completed within the Contract Time, and if Project is not completed to Substantial Completion or Final Completion with the limits of Contract Time provided for each, respectively, the City will sustain actual damages in the event of and by reason of such delay. Contractor and City agree that the amount of liquidated damages set forth in this Section 8.1, represent the reasonable, fair and equitable estimate at the Effective Date of the approximate damages that the City will sustain for each and every Day of delay beyond the number of Days allowed respectively for Contractor to complete the Project to Substantial Completion and to Final Completion (as such limits of Contractor Time may be modified in accordance with the Contract Documents).

8.1.3. Delay of Substantial Completion. Contractor shall pay the SFMTA Thirty-Five Thousand Dollars (\$35,000) for every Day that Substantial Completion is delayed due to the action or inaction of Contractor beyond the date that Contractor is required to complete the Project to Substantial Completion (that is, the 1110 Days time limit set out in Article 7, above, for Substantial Completion of Phases 4.1, 4.2, 4.3, 4.4 and 4.5).

8.1.4. Delay in Final Completion. Contractor shall complete all Punch List Work within 90 days from the date the City provides notice to Contractor that the Project has reached Substantial Completion (the "Substantial Completion Date"). Contractor shall pay as liquidated damages Five Thousand Dollars (\$5,000) per Day for each Day beyond 90 days from the Substantial Completion Date that Contractor has not completed all Punch List Work and otherwise brought the Project to Final Completion.

8.1.5. Limitation. The application of liquidated damages as compensation to the City for Contractor's unexcused delay is limited to those Days beyond the limits of Contract Time stated herein that Substantial Completion

and/or Final Completion of the Project has been delayed due to fault of the Contractor.

8.2. LIQUIDATED DAMAGES FOR FAILURE TO MEET SYSTEM PERFORMANCE SPECIFICATIONS.

8.2.1. Determination of Damages. The performance of the Project will be generally measured by the Availability and Coverage of the Radio System, as those metrics are set out in the Contract Documents. The actual amount of the damages that the City would suffer if the Project as designed and constructed by Contractor does not meet the Project Performance Requirements is dependent upon many circumstances and conditions, and from the nature of the Project and the operating requirements of the SFMTA, it is and would be impracticable and extremely difficult to determine the SFMTA's actual damages.

8.2.2. Measure of Damages. It is understood and agreed by Contractor and the City that if the Replacement Radio System does not meet the Performance Requirements set out in the Contract Documents, actual damages will be sustained by the City in the event of and by reason of Contractor's failure to design and/or construct the Project to meet those specifications and requirements. Damages that the City would suffer in the event that the Project as designed and constructed by Contractor does not meet the Performance Requirements include, but are not limited to: the loss of public benefit and utility for transit and public safety functions suffered by the City and the public within the City and County of San Francisco by reasons of the diminished functionality of the Project; the risks associated arising from the City's continued use of the existing radio system or portions thereof; the costs of alternate means of voice and data communication to serve the SFMTA's transit, public safety and business requirements; the expenses of prolonged employment of engineering and consultant staff; and, the City's prolonged costs of administration, inspection and supervision. The amounts of liquidated damages set out in this Article 8 represent the fair, equitable and agreed estimates as of the Effective Date of the damages that the City will incur if the Project as designed and constructed by Contractor does not meet said Performance Requirements. Said damages are based on the reduced utility, benefit and value of the Project that the City will receive from Contractor if the Replacement Radio System does not meet the Project's Performance Requirements.

8.2.3. System Availability.

A. Total System Loss. A period in which Thirty Percent (30%) or more of all revenue vehicles are unable to communicate through the Replacement Radio System at any one time shall constitute Total System Loss for purposes of this Section 8.2.3. The Radio System as constructed at Substantial Completion and through the Warranty Period shall be available 99.999 percent of the time, except as provided in the following paragraph B. System Availability shall be measured as the availability (i.e., non Total System Loss) of the Radio System, 24 hours per day, seven days per week, measured in one-year increments commencing on the Substantial Completion Date. That is, commencing on the Substantial Completion Date and continuing through the end of the Warranty Period, the Replacement Radio System shall not experience Total System Loss of a cumulative total time exceeding Five Minutes Sixteen

Seconds (5.256 minutes) in any year. (The calculation is: 365 days x 24 hours x 60 minutes x .00001 = 5.256 minutes per year.)

For purposes of calculating Total System Loss, a year commences upon the Substantial Completion Date and on each anniversary of the Substantial Completion Date up until the expiration of the Warranty Period. Contractor shall pay the SFMTA as liquidated damages One Thousand Dollars (\$1,000) for every minute or fraction thereof beyond 5.256 minutes in any year that the Radio System experiences Total System Loss.

B. Any Transmitter/Antenna Site. Contractor shall pay as liquidated damages One Thousand Dollars (\$1,000) for every hour or portion thereof exceeding Contractor's Response Time (as provided in Document 00835) in which the transmitter/antenna at any antenna site is inoperable due to fault of Contractor.

C. System Coverage. System Coverage must meet the requirements set out in the Design Criteria in the RFQ/RFP at Appendix 12 § 2. Contractor's failure to meet System Coverage requirements will result in a reduction in the Contract Sum, as set out below. Final coverage evaluation for purposes of determining application of liquidated damages for System Coverage shall be determined at Substantial Completion. The reduction in the Contract Sum represents the reduced consideration provided by Contractor to the City under the Contract. Said reduction in the Contract Sum shall not be construed as a penalty; the reductions in Contract Sum are liquidated damages meant to compensate the City for the damages the City will incur (which are described above). Said compensation may in the alternative be considered as a negative performance incentive or reduced consideration to the Contractor provided in return for a final product that has less functionality than Contractor was obligated to provide under the Contract. Whether characterized as liquidated damages or as a negative performance incentive, the Parties agree that the amount(s) of the reduction(s) of the Contract Sum, if any, is a fair, equitable and reasonable estimate of the reduced utility, benefit and value that the City will receive from Contractor if the Replacement Radio System does not meet the Design Requirements and system performance requirements provided in the Contract Documents.

D. Above Ground – Mobile Voice and Data (Excluding Cable Car. At Substantial Completion, Coverage for mobile voice and data applications for all mobile devices, excluding Cable Cars, must meet the Coverage requirements specified in Appendix 12 § 2. If System Coverage for mobile voice and data applications at Substantial Completion is greater than Ninety-Four (94%) Percent and less than Ninety-Five Percent (95%), the SFMTA in its sole and absolute discretion may reduce the Contract Sum by Five Million Dollars (\$5,000,000). If System Coverage for portable voice and data applications is Ninety-Four Percent (94%) or less by any amount, the SFMTA in its sole and absolute discretion may determine that Contractor is in material breach (default) of the Contract and may exercise all remedies available to the City. See RFQ/RFP Appendix 12 § 2.

E. Cable Car –Portable Voice and Data. At Substantial Completion, Coverage for voice and data applications for all portable devices used for Cable Cars, must meet or exceed Ninety Five Percent (95%). If Coverage for portable applications used for Cable Cars is less than Ninety Five Percent (95%) by any amount, the SFMTA in its sole and absolute discretion may reduce the Contract Sum by Three Million Dollars (\$3,000,000) or determine that Contractor is in material breach (default) of the Contract and exercise all remedies available to the City. See RFQ/RFP Appendix 12 § 2.

F. Below Ground – Mobile Voice and Data (Subway). At Substantial Completion, Coverage for mobile voice and data applications for vehicles in the Subway must meet or exceed Ninety-Seven Percent (97%). If said Coverage Ninety-Six Percent (96%) or greater and less than Ninety-Seven Percent (97%), the SFMTA in its sole and absolute discretion may reduce the Contract Sum by Three Million Dollars (\$3,000,000). If said Coverage is between Ninety-Five Percent (95%) and 95.99%, the SFMTA in its sole and absolute discretion may reduce the Contract Sum by an additional Three Million Dollars (\$3,000,000), for a total reduction in the Contract Sum of Six Million Dollars (\$6,000,000). If said Coverage is less than Ninety Five Percent (95%) by any amount, the SFMTA in its sole and absolute discretion may reduce the Contract Sum by Six Million Dollars (\$6,000,000) or determine that Contractor is in material breach (default) of the Contract and exercise all remedies available to the City. See RFQ/RFP at Appendix 12 § 2.

G. Below Ground – Portable (Subway). At Substantial Completion, Coverage for mobile voice and data applications for vehicles in the Subway must meet or exceed Ninety Five Percent (95%). If said Coverage is less than Ninety Five Percent (95%) by any amount, the SFMTA in its sole and absolute discretion may reduce the Contract Sum by Three Million Dollars (\$3,000,000) or determine that Contractor is in material breach (default) of the Contract and exercise all remedies available to the City. See RFQ/RFP Appendix 12 § 2.

H. Application. Application of liquidated damages provisions set out in this Section 8.2 for failure to meet Performance Requirements is an alternative assessment and remedy that the City in its sole and absolute discretion may apply in lieu of continuing assessment of liquidated damages for delay under Section 8.1, above. The City may assess liquidated damages for failure to meet Performance Requirements under this Section 8.2 if the SFMTA determines in its sole and absolute discretion that Contractor lacks or will not commit the necessary resources, abilities, skills, or personnel to design and construct a voice and data communications system that meets the Coverage and Availability requirements of the Project, but notwithstanding those failings, Contractor has produced a Replacement Radio System that meets most Performance Requirements and is minimally acceptable to the SFMTA. The City's ability to assess liquidated damages for Contractor's failure to meet Performance Requirements shall not reduce, replace, or in any way excuse the obligations of Contractor's sureties to guarantee the performance of Contractor and the completion of the Project to the SFMTA's satisfaction.

I. Assessment. The SFMTA may assess liquidated damages under this Section 8.2 at anytime subsequent to completion of the Availability

Demonstration (see Section 7.5.2) or during the Warranty Period if the Replacement Radio System fails to meet the Performance Requirements set out in the Contract Documents, that failure continues for a period of 90 Days (the "Cure Period"), and Contractor has failed or refuses to investigate and correct or otherwise cure the cause of the failure. If Contractor can show that more time is required to bring the Replacement Radio System into compliance with the Performance Requirements, Contractor may request extension of the Cure Period for a commercially reasonable period, which the SFMTA will not unreasonably refuse, but such extension shall not exceed 180 Days from the expiration of the initial Cure Period.

8.3. COLLECTION OF LIQUIDATED DAMAGES.

It is agreed that the City at its option may reduce the Contract Sum and withhold payment in an amount equal to all accrued liquidated damages or may demand immediate payment from Contractor of any or all amounts of accrued liquidated damages. If, after adjusting the Contract Sum to account for liquidated damages, the City determines that it has paid Contractor an amount in excess of the Contract Sum, then, upon written notice from the City of such overpayment, Contractor shall within 10 days refund such amount to the City.

8.4. BREACH OF CONTRACT DUE TO DELAY.

The SFMTA, in its sole and absolute discretion, may declare Contractor in material breach of the Contract if: (1) the total liquidated damages for unexcused delay that the City may assess against Contractor exceed Ten Percent (10%) of the Contract Sum; or (2) the total delays to Substantial Completion due to the fault of Contractor exceed 90 days and Contractor has not presented to the satisfaction of the SFMTA a plan and schedule to bring the Project to Substantial Completion. The SFMTA's acceptance of such a plan and schedule is entirely within the sole and absolute discretion of the SFMTA, and the acceptance of such plan shall not constitute any waiver of liquidated damages or other rights. If Contractor fails to provide the SFMTA an acceptable plan to bring the Project to Substantial Completion, the SFMTA in its sole and absolute discretion may determine the Contractor to be in default of the Agreement and require the performance bond surety to takeover and complete the Project, or in the alternative, the SFMTA may terminate the Agreement at no additional cost to the City.

8.5. LIMITATION OF LIABILITY FOR LIQUIDATED DAMAGES.

Contractor's liability for liquidated damages for unexcused delay to the Project shall not exceed Twenty Five Percent (25%) of the total Contract Sum, as that amount may be amended from time to time by lawful modification of the Contract.

ARTICLE 9 -- PAYMENT

9.1. CONTRACT SUM.

9.1.1. Payment to Contractor of the Contract Sum, as it may be adjusted by the City during the course of the Project in accordance with the Contract

Documents, shall be full compensation for furnishing all labor, Equipment and materials for the Project, and equipment and tools necessary to the Project; for performing and completing all Work in accordance with the requirements of the Contract Documents; and for all expenses incurred by Contractor for any purpose incidental to performing and completing the Project, including but not limited to the payment of applicable taxes (except as other Contract provisions may require concerning tax payment).

9.1.2. Wherever the Contract Documents specify that Contractor is to perform Work or Furnish Equipment or materials of any class for which no price is fixed in the Contract, it shall be understood that such Work is to be performed or such Equipment or materials Furnished to the Project without extra charge, allowance or direct payment of any sort, and that the cost of performing such Work or Furnishing such Equipment or materials is included in the Contract Sum.

9.1.3. The City's payment obligations under this Contract shall be limited to the amount of Work completed, and shall in no case exceed the authorized Contract Sum. Notwithstanding any other provision of this Contract, in no event shall the City be liable, regardless of whether any claim is based on contract or tort, for any special, consequential, indirect or incidental damages, including, but not limited to, lost profits, arising out of or in connection with this Contract or the services performed in connection with this Contract. In no event shall the City become liable for interest or other charges for late payment except as set forth in San Francisco Administrative Code section 6.22(J)(6).

9.1.4. The provisions of this Section 9.1 shall survive the expiration or termination of the Contract.

9.2. PROJECT PERFORMANCE AND PAYMENT SCHEDULE.

The City shall make payments to Contractor as provided in the Milestone Payment Schedule set out in Document 530 and in accordance with Document 809, as to progress payments, Milestones and Unit prices stated therein. The total cost of performing the Project and each Item and each Phase of Work, including providing all labor, materials, fixed cost elements, tools and equipment necessary for the Project, Furnishing Equipment and materials, incurred incidental expenses, and overhead and profit, shall be included in the Contract Sum. The City will make payments to Contractor based on Contractor's completion to the City's satisfaction of the Work described in the Contract according the Project Schedule for the amounts listed in the Payment Schedule. The City shall not make payments in excess of the value of the Work that Contractor has completed to the City's satisfaction, based on the value of the Work set out in the Document 0530. Contractor shall submit with any payment application such forms as may be required by the SFMTA, including but not limited to SBE participation reports.

9.3. PAYMENTS.

9.3.1. As Contractor progresses the Project, the City shall make lump sum payments to Contractor for its completion of those Items and elements of the Work identified in the Document 530 to be paid lump sum. The City shall make Milestone payments to Contractor for completed Work that is identified in the

Document 0530 as Milestone Work. The City shall pay Contractor for each Item installed that is listed in the Document 0530 as a Unit Price Item.

9.3.2. If requested by Contractor, the SFMTA may issue progress payments for completed portions of lump sum Work. It shall be entirely within the SFMTA's discretion whether to approve a requested progress payment. At no time shall the City make any progress payment in advance of Contractor's completion of the portion of the Work, Item or Milestone for which Contractor is to be compensated.

9.3.3. The City shall endeavor to make payments for undisputed amounts within fifteen (15) business days but no later than thirty (30) business days of receipt of a payment request and all required supporting documentation, including without limitation certified payrolls and San Francisco Human Rights Commission program participation forms.

9.3.4. Applications for payments shall be processed as follows:

A. As Contractor completes the Work, but no more frequently than once per month, Contractor shall submit to the City for review an Application for Payment, on a form approved by the City and signed by Contractor, describing the Work, Item, Milestone or other compensable deliverable completed by Contractor as of the date of the application and accompanied by required supporting documentation.

B. Contractor shall state the Milestone or Unit Price Work and associated value (as applicable) of Work completed in the preceding month per the Document 0530 as that may have been amended by the current City-approved progress schedule update.

C. Payments on account of Unit Price Work shall be based on the number of units of Work satisfactorily completed as determined by the City and the unit prices for such items, adjusted for the actual quantities of Work performed. Payments for Milestones shall be made only upon completion of the Milestone. The SFMTA may in its discretion pay Contractor for the completed portion of a Milestone or the entire Milestone and designate the remainder of the Work to be performed under that Milestone as Punch List Work to be completed prior to Final Completion.

D. Except as provided in Section 9.5 ("Long Lead Items"), no payment will be made for materials or Equipment not incorporated into the Work.

E. Only Change Orders and undisputed portions of Unilateral Change Orders completely approved and executed by the City shall be included with an Application for Payment. Contractor shall submit a breakdown for each Change Order by Change Order Number on its Application for Payment.

F. Each Application for Payment must include a unique invoice number, and shall state the total amount paid to Contractor as of the date the Application for Payment is prepared.

G. All amounts paid by the City to Contractor shall be subject to audit by the City, as provided in Section 2.5.

H. Payment shall be made by the City to Contractor at the address specified in Article 10 of the Design Build Agreement (Document 00520) (Notices to the Parties), below, or as specifically directed by Contractor in writing.

I. The Controller is not authorized to pay invoices submitted by Contractor prior to Contractor's submission of the SFMTA Progress Payment Form. If a Progress Payment Form is not submitted with a Contractor's invoice, the SFMTA will notify Contractor of the omission and will withhold payment of that invoice until the SFMTA Progress Payment Form is provided.

J. Following the City's payment of an invoice, Contractor has five (5) Days to file an affidavit using the SFMTA Payment Affidavit verifying that all subcontractors have been paid and specifying the amounts paid.

9.3.5. The City will pay to Contractor, as provided in Document 0530, the value of the Milestone Work and Unit Price Work completed, less ten percent of the value of said Work (which the City shall hold as retention as provided in Section 9.4) less the aggregate of the amount of previous payments. The City may withhold payments at any time that the Work, in the City's estimation, is not proceeding in accordance with the Contract.

9.3.6. Notwithstanding any other provision of the Contract, the City shall not be obligated to pay Contractor more than Thirty Seven Percent (37%) of the Contract Sum prior to Contractor's completion of Phase 4.3. (Equipment Installation, System Configuration, and Training Program Planning). Notwithstanding any other provision of the Contract, the City shall not be obligated to pay Contractor more than Sixty Percent (60%) of the Contract Sum prior to Contractor's completion of Phase 4.4, Integrated System Testing.

9.3.7. No inaccuracy or error in the City's review of Contractor's monthly estimates of completed Work or of any estimate of completed Work performed by the City shall operate to release Contractor or its sureties from damages arising from such Work or from the enforcement of each and every provision of the Contract Documents, and the City shall have the right to correct any error made in any estimate for payment.

9.3.8. The granting of any payment by the City, or the receipt thereof by Contractor, shall not constitute or be construed that the City has:

A. Inspected the Work exhaustively to confirm without question that the quality or quantity are in conformance to the requirements of the Contract Documents; or

B. Reviewed Contractor's means, methods, techniques, sequences or procedures of design or construction; or

C. Ascertained how or for what purpose Contractor has used money paid, or determined that title to any of the Work, materials, or Equipment has passed to the City free and clear of any liens; or

D. Waived any requirement of this Contract or obligation of Contractor;

E. Accepted the Work or any portion thereof; or

F. Relieved Contractor of its duty to replace unsatisfactory Work, Equipment or material, though the unsatisfactory character of such Work, Equipment or material may not have been apparent or detected at the time such payment was made.

9.4. RETENTION.

9.4.1. The City shall withhold from each progress or Milestone payment ten percent (10%) of the amount due, as provided in S.F. Administrative Code Section 6.22.J.

9.4.2. When the City determines that: (1) the Work is fifty percent or more complete; (2) that Contractor is making satisfactory progress; and, (3) that there is no specific cause for greater withholding, the City, at its sole option and discretion and upon the written request of Contractor, may either:

A. Release part of the retention to Contractor so that the amount held in retention by the City, after release to Contractor, is reduced to not less than Five Percent (5%) of the total value of the labor and materials furnished, and the City shall proceed to retain Five Percent (5%) of any subsequent progress payment under the Contract; or

B. Continue to hold the already withheld retention amount, up to Five Percent (5%) of the total Contract Sum, and shall not deduct further retention from progress payments.

9.4.3. When the City determines that the Work is 98 percent or more complete, the City may reduce retention funds to an amount equal to 200 percent of the estimated value of Work yet to be completed, provided that the Contract is free of offsets by the City and is free of stop notices, forfeitures, and other charges.

9.4.4. In accordance with Section 22300 of the California Public Contract Code, Contractor will be permitted to substitute securities for any moneys withheld by the City to ensure performance under the Contract under the following conditions:

A. At the request and expense of Contractor, securities listed in California Government Code section 16430, bank or savings and loan certificate of deposits, interest bearing demand deposit accounts, irrevocable standby letters of credit, or any other security mutually agreed to by the City and Contractor which are equivalent to the amount withheld under the retention provisions of the Contract Documents shall be deposited with the City Controller who shall then pay such moneys to Contractor. Upon satisfactory completion of the Project and all Work under this Contract, the securities shall be returned to Contractor.

B. Contractor shall receive and may withdraw any interest gained on the securities substituted for monies withheld as provided by Law.

C. Contractor shall enter into an escrow agreement with the City Controller according to Document 01002 ("Escrow Agreement for Security Deposits in Lieu of Retention"), specifying the amount of securities to be

deposited, terms and conditions of conversion to cash in case of default of Contractor, and termination of escrow upon completion of the Contract.

9.5. LONG LEAD ITEMS .

Pursuant to Section 6.22.J of the San Francisco Administrative Code, payment for long-lead material or Equipment procured by Contractor but stored on or off a Site and not incorporated in the Project will not be allowed, except as provided in this Section 9.5. The City may, in its sole discretion, pay for material or Equipment procured by Contractor and not incorporated in the Project if the material or Equipment is: (i) unique to the Project or requires a long-lead to procure or manufacture; and (ii) either stored on a Site or at an off-Site location approved in advance and in writing by the City. Should the City agree to make payment for such material or Equipment, all of the following shall apply:

9.5.1. Prior to billing the SFMTA for approved Long Lead Items, Contractor shall submit to the City proof of purchase of Long Lead Items, including bills of sale, invoices, or other documentation warranting that Contractor has received said Long Lead Item(s) in good condition and free and clear of all liens, charges, security interests, and encumbrances.

9.5.2. Title to stored material shall be vested in the City at time of delivery to a Site or off-Site warehouse approved by the City.

9.5.3. Contractor shall obtain a negotiable warehouse receipt, endorsed over to the City, for material and Equipment stored in an off-Site warehouse. No payment will be made until said endorsed receipts are delivered to the City.

9.5.4. Contractor, at no additional cost to the City, shall insure stored material and Equipment for the full value of its replacement cost (less deductible) against theft, fire, loss, vandalism, and malicious mischief, and shall deliver the policy or policy endorsement of such insurance to the Engineer naming the City as an additional insured or loss payee. Insurance shall not be cancelable for at least thirty (30) days after written notice of such cancellation has been delivered to the SFMTA. Said insurance shall protect against loss until SFMTA's acceptance of the Project. Contractor shall pay any loss claim not covered by said insurance.

9.5.5. Contractor shall furnish to the City written consent from Contractor's sureties approving the advanced payment for materials and Equipment stored off-Site.

9.5.6. The City shall not pay more than 75 percent of the fair market value of any long-lead Item, Equipment or material, as that value is determined by SFMTA.

9.5.7. Contractor shall protect stored materials and Equipment from damage. Damaged materials and Equipment, even though paid for, shall not be incorporated into the Work and shall be replaced at no cost to the City.

9.5.8. Stored materials and Equipment shall be available for inspection by the City.

9.5.9. Contractor shall deliver stored materials and Equipment to a Site at no additional cost to the City.

9.5.10. After delivery of stored materials and Equipment to a Site, if any inherent or acquired defects are discovered therein, Contractor shall remove such defective material and Equipment and replace it with Equipment and materials that meet the requirements of the Contract at no additional cost to the City.

9.5.11. In the event of loss of or damage to paid materials or Equipment, Contractor shall be responsible for replacing the lost or damaged materials and Equipment at its own cost and shall be responsible for all delays incurred on the Project as a result of such loss or damage.

9.5.12. Nothing in this Section 9.5 shall relieve Contractor of its responsibility for incorporating materials and Equipment in the Work that conform to the requirements of the Contract Documents.

9.6. TRANSFER OF TITLE AND RISK OF LOSS.

As described in the Document 0530, the SFMTA will pay Contractor for the installation and equipment charges for Mobile Equipment and Stationary Equipment that has been installed (where applicable), has passed applicable performance tests, for which the SFMTA has given Conditional Acceptance. The City will accept title and risk of loss for said equipment due to theft, vandalism or other wrongful actions of third parties upon Conditional Acceptance, prior to payment. Such risk of loss shall not excuse Contractor's obligation to warrant the operation of said Equipment from the date of payment until expiration of the Warranty Period.

9.7. ELECTRONIC CERTIFIED PAYROLLS.

9.7.1. Submission of Payroll Records. The City will not process a progress payment request unless and until Contractor has submitted weekly certified payrolls to the City for the applicable time period for Contractor and subcontractor's employees who perform Construction Work subject to prevailing wage requirements (see Section 11.1, below). Contractor shall prepare certified payrolls in accordance with Section 1770 et seq. of the California Labor Code for the period involved for all employees and owner-operators, including those of Subcontractors and Suppliers of all tiers, who have provided labor, materials or Equipment for the Project.

A. Contractor shall submit certified payrolls to the City electronically via the Project Reporting System ("PRS") selected by the City. The PRS will be an Internet-based system accessible on the World Wide Web through a web browser. Contractor and each Subcontractor and Supplier will be assigned a log-on identification and password to access the PRS.

B. Use of the PRS may require Contractor, Subcontractors and Suppliers to enter data relating to weekly payroll information including, but not limited to, employee identification, labor classification, total hours worked and hours worked on this Project, and wage and benefit rates paid. Contractor's payroll and accounting software may be capable of generating a "comma delimited file" that will interface with the PRS software.

C. The City will provide basic training in the use of the PRS at a scheduled training session. Contractor and all Subcontractors and Suppliers and/or their designated representatives must attend the PRS training session.

D. Contractor shall comply with the payroll reporting requirements of this Contract at no additional cost to the City.

E. The City will not be liable for interest, charges or costs arising out of or relating to any delay in making progress payments due to Contractor's failure to make a timely and accurate submittal of certified payrolls.

F. Retention of Payroll Records.

G. Contractor shall comply with the requirements of Section 1776 of the California Labor Code, or as amended from time to time, regarding the keeping, filing and furnishing of certified copies of payroll records of wages paid to its employees and to the employees of its Subcontractors of all tiers.

H. Contractor shall make the certified payroll records available for inspection at all reasonable hours at the Project Office on the following basis:

1. A certified copy of an employee's payroll record shall be made available for inspection or furnished to such employee or his or her authorized representative upon request.

2. A certified copy of all payroll records shall be made available for inspection or furnished to a representative of the City upon request.

3. A certified copy of all payroll records shall be made available upon request to the public for inspection or copies thereof made; provided, however, that a request by the public shall be made through the City, the Division of Apprenticeship Standards, or the Division of Labor Standard Enforcement. The public shall not be provided access to such records at the Project Office.

4. Contractor shall file a certified copy of the payroll records with the entity that requested such records within 10 Days of a written request.

I. Any copy of payroll records made available for inspection as copies and furnished upon request to the public or any public agency by the City, the Division of Apprenticeship Standards or the Division of Labor Standards Enforcement shall be marked or obliterated in such a manner as to prevent disclosure of an individual's name, address and social security number. The name and address of Contractor shall not be marked or obliterated.

J. Contractor shall inform the City of the location of the payroll records, including the street address, city and county, and shall, within 5 working days, provide a notice to the City of a change of location and address.

K. In the event that Contractor receives a written notification of noncompliance with Section 1776, Contractor shall have 10 Days from receipt of such written notice to comply. Should noncompliance still be evident after such 10-Day period, Contractor shall, as a penalty to the City, forfeit \$25 for each day, or a portion thereof, of non-compliance, for each worker, until strict compliance is effected. Upon the request of the Division of Apprenticeship Standards or the Division of Labor Standards Enforcement, such penalties shall be withheld from the Contract Sum.

L. Contractor is solely responsible for compliance with Labor Code section 1776. The City shall not be liable for and Contractor shall indemnify the City for any claim or action arising from Contractor's failure to make timely or accurate submittals of certified payrolls.

9.8. WITHHOLDING PAYMENT.

9.8.1. It is mutually understood and agreed that the City may withhold from any payment otherwise due Contractor such amounts as may be necessary to protect the City to ensure completion of the Project pursuant to the requirements of this Contract. The failure or refusal of the City to withhold any moneys from Contractor shall in no way impair the obligations of any surety or sureties under any bonds furnished under this Contract. If any payment or portion of payment is withheld by the City, Contractor will be notified in writing of the cause(s) of such action. If the City does not authorize payment of any amount included in an application for payment, the City will notify Contractor of the reasons for withholding payment.

9.8.2. The City may also decline to authorize payment based on subsequently discovered evidence, and the City may nullify the whole or a part of a payment previously issued, for one or more of the following reasons:

A. The City determines the existence of Nonconforming Work or completed Work that has been damaged, requiring correction or replacement.

B. Third party claims have been filed (including but not limited to stop notices), or there is reasonable evidence indicating probable filing of such claims.

C. The City determines that the Work cannot be completed for the unpaid balance of the Contract Sum.

D. The Contract Sum has been reduced by Change Orders.

E. Damage has occurred to the City or another contractor due to the actions of Contractor.

F. The City determines that the Work will not be completed within the Contract Time and that the current unpaid balance and retention will not be adequate to cover actual or liquidated damages owed to the City for Contractor's anticipated delay.

G. The City determines that Contractor persistently fails to perform the Work in accordance with the Contract Documents.

H. The City determines that Contractor fails to submit timely Change Order cost proposal breakdowns in accordance with the Contract Documents.

I. The City determines that Contractor fails to submit timely progress schedules, revised schedules, schedule updates and reports in accordance with the Contract Documents.

J. The City determines that Contractor fails to maintain timely updated Contract Documents or record documents.

K. The City determines that Contractor fails to submit certified payroll records and reports in accordance with the Contract Documents.

L. The City determines that Contractor fails to comply with any other requirements of the Contract Documents.

ARTICLE 10 -- INSURANCE AND BONDS

10.1. INSURANCE REQUIREMENTS.

10.1.1. Insurance. No later than the Effective Date and throughout the duration of the Work, Contractor will maintain insurance in conformance with the requirements set forth below. Contractor shall use existing coverage to comply with these requirements; project specific insurance is not acceptable and shall not be a substitute for Contractor's existing insurance coverage and policies. If that existing coverage does not at any time meet the requirements as set forth here, Contractor shall immediately amend its coverage to comply with these requirements. Contractor acknowledges that the insurance coverage and policy limits set forth in this Section 10.1 constitute the minimum amount of coverage required. Any insurance proceeds in excess of the limits and coverage required in this Contract and which is applicable to a given loss, shall also be available to the City. Contractor's insurance coverage shall not in any way limit Contractor's liability under this Contract or in any way limit or modify the indemnification provisions of this Contract. Failure to maintain insurance as set out below shall constitute a material breach of this Contract.

10.1.2. Coverage Amounts. Contractor must maintain in force, during the full term of the Agreement, insurance in the following amounts and coverages:

A. Workers' Compensation, in statutory amounts, with Employers' Liability Limits not less than One Million Dollars (\$1,000,000) each accident, injury, or illness.

B. Commercial General Liability Insurance with limits not less than Two Million Dollars (\$2,000,000) each occurrence Combined Single Limit for Bodily Injury, Personal Injury, and Property Damage, including Contractual Liability, Personal Injury, Products and Completed Operations. If Commercial General Liability Insurance or other form with a general aggregate limit is used, either the general aggregate limit shall apply separately to this Project or the general aggregate limit shall be twice the required occurrence limit.

C. Commercial Automobile Liability Insurance with limits not less than One Million Dollars (\$1,000,000) each occurrence Combined Single Limit for Bodily Injury and Property Damage, including Owned, Non-Owned and Hired auto coverage, as applicable.

D. Professional (architecture and engineering) liability insurance, applicable to Contractor's profession, with limits not less than Five Million Dollars (\$5,000,000) each claim with respect to negligent acts, errors or omissions in connection with professional services to be provided under this Contract. To the extent that Contractor directs a subcontractor to perform architectural and engineering Work covered under such professional liability insurance and Contractor does not perform such Work, the City will accept the subcontractor's professional liability insurance in lieu of Contractor providing that coverage.

Subcontractor shall through Contractor submit to the SFMTA insurance certificates and brokers' policy endorsements.

E. Technology errors and omissions insurance with limits not less than Five Million Dollars (\$5,000,000) each claim with respect to negligent acts, errors or omissions in connection with technology services (including but not limited to system integration and configuration) to be provided under this Contract.

F. Builder's Risk Insurance, maintained in force, throughout the term of this Contract (i.e., through Final Acceptance by the SFMTA), with an installed equipment rider (to include installed Mobile Equipment and Stationary Equipment) on an all-risk form, excluding earthquake and flood, for 100 percent of the completed value of the Work. Any deductible shall be the responsibility of Contractor including coverage for debris removal of at least 100 percent of the completed value of removal. Such policy shall include City as an additional insured or loss payee and be made payable to Contractor, to its Subcontractors and suppliers of all tiers, and to the City and County of San Francisco, as their interest may appear, and shall be issued by carrier(s) satisfactory to the City to conduct insurance business in California. In the event of damage, it shall be Contractor's responsibility to perform at its expense all required repair and replacement at no cost to the City. In accordance with Public Contract Code section 7105, in the event of damage caused by earthquake over 3.5 on the Richter scale or tidal wave, flood, Contractor shall not be responsible for losses in excess of 5 percent of the Contract Sum, including deductibles.

G. Environmental Pollution Liability, in the event that hazardous / contaminated material is discovered during the course of the Work, and Contractor or its subcontractors is required to perform abatement or disposal of such materials, and sudden and accidental release of hazardous materials is excluded from general liability coverage, then Contractor, or its sub-contractor, who perform abatement of hazardous or contaminated materials removal shall maintain in force, throughout the term of this Contract, Contractor's pollution liability insurance with limits not less than One Million Dollars (\$1,000,000) each occurrence combined single limit (true occurrence form), including coverages for on-Site or off-Site third party claims for bodily injury and property damage. Coverage shall include Contractor and subcontractor's legal liability for contaminated soils, in ground or airborne asbestos, lead, PCBs and other hazardous material that may be encountered on a Site. The City will accept an additional coverage rider for sudden and accidental pollution coverage under Contractor's or a subcontractor's general liability insurance policy in lieu of a separate environmental pollution liability insurance policy. If said environmental pollution liability coverage is provided by a subcontractor, the subcontractor shall list the City, its employees and officers, as an additional insureds, as provided in Section 10.1.3.F, below.

10.1.3. Required Insurance Provisions.

A. All policies shall provide thirty (30) days' advance written notice to the City of cancellation of coverages for any reason. Contractor shall provide thirty (30) days' advance written notice to the City of any reduction or nonrenewal

of coverages. Notices from the insurer and from Contractor shall be sent to the City address listed in Article 10 of the Design Build Agreement (Document 520).

B. Should any of the required insurance be provided under a claims-made form, Contractor shall maintain such coverage continuously throughout the Term of this Contract and, without lapse, for a period of three years beyond the expiration of this Contract, to the effect that, should occurrences during the Contract Term give rise to claims made after expiration of the Contract, such claims shall be covered by such claims-made policies and if renewed annually, Contractor shall ensure that said coverage is included within each annual policy renewal.

C. Should any of the required insurance be provided under a form of coverage that includes a general annual aggregate limit or provides that claims investigation or legal defense costs are included in such general annual aggregate limit, such general annual aggregate limit shall be double the occurrence or claims limits specified above.

D. Should any required insurance lapse during the term of this Contract, requests for payments originating after such lapse shall not be processed until the City receives satisfactory evidence of reinstated coverage as required by this Agreement, effective as of the lapse date. If insurance is not reinstated, the City may, at its sole option, terminate this Contract effective as of the date of such lapse of insurance.

E. Approval by the City of insurance policies maintained by Contractor shall not relieve or decrease Contractor's liability under this Contract.

F. If a Subcontractor will be used to complete any portion of this Contract, Contractor shall ensure that the subcontractor shall provide all necessary insurance and shall name the City and County of San Francisco, its officers, agents and employees and Contractor listed as additional insureds.

G. Any deductibles or self-insured retentions must be declared. At the option of the City, either: the insurer shall reduce or eliminate such deductibles or self-insured retentions as respects the City, its officers, officials, employees and volunteers; or Contractor shall provide a financial guarantee satisfactory to the City guaranteeing payment of losses and related investigations, claim administration and defense expenses. The commercial General Liability and automobile liability policies are to contain, or be endorsed to contain, the following provisions:

1. The City, its officers, officials, employees and volunteers are to be covered as additional insureds as respects: liability arising out of work or operations performed by or on behalf of Contractor; or automobiles owned, leased, hired or borrowed by Contractor.

2. For any claims related to this project, Contractor's insurance coverage shall be primary insurance as respects the City, its officers, officials, employees and volunteers and that said insurance applies separately to each insured against whom claim is made or suit is brought. Any insurance or self-insurance maintained by the City, its

officers, officials, employees or volunteers shall be excess of Contractor's insurance and shall not contribute to it.

H. If Professional Liability, and/or Errors & Omissions coverages are written on a claims-made form:

1. The retroactive date must be shown, and must be before the date of the Contract or the beginning of the Work.

I. Insurance must be maintained and evidence of insurance must be provided for at least five (5) years after completion of the Work. If Contractor's insurance is renewed annually, Contractor shall ensure that said coverage is included within each annual policy renewal.

1. If coverage is canceled or non-renewed, and not replaced with another claims-made policy form with a retroactive date prior to the Effective Date of the Contract, Contractor must purchase an extended period coverage for a minimum of five (5) years after completion of the Work.

2. A copy of the claims reporting requirements must be submitted to the City upon request

J. Contractor shall provide any additional insurance required by the owner of any private property on which the Contractor must enter, perform Work, or install equipment for the Project.

10.1.4. Alternate Coverage. Contractor may propose alternate insurance to the policies and coverage described in this Section 10.1, which the SFMTA may accept or reject in its sole and absolute discretion. If the SFMTA rejects a proposed alternate, Contractor shall obtain the required insurance specified herein.

10.1.5. Acceptability of Insurers. Insurance is to be placed with insurers with a current A.M. Best's rating of no less than A-VII, unless otherwise acceptable to the City. Exception may be made for the State Compensation Insurance Fund when not specifically rated.

10.1.6. Verification of Coverage. Contractor shall provide to the City original certificates and amendatory broker endorsements effecting the insurance coverages required by this Contract. The endorsements should be on forms provided (or approved) by the City. All certificates and endorsements must be received and approved by the City before work commences. However, Contractor's failure to do so shall not operate as a waiver of these insurance requirements. The City reserves the right to require complete, certified copies of all required insurance policies, including endorsements affecting the coverage required by these specifications at any time.

10.1.7. Waiver of Subrogation. Contractor hereby agrees to waive subrogation that which any insurer of Contractor may acquire from Vendor by virtue of the payment of any loss. Contractor agrees to obtain any endorsement that may be necessary to effect this waiver of subrogation. All insurance policies shall be endorsed with a waiver of subrogation in favor of the City for all claims

arising out of the Work and services performed by Contractor, its employees, agents and subcontractors.

10.1.8. Prohibited Exclusions.

A. No insurance policy shall include any provision excluding from coverage a design build contract or any provision of this Contract.

B. If Contractor is a joint venture, no insurance policy shall include any provision excluding a joint venture from coverage.

10.1.9. Survival of Obligations. The requirements of this Section 10.1 shall survive expiration or termination of the Contract.

10.2. PERFORMANCE BOND AND PAYMENT BOND

10.2.1. Within fifteen (15) Days of the SFMTA's issuing a notice of intent to award the Contract to Contractor, Contractor shall provide to the SFMTA the following bonds in a form approved by the City.

A. Performance Bond. A corporate surety bond, in a sum not less than 100 percent of the Contract Sum, to guarantee the faithful performance of the Contract ("Performance Bond"); and

B. Payment Bond: A corporate surety bond, in a sum not less than 100 percent of the Contract Sum, to guarantee the payment of labor, materials, supplies, and Equipment used in the performance of the Contract ("Payment Bond").

10.2.2. Said Performance Bond shall cover all corrective Work required during the Warranty Period as provided in Document 00835, all warranty and maintenance work required under the Contract Documents, and any and all Work required to correct latent defects. The Performance Bond and Payment Bond shall cover all extensions of time and increases to the Contract Sum effected by amendments to the Contract. The sureties for said bonds waive any notice requirement of amendment to the Contract that may increase the obligations of the sureties beyond the original scope of work of the Contract or the original Contract Sum.

10.2.3. Contractor may upon Final Acceptance, request that the value of the Performance Bond shall be reduced to fifteen percent (15%) of the Contract Sum to cover only the value of the Construction Work. If Contractor requests that the value of the Performance Bond be so reduced, Contractor shall provide a Warranty and Maintenance Bond in the amount of ten percent (10%) of the Contract Sum to guarantee OEM warranties and system performance, including but not limited to systems integrations, Equipment, installation, configuration, and Software in the total amount of the value of non-construction elements of the Work.

10.2.4. Call of the Performance Bond by the City to complete the Project and assessment of liquidated damages for Contractor's delay or for failure to meet Project performance requirements are not mutually exclusive remedies.

10.2.5. In case of default, breach or unavailability of the Contractor, the bond(s) issuers' ("the Surety") shall either: (1) complete all of the Work as required

by the Contract Documents, or (2) pay to the City the full value (penal sum) of the Performance Bond without reduction or credit of any kind. The determination of whether to complete the Work as required by the Contract or to pay to the City the penal sum of the Performance Bond is within the discretion of the Surety. The Surety's payment of the penal sum of the Performance Bond to the City shall relieve Surety of all obligations under the Performance Bond, but shall not relieve Contractor of its liability and obligation pay liquidated damages for delay, as provided in Article 8 of this Agreement.. The obligation of the Surety to complete the Work is limited to the City's ability to pay for the Work in the amounts set out in Document 00520, Design Build Agreement, Section 3.5, Certification of Availability of Funds by Controller.

10.2.6. Corporate sureties issuing these bonds as specified in the RFP shall be legally authorized to engage in the business of furnishing surety bonds in the State of California. All sureties shall have a current A.M. Best Rating not less than "A-, VIII" and must be satisfactory to the City.

ARTICLE 11 -- LABOR STANDARDS

11.1. PREVAILING WAGES.

11.1.1. It is hereby understood and agreed that all provisions of California Labor Code sections 1770 et seq. are required to be incorporated into every contract for any public work or improvement and are provisions of this Contract.

11.1.2. It is hereby understood and agreed that all provisions of San Francisco Administrative Code sections 6.22E and 6.22F are incorporated as provisions of this Contract including, but not limited to, the following:

A. Contractor shall pay to all persons performing labor that constitutes construction for the Project not less than the highest general prevailing rate of wages determined as set forth herein for the respective crafts and employments, including such wages for holiday and overtime work.

B. Contractor shall insert in every subcontract or other arrangement, which it may make for the performance of any Work that constitutes construction on the Project, a provision that said Subcontractor shall pay to all persons performing labor or rendering service under said subcontract or other arrangement the highest general prevailing rate of wages determined as set forth herein for the respective crafts and employments, including such wages for holiday and overtime work.

C. Contractor shall keep or cause to be kept an accurate record showing the name, place or residence, occupation, and per diem pay, of each person engaged in the execution of the Work, and every subcontractor who shall undertake the performance of any part of the Work herein required shall keep a like record of each person engaged in the execution of the subcontract. All such records shall at all times be available for inspection of and examination by the City and its authorized representatives.

D. Should Contractor, or any Subcontractor who shall undertake the performance of any part of the Work herein required, fail or neglect to pay to the

persons who shall perform labor under this Contract, subcontract or other arrangement for the Work, the highest general prevailing rate of wages as herein specified, Contractor shall forfeit, and in the case of any Subcontractor so failing or neglecting to pay said wage, Contractor and the Subcontractor shall jointly and severally forfeit, to the City back wages due plus the penal sum of \$50 per day for each laborer, worker or mechanic employed for each calendar day or portion thereof, while they shall be so employed and not paid the highest general prevailing rate of wages. The City at its option will deduct from the Contract Sum the amount that would otherwise be due on such payment the amount of said forfeiture or forfeitures as so certified.

E. No person performing labor or rendering service in the performance of the Contract or a Subcontract for the Work herein required shall perform labor for a longer period than five days (Monday-Friday) per calendar week of eight hours each (with two 10-minute breaks per eight-hour day), except in those crafts in which a different work day or week now prevails by agreement in private employment. Any person working hours in addition to the above shall be compensated in accordance with the prevailing overtime standard and rates. Contractor or any Subcontractor who violates this provision shall forfeit to the City back wages due plus the penal sum of \$50 per day for each laborer, mechanic or artisan employed for each calendar day or portion thereof whereon such laborer, mechanic or artisan is compelled or permitted to work more than the days and hours specified herein.

11.1.3. A copy of the most current highest general prevailing wage rates will be posted at a Site by the City, and such highest prevailing wage rate determinations are hereby incorporated as part of the Contract Documents. Such wage rates shall increase or decrease in accordance with any changes promulgated by the California Department of Industrial Relations Board without any adjustment to the Contract Sum.

A. Copies of the prevailing wage rates are available from the SFMTA department, and are also available on the Internet at <http://www.dir.ca.gov/DLSR/PWD>.

B. Payments to a craft or classification not shown on the prevailing rate determinations shall comply with the rate of the craft or classification most closely related to it. Contact the California Division of Labor Statistics and Research, Prevailing Wage Unit at telephone (415) 972-8628 for job classifications not listed in the General Prevailing Wage Determinations of the Director of Industrial Relations.

11.1.4. All wages for the Work under the Contract are within the Contract Sum, and the City shall have no liability for any increase in the prevailing wage rates during the term of the Contract.

11.1.5. Contractor shall provide (and shall also require any subcontractor on the Project to provide) and deliver to City every month during any construction period, certified payroll reports with respect to all persons performing labor in the Provision of the Work.

11.2. PAYROLLS.

As more specifically provided in Section 9.6.1, above, Contractor shall comply with the requirements of California Labor Code section 1776, or as amended from time to time, regarding the keeping, filing and furnishing of certified copies of payroll records of wages paid to its employees and to the employees of its Subcontractors of all tiers. Contractor shall certify and submit the payroll records electronically to the City as set forth in Section 9.6.1.

11.3. APPRENTICES.

11.3.1. Contractor and its Subcontractors at every tier performing Work that constitutes construction shall comply with the requirements of the State Apprenticeship Program (as set forth in the California Labor Code, division 3, chapter 4 [commencing at section 3070], and section 1777.5) and San Francisco Administrative Code, section 6.21(O). Contractor shall be solely responsible for securing compliance with section 1777.5 for all apprenticeable occupations.

A. Contractor shall comply with all requests by the City to provide proof that Contractor and all of its Subcontractors at every tier are in compliance with the State Apprenticeship Program.

B. Contractor shall include in all of its subcontracts the obligation for Subcontractors to comply with the requirements of the State Apprenticeship Program.

C. Section 1777.5 shall not apply to contracts of general contractors involving less than thirty thousand dollars (\$30,000) and less than twenty working days, or to contracts of specialty contractors not bidding for work through a general or prime contractor, involving less than two thousand dollars (\$2,000) or fewer than five working days.

11.3.2. Should Contractor fail to comply with the apprenticeship requirements of Labor Code section 1777.5, Contractor shall be subject to the penalties prescribed in Labor Code 1777.7. The interpretation and enforcement of Labor Code section 1777.5 shall be in accordance with rules and procedures prescribed by the California Apprenticeship Council.

11.3.3. Contractor, if not signatory to a recognized apprenticeship training program under chapter 4 of the California Labor Code, shall provide to the City with all progress payment requests for Work that constitutes construction, starting with the second such request, satisfactory evidence that it has contributed to the appropriate apprenticeship fund(s). Contractor shall require its Subcontractors who are not signatories to provide such evidence to the City as a condition precedent for qualifying for payment from the City. The City reserves the right to demand such evidence upon request.

11.3.4. Under California Public Contract Code section 6109, Subcontractors who are ineligible to bid or work on, or be awarded, a public works project under California Labor Code sections 1777.1 or 1777.7 are prohibited from performing Work on the Project.

A. Any contract for the Project entered into between Contractor and a debarred subcontractor is void as a matter of law.

B. A debarred subcontractor may not receive any public money for performing work as a subcontractor on a public works project. Contractor shall return to the City any public money that may have been paid to a debarred subcontractor by Contractor.

C. Contractor shall be responsible for the payment of wages to workers of a debarred subcontractor that has been allowed to work on the Project.

11.4. LABOR STANDARDS ENFORCEMENT.

11.4.1. In accordance with Administrative Code sections 6.22(E)(7) and 6.24, Contractor further acknowledges and agrees as follows:

A. Contractor will cooperate fully with the Labor Standards Enforcement Officer and other City employees and agents authorized to assist in the administration and enforcement of the prevailing wage requirements and other labor standards imposed on public works contractors by the San Francisco Charter and Chapter 6 of the San Francisco Administrative Code.

B. Contractor agrees that the Labor Standards Enforcement Officer and his or her designees, in the performance of their duties, shall have the right to engage in random inspections of job sites and to have access to the employees of Contractor, employee time sheets, inspection logs, payroll records and employee paychecks.

C. Contractor shall maintain a sign-in and sign-out sheet showing which employees are present on the job site.

D. Contractor shall prominently post at each job-site a sign informing employees that the project is subject to the City's prevailing wage requirements and that these requirements are enforced by the Labor Standards Enforcement Officer.

E. The Labor Standards Enforcement Officer and any authorized representative of the SFMTA and Project funding agencies may audit such records of Contractor as he or she reasonably deems necessary to determine compliance with the prevailing wage and other labor standards imposed by the City's Charter and Administrative Code Chapter 6 on public works contractors.

F. Contractor shall give the Labor Standard Enforcement Officer and/or the SFMTA, at either's request at any time, full and correct information as to the number of persons employed in connection with each subdivision and task of the Work, the classification and rate of pay of each person, the cost to Contractor of each class of materials, tools and appliances used by Contractor in the Work, and the amount of each class of materials used in each subdivision of the work.

ARTICLE 12 -- SAFETY

Contractor shall comply with the Health and Safety requirements set out in Document 00828. The Health and Safety requirements set out therein are material requirements of the

Contract. Contractor shall be wholly responsible for the safety of its employees, Subcontractors, Subconsultants and Suppliers while performing Work on or related to the Project, and City shall have no liability whatsoever for said persons' safety except as specifically provided in the Contract. To the maximum extent allowable by law, Contractor shall defend and indemnify the City against any action arising from a violation of a safety regulation order by Contractor, its employees, Subcontractors, Subconsultants and Suppliers.

ARTICLE 13 -- PARTNERING AND CLAIMS

13.1. PARTNERING.

13.1.1. The City intends to encourage the foundation of a cooperative and cohesive partnership with Contractor, its Subconsultants, Subcontractors and Suppliers, and the City's representatives and contractors. This cooperative partnership will be structured to draw on the strengths of each participant to identify and achieve mutual and reciprocal goals, including resolution of disputes in a timely, equitable, professional and non-adversarial manner. The objective of the partnership shall be the successful completion of the Project.

13.1.2. The Parties agree to work in good faith to establish a small group of executive management functional representatives ("Executive Committee") that will meet on a regularly scheduled basis. The Executive Committee will review: Project status and progress at the prime and subcontract level; assessment of collaborative relationships between Harris and the SFMTA; system design and program document submittal and approval metrics; and compliance with Contract terms. The Executive Committee will meet no less than semi-annually and more frequently if considered necessary by either Party. Both Harris and the SFMTA will coordinate their respective presentations one week in advance of the Executive Committee meeting.

13.1.3. Other than provided in this Article, neither Party obligated to enter into a "partnering" type relationship, or similar such term as used in the construction industry. There will be no penalties of any kind imposed should either Party not agree to use "partnering." Fees and expenses associated with any partnership arrangement shall be shared equally by the City and Contractor.

13.1.4. "Partnering" (as set forth above) shall not alter the legal rights and obligations of Contractor or the City under the Contract Documents.

13.1.5. Nothing herein shall be deemed to create a legal partnership or joint venture between the City and any other party, and there shall be no third party beneficiaries of any agreement between the City and any other party (unless expressly stated otherwise in an agreement).

13.2. CLAIMS.

13.2.1. Notice of Potential Claim. If, during the course of the Project, Contractor disputes any directive, determination, delay, Change Order, payment, or other act by the City impacting or potentially impacting the performance of the Work (collectively, "Potential Claim Events"), Contractor shall submit to the City a Notice of Potential Contract Claim. Contractor shall submit such Notice within 15

Days of the occurrence of the Potential Claim Event. The Notice shall describe the Potential Claim Event, provide a good faith estimate of any impact, and reference any relevant provisions of the Contract Documents and any schedules with sufficient specificity for the City to review the matter. Failure to submit a timely, properly documented Notice of Potential Claim shall constitute a waiver of any claim arising out of the Potential Claim Event.

13.2.2. Contract Claim. No later than 60 days after submitting a timely Notice of Potential Claim to the City in accordance with Section 13.2.1, Contractor to preserve said claim Contractor shall submit a Contract Claim for additional compensation or time based on any disputed item (1) respecting the true value of any Work performed or any changes in the Work which Contractor may be required to perform; and/or (2) regarding time extensions; and/or (3) respecting the amount of payment to Contractor during the performance of the Contract; and/or (4) regarding the performance of obligations by any Party. The Contract Claim shall be Contractor's sole and exclusive administrative remedy for additional compensation or extension of time associated with its performance of the Work. Failure to submit a timely, certified, and documented Contract Claim in conformance with this Section 13.2 shall constitute a waiver by Contractor as to any claims relating to its performance of the Work under the Contract and a failure to exhaust its administrative remedies.

13.2.3. Certification Requirements. Contractor, under penalty of perjury, shall submit written certification for each claim submitted by Contractor and its Subcontractor(s) or Subconsultant(s), as applicable, that:

- A.** The Claim is made in good faith;
- B.** Supporting data are accurate and complete to the best of Contractor's and, if applicable, Subcontractor's and/or Subconsultant's, knowledge and belief; and
- C.** The time and/or amount requested accurately reflect the Contract adjustment for which Contractor believes the City is liable.

An individual or officer who is authorized to act on Contractor's behalf shall sign the certification before submitting the Claim to the City.

In regard to a Contract Claim or portion of a Contract Claim by a Subcontractor or Subconsultant, Contractor shall fully review the Subcontractor's or Subconsultant's claim and shall certify the Subcontractor's or Subconsultant's claim or such relevant portion(s) of the Subcontractor's or Subconsultant's Claim, under penalty of perjury, in the same manner Contractor would certify its own Contract Claim under the foregoing subsection 13.2.3.A. The City will not consider a direct claim by any Subcontractor or Subconsultant. Subcontractors and Subconsultants at any tier are not third-party beneficiaries of this Contract.

Contractor hereby agrees that failure to furnish certification as required in this Section 13.2 shall constitute a waiver by Contractor as to the subject Claim.

Contractor further acknowledges and agrees that if it submits a false claim, on behalf of itself or a Subcontractor, Contractor may be subject to civil penalties, damages, debarment, and criminal prosecution in accordance with local, state, and federal statutes.

13.2.4. Format of a Contract Claim. Contractor shall document its Contract Claim in the following format:

- A.** Cover letter and certification.
- B.** Narrative Summary of the facts supporting the Contract Claim, the amount of compensation claimed, and Contract provision(s) under which the Contract Claim is made.
- C.** List of documents relating to Contract Claim:
 - 1.** Criteria Package
 - 2.** Contract Documents
 - 3.** Clarifications/RFIs
 - 4.** Correspondence
 - 5.** Schedules
 - 6.** Other relevant documents
- D.** Chronology of events and correspondence
- E.** Analysis of claim merit (facts on which claim is based)
- F.** Analysis of claim cost (money and time)
- G.** Attachments:
 - 1.** Pertinent portions of the Criteria Package
 - 2.** Specifications and/or Drawings
 - 3.** Clarifications/RFIs
 - 4.** Correspondence
 - 5.** Schedules
 - 6.** Other supporting documents

13.2.5. When requested by the City, Contractor shall provide job cost documents to substantiate a Contract Claim.

13.2.6. Additional Requirements for Contract Claims Regarding Time Extensions:

- A.** All Contract Claims regarding time extensions shall include, in addition to all other applicable requirements of this Section 13.2, an analysis of the delays impacting the as-built critical path. The as-built critical path shall be determined by (1) comparing the late dates for schedule activities indicated within Contractor's "as-planned" CPM schedule (as approved by the City) with the actual dates for the same activities, and then (2) determining the longest path through the as-built schedule using Contractor's originally-approved as-planned

activity to activity logic. The "as-built" CPM shall reflect the exact manner in which the Project was actually constructed (including start and completion dates, actual sequence and durations of work activities, and logic).

B. The City will not review or consider any Contract Claim regarding time extensions based upon an impacted as-planned Critical Path Method, collapsed as-built schedule, time impact analysis or similar method that does not take into account actual events on the Project.

C. Contractor shall not base any Contract Claim on the Leonard Study or similar theory.

13.2.7. Procedure for Review of a Contract Claim:

A. The City shall review only a timely, certified, and properly documented Contract Claim.

B. The City shall respond to a Contract Claim in writing, within 45 days of receipt of such Claim. In its response, the City shall either grant or deny the Claim in whole or in part. If the City does not respond to a Claim within the 45-day period, the Claim is deemed denied in its entirety.

C. Within 10 days of the date of the City's response or expiration of the 45-day period, whichever is earlier, Contractor may request review of the Contract Claim and the City's response by the Director of Transportation or his or her designee. The request must be in writing, directed to the Director of Transportation and copied to the Engineer. Failure by Contractor to make a timely request to the Director, copied to the Engineer, shall constitute acceptance by Contractor of the City's original response and waiver of any further claim or appeal as to the matters raised in the Notice of Potential Claim and the Claim.

D. Upon a timely and proper request, the Director, or his/her designee (other than personnel assigned to the Project), shall review the relevant documents, meet with Contractor and City personnel assigned to the Project, and confirm or revise the City's response to the Contract Claim. The Director, or his/her designee, shall issue such determination within 60 days of the date of the request for review. The determination by the Director, or his/her designee, shall constitute the final administrative determination of the City. If the Director takes no action on a request for review within the 60-day period, the City's original response shall constitute the final administrative determination by the City.

13.2.8. Government Code Claim. The administrative procedure under this Article shall not operate to toll, waive, or excuse Contractor's compliance with the requirements to file a Legal Claim under California Government Code section 900, et seq., and San Francisco Administrative Code Chapter 10. For the purposes of this Contract, the City and Contractor hereby agrees that any action at law against the City arising out of or relating to Contractor's performance of the Work shall accrue on the date of Substantial Completion.

ARTICLE 14 -- TERMINATION OR SUSPENSION OF THE CONTRACT

14.1. NOTICE OF DEFAULT; REMEDIES AND TERMINATION BY THE CITY FOR CAUSE.

14.1.1. Grounds for Default. Each of the following are Events of Default and the City may declare Contractor to be in Default of the Contract if Contractor:

- A.** Refuses or fails to supply enough properly skilled workers, adequate and proper materials, or supervision to prosecute the Work at a rate necessary to complete the Work within the specified limits of Contract Time, in accordance with the currently accepted updated progress schedule; or
- B.** Is adjudged bankrupt, makes a general assignment for the benefit of its creditors, or a receiver is appointed on account of its insolvency; or
- C.** Refuses or fails in a material way to replace or correct Work not in conformance with the Contract Documents; or
- D.** Repeatedly fails to make prompt payment due to Subcontractors or for other labor; or
- E.** Materially disregards or fails to comply with any law, ordinance, rule, regulation or order of any public authority having jurisdiction; or
- F.** Intimidates or sexually harasses a City employee, agent, or member of the public; or
- G.** Submits a false claim; or
- H.** Violates drug-free work place requirements; or
- I.** Fails to pay required taxes; or
- J.** Fails to maintain during the periods and the in amounts specified in this Contract required insurance policies; or
- K.** Is in violation of any applicable law where such violation materially affects the Project or potentially creates liability for the City; or
- L.** Violates proprietary, confidential and/or Sensitive Security Information provisions of this Contract; or
- M.** Assigns this Contract without all required approvals from the City; or
- N.** Fails or refuses to perform or observe any other term, covenant or condition contained in this Agreement, and such default continues for a period of ten days after written notice thereof from City to Contractor and the City has not provided Contractor with an extension of time for compliance or cure; or
- O.** Is otherwise in material breach of any provision of the Contract Documents.

14.1.2. Bankruptcy. Contractor shall be in default of this Contract if Design Builder: (1) is generally not paying its debts as they become due; (2) files, or consents by answer or otherwise to the filing against it of a petition for relief or reorganization or arrangement or any other petition in bankruptcy or for liquidation or to take advantage of any bankruptcy, insolvency or other debtors' relief law of any jurisdiction; (3) makes an assignment for the benefit of its creditors, (4) consents to the appointment of a custodian, receiver, trustee or other officer with similar powers of Contractor or of any substantial part of Contractor's property; (5)

takes action for the purpose of any of the foregoing. Design Builder is in default of this Contract if a court or government authority enters an order: (1) appointing a custodian, receiver, trustee or other officer with similar powers with respect to Contractor or with respect to any substantial part of Contractor's property; (2) constituting an order for relief or approving a petition for relief or reorganization or arrangement or any other petition in bankruptcy or for liquidation or to take advantage of any bankruptcy, insolvency or other debtors' relief law of any jurisdiction; or, (3) ordering the dissolution, winding-up or liquidation of Contractor.

14.1.3. Notice of Default. When any of the above grounds for Default exist, the City may, without prejudice to any other rights or remedies that the City may have, issue a written Notice of Default to Contractor. The City shall provide a copy of any Notice of Default to Contractor's surety.

A. The Notice of Default shall identify the ground(s) for Default and provide Contractor with a 15-Day cure period to complete necessary corrective Work and/or actions.

B. In the event that necessary corrective Work and/or other actions to cure the default cannot be completed within the 15-day cure period through no fault of Contractor or its subcontractors/suppliers, Contractor shall, within the 15-Day cure period, (i) provide the City with a schedule, acceptable to the City, for completing the corrective Work and/or actions; and (ii) commence diligently the corrective Work and/or actions. The City, after accepting Contractor's proposed schedule, will amend the Notice of Default in writing to set forth the agreed-upon cure period. The City will provide a copy of the amended Notice of Default to Contractor's surety.

14.1.4. Termination for Cause. If Contractor fails to completely cure the Default either (i) within the 15-day cure period set forth in the Notice of Default; or (ii) within the agreed-upon cure period set forth in an amended Notice of Default, the City may, without prejudice to any other rights or remedies that the City may have, immediately terminate employment of Contractor and, subject to the prior rights and duties of the surety under any bond provided in accordance with the Contract Documents:

A. Enter the Work Area and take possession of the Work and Equipment and use any materials, equipment, tools, and construction equipment and machinery thereon owned by Contractor to complete the Project;

B. Accept assignment of subcontracts and agreements pursuant to Section 4.5; and

C. Finish the Work by whatever reasonable method the City may deem expedient.

14.1.5. Remedies. On and after any Event of Default, City shall have the right to exercise its legal and equitable remedies, including, without limitation, the right to terminate this Agreement or to seek specific performance of all or any part of this Agreement. In addition, City shall have the right (but no obligation) to cure (or cause to be cured) on behalf of Contractor any Event of Default; Contractor shall pay to City on demand all costs and expenses incurred by City in effecting such cure, with interest thereon accruing from the date of incurrence at the

maximum rate then permitted by law. City shall have the right to offset from any amounts due to Contractor under this Agreement or any other agreement between City and Contractor all damages, losses, costs or expenses incurred by City as a result of such Event of Default and any liquidated damages due from Contractor pursuant to the terms of this Agreement or any other agreement. All remedies provided for in this Agreement may be exercised individually or in combination with any other remedy available hereunder or under applicable laws, rules and regulations. The exercise of any remedy shall not preclude or in any way be deemed to waive any other remedy.

14.1.6. Suspension of Payment. When the City terminates the Contract for one of the grounds set forth in this Section 14.1, Contractor shall not be entitled to receive further payment until the Work is finished. If the unpaid balance of the Contract Sum exceeds the cost of finishing the Work, including all liquidated damages for delays, such excess shall be paid to Contractor. If such costs exceed the unpaid balance, Contractor shall pay the difference to the City. The obligation to pay said amount to Contractor or City, as the case may be, upon application, shall be an obligation Contractor that survives termination of the Contract. Upon completion of all Work, Contractor shall be entitled to the return of all its materials which have not been used in the Work, including its plant, tools, equipment and other property provided, however, that Contractor shall have no claim on account of usual and ordinary depreciation, loss, wear and tear.

14.1.7. If the City terminates the Contract for cause, and it is later determined that none of the grounds set forth in this Section 14.1 exist and the Agency acted in error, then such termination may still be deemed a termination for convenience pursuant to Section 14.3.

14.2. SUSPENSION BY THE CITY FOR CONVENIENCE.

14.2.1. The City may, without cause, order Contractor in writing to suspend, delay or interrupt the Work in whole or in part for such period of time as the City may determine.

14.2.2. An adjustment shall be made as specified in Section 7.7 for increases in the cost of performance of the Contract caused by suspension, delay or interruption, to the extent such an occurrence causes Contractor to incur actual additional costs. No adjustment shall be made to the extent:

- A.** That performance is, was or would have been so suspended, delayed or interrupted by another cause for which Contractor is responsible; or
- B.** That an equitable adjustment is denied under another provision of this Contract; or
- C.** Contractor claims lost profits or lost opportunity costs or other speculative losses.

14.3. TERMINATION BY THE CITY FOR CONVENIENCE.

14.3.1. Under San Francisco Administrative Code section 6.22L, the City may, at any time during the course of the Contract, terminate the performance of Work under this Contract in accordance with this Section 14.3 in whole, or from time to time in part, whenever the City shall determine that such termination is in

the best interest of the City. Any such termination shall be effected by delivery to Contractor of a notice of termination specifying the extent to which performance of Work under the Contract is terminated, and the date upon which the termination becomes effective.

14.3.2. After receipt of a notice of termination, and except as otherwise directed by the City, Contractor shall comply with all of the following requirements.

A. Stop Work under the Contract on the date and to the extent specified in the notice of termination.

B. Place no further orders or subcontracts for Equipment materials, services, or facilities except as necessary to complete the portion of the Work under the Contract that is not terminated.

C. Terminate all orders and subcontracts to the extent that they relate to the performance of Work terminated by the notice of termination.

D. Assign to the City, in the manner, at the times, and to the extent directed by the City, all of the right, title, and interest of Contractor under the orders and subcontracts so terminated. The City shall have the right, at its discretion, to settle or pay any or all claims arising out of the termination of such orders and subcontracts.

E. Settle all outstanding liabilities and all claims arising out of such termination of orders and subcontracts with the approval or ratification of the City, in writing, to the extent it may require. The City's approval or ratification shall be final for all the purposes of this Section 14.3.

F. Transfer title to the City, and deliver in the manner, at the times, and to the extent, if any, directed by the City, (i) the fabricated or unfabricated parts, Work in process, completed Work, Equipment, software, firmware, Equipment and documentation, Equipment, supplies, and other material produced as a part of, or acquired in connection with the performance of, the Work terminated by the notice of termination, and (ii) the completed or partially completed drawings, plans, specifications, designs (including CADD files in a format requested by the City), renderings, blueprints, manuals, equipment layouts, reports, estimates, summaries applications, submittals, other information prepared for the purpose of planning, designing, constructing and operating the Work, and other property which, if the Contract had been completed, would have been required to be furnished to the City.

G. Use its best efforts to sell, in the manner, at the times, to the extent, and at the price or prices that the City directs or authorizes, any property of the types previously referred to herein, but Contractor (a) shall not be required to extend credit to any purchaser, and (b) may acquire any such property under the conditions prescribed and at a price or prices approved by the City. The proceeds of any such transfer or disposition shall be applied in reduction of any payments to be made by the City to Contractor under this Contract or shall otherwise be credited to the price or cost of the Work covered by this Contract or paid in such other manner as the City may direct.

H. Complete performance of such part of the Work as shall not have been terminated by the notice of termination.

I. Take such action as may be necessary, or as the City may direct, for the protection and preservation of the property related to this Contract which is in the possession of Contractor and in which the City has or may acquire an interest.

14.3.3. After receipt of a notice of termination, Contractor shall submit to the City its termination claim, in the form and with the certification required of a Contract Claim or as the City otherwise requires. Such termination claim shall be submitted promptly, but in no event later than 90 Days from the effective date of termination, unless one or more extensions in writing are granted by the City upon written request of Contractor within such three -month period or authorized extension. However, if the City determines that the facts justify such action, it may receive and act upon any such termination Claim at any time after such three-month period or extension. If Contractor fails to submit its termination Claim within the time allowed, the City may determine, on the basis of information available to the City, the amount, if any, due to Contractor because of the termination. The City shall then pay to Contractor the amount so determined.

14.3.4. Subject to the previous provisions, Contractor and the City may agree upon the whole or any part of the amount or amounts to be paid to Contractor because of the total or partial termination of Work under this Section 14.3. The amount or amounts may include a reasonable allowance for profit on Work completed. However, such agreed amount or amounts, exclusive of settlement costs, shall not exceed the total Contract Sum as reduced by the amount of payments otherwise made and as further reduced by the portion of the Contract Sum of Work not terminated. Contractor shall have no right to recover lost profits on unperformed Work. The Contract shall be amended accordingly, and Contractor shall be paid the agreed amount. Nothing following, prescribing the amount to be paid to Contractor in the event of failure of Contractor and the City to agree upon the whole amount to be paid to Contractor because of the termination of Work under this Section 14.3, shall be deemed to limit, restrict, or otherwise determine or affect the amount or amounts which may be agreed upon to be paid to Contractor pursuant to this Section 14.3.4.

14.3.5. If Contractor and the City fail to agree, as Section 14.3.4 provides, on the whole amount to be paid to Contractor because of the termination of Work under Section 14.3, the City shall determine, on the basis of information available to the City, the amount, if any, due to Contractor by reason of the termination and shall pay to Contractor the amounts determined as follows:

14.3.6. For all Contract Work completed before effective date of the notice of termination, the total (without duplication of any items) of the following items:

A. The cost of such Work.

B. The cost of settling and paying Claims arising out of the termination of Work under subcontracts or orders as previously provided. This cost is exclusive of the amounts paid or payable on account of supplies or materials delivered or services furnished by Contractor before the effective date of the notice of termination. These amounts shall be included in the cost on account of which payment is made for the cost of Work previously provided.

C. A sum, as profit on the cost of the Work as provided in Section 14.3.4 that the City determines to be fair and reasonable. But, if it appears that Contractor would have sustained a loss on the entire Contract had it been completed, no profit shall be included or allowed, and an appropriate adjustment shall be made reducing the amount of the settlement to reflect the indicated loss.

D. The reasonable cost of the preservation and protection of property, completed Work, and Equipment, incurred as previously provided. The total sum to be paid to Contractor shall not exceed the total Contract Sum as reduced by the amount of payments otherwise made and as further reduced by the Contract price of Work not terminated. Except for normal spoilage, and except to the extent that the City shall have otherwise expressly assumed the risk of loss, there shall be excluded from the amounts payable to Contractor the fair value, as determined by the City, of property which is destroyed, lost, stolen, or damaged, to the extent that it is undeliverable to the City, or to a third party buyer as previously provided, where such loss is not compensated by insurance.

14.3.7. Contractor shall have the right to dispute in a court any determination the City makes under Section 14.3.5. But, if Contractor has failed to submit its Termination Claim within the time provided and has failed to request extension of such time, it shall have no such right to dispute the City's determination and all such claims shall be deemed waived. In any case where the City has determined the amount owed, the City shall pay to Contractor the following:

A. If there is no right to dispute hereunder or if no timely appeal has been taken, the amount so determined by the City; or

B. If a proceeding is initiated in a court of competent jurisdiction within the State of California, the amount finally determined in said proceeding.

C. In arriving at the amount due Contractor under this Section 14.3, there shall be deducted:

D. All unliquidated advance or other payments on account theretofore made to Contractor, applicable to the terminated portion of this Contract;

E. Any claim which the City may have against Contractor in connection with this Contract; and

F. The agreed price for, or the proceeds of sale of, any materials, supplies, or other things kept by Contractor or sold, under the provisions of this Section 14.3, and not otherwise recovered by or credited to the City.

G. Any liquidated damages incurred up to the date of termination.

14.3.8. If the termination hereunder be partial, before the settlement of the terminated portion of this Contract, Contractor may file with the City a request in writing for an equitable adjustment of the price or prices specified in the Contract relating to the continued portion of the Contract (the portion not terminated by the notice of termination). Such equitable adjustment as the Parties may agree upon shall be made in the specified price or prices. Nothing contained herein shall limit the right of the City and Contractor to agree upon the amount or amounts to be

paid to the continued portion of the Contract when the Contract does not contain an established Contract price for the continued portion.

14.4. LOSS OF PROJECT FUNDING.

The SFMTA will provide notice to Contractor if it is unable to fund the Total Amount of the Contract, and the Parties will negotiate a Suspension of the Work or Termination for Convenience (as determined by City), as provided in Sections 14.2 and 14.3, above.

ARTICLE 15 -- STATUTORY REQUIREMENTS

15.1. NONDISCRIMINATION IN CONTRACTS AND BENEFITS.

15.1.1. In the performance of this Agreement, Contractor agrees not to discriminate against any employee, any City and County employee working with the Contractor or a Subcontractor or Subconsultant, applicant for employment with Contractor or a Subcontractor or Subconsultant, or against any person seeking accommodations, advantages, facilities, privileges, services, or membership in all business, social, or other establishments or organizations, on the basis of the fact or perception of a person's race, color, creed, religion, national origin, ancestry, age, height, weight, sex, sexual orientation, gender identity, domestic partner status, marital status, disability or Acquired Immune Deficiency Syndrome or HIV status (AIDS/HIV status), or association with members of such protected classes, or in retaliation for opposition to discrimination against such classes.

15.1.2. Contractor shall incorporate by reference in all subcontracts the provisions of San Francisco Administrative Code sections 12B.2(a), 12B.2(c)-(k), and 12C.3, and shall require all subcontractors to comply with such provisions. Contractor's failure to comply with the obligations in this Section 15.1.2 shall constitute a material breach of this Agreement.

15.1.3. Contractor does not as of the date of this Agreement and will not during the term of this Agreement, in any of its operations in San Francisco, on real property owned by San Francisco, or where work is being performed for the City elsewhere in the United States, discriminate in the provision of bereavement leave, family medical leave, health benefits, membership or membership discounts, moving expenses, pension and retirement benefits or travel benefits, as well as any benefits other than the benefits specified above, between employees with domestic partners and employees with spouses, and/or between the domestic partners and spouses of such employees, where the domestic partnership has been registered with a governmental entity pursuant to state or local law authorizing such registration, subject to the conditions set forth in §12B.2(b) of the San Francisco Administrative Code.

15.1.4. The provisions of Chapters 12B and 12C of the San Francisco Administrative Code are incorporated in this Document by reference and made a part of this Agreement as though fully set forth herein. Contractor shall comply fully with and be bound by all of the provisions that apply to this Agreement under such Chapters, including but not limited to the remedies provided in such Chapters. Without limiting the foregoing, Contractor understands that pursuant to §§12B.2(h) and 12C.3(g) of the San Francisco Administrative Code, a penalty of

\$50 for each person for each calendar day during which such person was discriminated against in violation of the provisions of this Agreement may be assessed against Contractor and/or deducted from any payments due Contractor.

15.2. MINIMUM COMPENSATION ORDINANCE FOR EMPLOYEES (MCO).

Contractor agrees to comply fully with and be bound by all of the provisions of the Minimum Compensation Ordinance (MCO), as set forth in San Francisco Administrative Code Chapter 12P (Chapter 12P), including the remedies provided, and implementing guidelines and rules, as said ordinance and, guidelines and rules may be amended from time to time. The provisions of Chapter 12P.5 and 12.P.5.1 are incorporated herein by reference and made a part of this Agreement as though fully set forth. The text of the MCO is available on the web at <http://www.sfgov.org/olse>. Capitalized terms used in this Section 15.2 and not defined in the Agreement shall have the meanings assigned to such terms in Chapter 12P. Consistent with the requirements of the MCO, Contractor agrees to all of the following:

15.2.1. For each hour worked by a Covered Employee during a Pay Period on work funded under the City contract during the term of this Agreement, Contractor shall provide to the Covered Employee no less than the Minimum Compensation, which includes a minimum hourly wage and compensated and uncompensated time off consistent with the requirements of the MCO. For the hourly gross compensation portion of the MCO, Contractor shall pay a minimum of \$10.77 an hour for the term of this Agreement; provided, however, that Contractors that are Nonprofit Corporations or public entities shall pay a minimum of \$9 an hour for the term of this Agreement.

15.2.2. If a Covered Employee of a Nonprofit Corporation works in San Francisco, then that employee is covered by San Francisco's Minimum Wage Ordinance, which is Chapter 12R of the Administrative Code.

15.2.3. Contractor shall not discharge, reduce in compensation, or otherwise discriminate against any employee for complaining to the City with regard to Contractor's compliance or anticipated compliance with the requirements of the MCO, for opposing any practice proscribed by the MCO, for participating in proceedings related to the MCO, or for seeking to assert or enforce any rights under the MCO by any lawful means.

15.2.4. Contractor understands and agrees that the failure to comply with the requirements of the MCO shall constitute a material breach by Contractor of the terms of this Agreement. The City, acting through the Contracting Department, shall determine whether such a breach has occurred.

15.2.5. If, within 30 days after receiving written notice of a breach of this Agreement for violating the MCO, Contractor fails to cure such breach or, if such breach cannot reasonably be cured within such period of 30 days, Contractor fails to commence efforts to cure within such period, or thereafter fails diligently to pursue such cure to completion, the City, acting through the Contracting Department, shall have the right to pursue the following rights or remedies and any rights or remedies available under applicable law:

- A.** The right to charge Contractor an amount equal to the difference between the Minimum Compensation and any compensation actually provided to a Covered Employee, together with interest on such amount from the date payment was due at the maximum rate then permitted by law;
- B.** The right to set off all or any portion of the amount described in Section 15.2.1 against amounts due to Contractor under this Agreement;
- C.** Right to terminate this Agreement in whole or in part;
- D.** In the event of a breach by Contractor of the covenant referred to in Section 15.2.1, the right to seek reinstatement of the employee or to obtain other appropriate equitable relief; and
- E.** The right to bar Contractor from entering into future contracts with the City for three years.

Each of the rights provided in this 15.2.5 shall be exercisable individually or in combination with any other rights or remedies available to the City. Any amounts realized by the City pursuant to this Section 15.2.5 shall be paid to the Covered Employee who failed to receive the required Minimum Compensation.

15.2.6. Contractor represents and warrants that it is not an entity that was set up, or is being used, for the purpose of evading the intent of the MCO.

15.2.7. Contractor shall keep itself informed of the current requirements of the MCO, including increases to the hourly gross compensation due Covered Employees under the MCO, and shall provide prompt written notice to all Covered Employees of any increases in compensation, as well as any written communications received by Contractor from the City, which communications are marked to indicate that they are to be distributed to Covered Employees.

15.2.8. Contractor shall provide reports to the City in accordance with any reporting standards promulgated by the City under the MCO, including reports on subcontractors.

15.2.9. Contractor shall provide the City with access to pertinent records after receiving a written request from the City to do so and being provided at least five (5) business days to respond.

15.2.10. The City may conduct random audits of Contractor. Random audits shall be (i) noticed in advance in writing; (ii) limited to ascertaining whether Covered Employees are paid at least the minimum compensation required by the MCO; (iii) accomplished through an examination of pertinent records at a mutually agreed upon time and location within ten days of the written notice; and (iv) limited to one audit of Contractor every two years for the duration of this Agreement. Nothing in this Agreement is intended to preclude the City from investigating any report of an alleged violation of the MCO.

15.2.11. Any subcontract entered into by Contractor shall require the subcontractor to comply with the requirements of the MCO and shall contain contractual obligations substantially the same as those set forth in this Section 15.2. A subcontract means an agreement between Contractor and a third party which requires the third party to perform all or a portion of the services covered by

this Agreement. Contractor shall notify the Department of Administrative Services when it enters into such a subcontract and shall certify to the Department of Administrative Services that it has notified the subcontractor of the obligations under the MCO and has imposed the requirements of the MCO on the subcontractor through the provisions of the subcontract. It is Contractor's obligation to ensure that any subcontractors of any tier under this Agreement comply with the requirements of the MCO. If any subcontractor under this Agreement fails to comply, City may pursue any of the remedies set forth in this Section 15.2 against Contractor.

15.2.12. Each Covered Employee is a third-party beneficiary with respect to the requirements of this Section 15.2, and may pursue the following remedies in the event of a breach by Contractor of Sections 15.2.1, 15.2.2, or 15.2.3, but only after the Covered Employee has provided the notice, participated in the administrative review hearing, and waited the 21-day period required by the MCO. Contractor understands and agrees that if the Covered Employee prevails in such action, the Covered Employee may be awarded: (1) an amount equal to the difference between the Minimum Compensation and any compensation actually provided to the Covered Employee, together with interest on such amount from the date payment was due at the maximum rate then permitted by law; (2) in the event of a breach by Contractor of Sections 15.2.1, 15.2.2, or 15.2.3, the right to seek reinstatement or to obtain other appropriate equitable relief; and (3) all additional statutory remedies.

15.3. HEALTH CARE ACCOUNTABILITY ORDINANCE (HCAO).

Contractor agrees to comply fully with and be bound by all of the provisions of the Health Care Accountability Ordinance (HCAO), as set forth in San Francisco Administrative Code Chapter 12Q, including the remedies provided, and implementing regulations, as the same may be amended from time to time. The provisions of Section 12Q.5.1 of Chapter 12Q are incorporated by reference and made a part of this Agreement as though fully set forth herein. The text of the HCAO is available on the web at <http://www.sfgov.org/olse> and at <http://www.amlegal.com/sanfran/viewcode.htm>. Capitalized terms used in this Section 15.3 and not defined in this Agreement shall have the meanings assigned to such terms in Chapter 12Q.

15.3.1. For each Covered Employee, Contractor shall provide the appropriate health benefit set forth in Section 12Q.3 of the HCAO. If Contractor chooses to offer the health plan option, such health plan shall meet the minimum standards set forth by the San Francisco Health Commission.

15.3.2. Notwithstanding the above, if Contractor is a small business as defined in Section 12Q.3(e) of the HCAO, it shall have no obligation to comply with part (a) above.

15.3.3. Contractor's failure to comply with the HCAO shall constitute a material breach of this Agreement. The City shall notify Contractor if such a breach has occurred. If, within 30 days after receiving The City's written notice of a breach of this Agreement for violating the HCAO, Contractor fails to cure such breach or, if such breach cannot reasonably be cured within such period of 30 days, Contractor fails to commence efforts to cure within such period, or thereafter

fails diligently to pursue such cure to completion, The City shall have the right to pursue the remedies set forth in Section 12Q.5.1 and 12Q.5(f)(1-6) of the HCAO. Each of these remedies shall be exercisable individually or in combination with any other rights or remedies available to The City.

15.3.4. Any Subcontract entered into by Contractor shall require the Subcontractor to comply with the requirements of the HCAO and shall contain contractual obligations substantially the same as those set forth in this Section 15.3. Contractor shall notify The City's Office of Contract Administration when it enters into such a Subcontract and shall certify to the Office of Contract Administration that it has notified the Subcontractor of the obligations under the HCAO and has imposed the requirements of the HCAO on Subcontractor through the Subcontract. Each Contractor shall be responsible for its Subcontractors' compliance with this Chapter. If a Subcontractor fails to comply, the City may pursue the remedies set forth in the HCAO and this Agreement against Contractor based on the Subcontractor's failure to comply, provided that the City has first provided Contractor with notice and an opportunity to obtain a cure of the violation.

15.3.5. Contractor shall not discharge, reduce in compensation, or otherwise discriminate against any employee for notifying The City with regard to Contractor's noncompliance or anticipated noncompliance with the requirements of the HCAO, for opposing any practice proscribed by the HCAO, for participating in proceedings related to the HCAO, or for seeking to assert or enforce any rights under the HCAO by any lawful means.

15.3.6. Contractor represents and warrants that it is not an entity that was set up, or is being used, for the purpose of evading the intent of the HCAO.

15.3.7. Contractor shall maintain employee and payroll records in compliance with the California Labor Code and Industrial Welfare Commission orders, including the number of hours each employee has worked on the City Contract.

15.3.8. Contractor shall keep itself informed of the current requirements of the HCAO.

15.3.9. Contractor shall provide reports to the City in accordance with any reporting standards promulgated by the City under the HCAO, including reports on Subcontractors and Subtenants, as applicable.

15.3.10. Contractor shall provide the City with access to records pertaining to compliance with HCAO after receiving a written request from City to do so and being provided at least ten business days to respond.

15.3.11. Contractor shall allow City to inspect Contractor's job sites and have access to Contractor's employees in order to monitor and determine compliance with HCAO.

15.3.12. The City may conduct random audits of Contractor to ascertain its compliance with HCAO. Contractor agrees to cooperate with the City when it conducts such audits.

15.3.13. If Contractor is exempt from the HCAO when this Agreement is executed because its amount is less than \$25,000 (\$50,000 for nonprofits), but Contractor later enters into an agreement or agreements that cause Contractor's aggregate amount of all agreements with the City to reach \$75,000, all the agreements shall be thereafter subject to the HCAO. This obligation arises on the effective date of the agreement that causes the cumulative amount of agreements between Contractor and the City to be equal to or greater than \$75,000 in the fiscal year.

15.4. MACBRIDE PRINCIPLES - NORTHERN IRELAND.

Pursuant to San Francisco Administrative Code 12F.5, the City and County of San Francisco urges companies doing business in Northern Ireland to move towards resolving employment inequities, and encourages such companies to abide by the MacBride Principles. The City and County of San Francisco urges San Francisco companies to do business with corporations that abide by the MacBride Principles. By signing below, the signatory representative executing this agreement on behalf of Contractor acknowledges and agrees that he or she has read and understood this Section 15.4.

15.5. PROHIBITION ON POLITICAL ACTIVITY WITH CITY FUNDS.

Under San Francisco Administrative Code Chapter 12.G, Contractor may not participate in, support, or attempt to influence any political campaign for a candidate or for a ballot measure (collectively, "Political Activity") in the performance of the services provided under this Agreement. Contractor agrees to comply with San Francisco Administrative Code Chapter 12.G and any implementing rules and regulations promulgated by the City's Controller. The terms and provisions of Chapter 12.G are incorporated herein by this reference. In the event Contractor violates the provisions of this Section 15.5, the City may, in addition to any other rights and remedies available hereunder, (i) terminate this Agreement, and (ii) prohibit Contractor from bidding on or receiving any new City contract for a period of two(2) years. The Controller will not consider Contractor's use of profit as a violation of this Section 15.5.

15.6. PROTECTION OF PRIVATE INFORMATION.

Contractor has read and agreed to the terms set forth in San Francisco Administrative Code sections 12M.2, "Nondisclosure of Private Information," and 12M.3, "Enforcement of Administrative Code Chapter 12M, "Protection of Private Information," which are incorporated herein as if fully set forth. Contractor agrees that any failure of Contractor to comply with the requirements of Administrative Code section 12M.2 shall be a material breach of this Agreement. In such an event, in addition to any other remedies available to it under equity or law, the City may terminate the Agreement, bring a false claim action against Contractor under Chapter 6 or Chapter 21 of the Administrative Code, or debar Contractor. The provisions of this Section 15.6 shall survive termination or expiration of the Contract.

15.7. PUBLIC RECORD - SUNSHINE ORDINANCE.

In accordance with San Francisco Administrative Code section 67.24(e), contracts, contractors' bids, responses to solicitations and all other records of communications between the City and persons or firms seeking contracts, shall be open to inspection immediately after a contract has been awarded. Nothing in this provision requires the disclosure of a private person or organization's net worth or other proprietary financial data submitted for qualification for a contract or other benefit until and unless that person or organization is awarded the contract or benefit. Information provided which is covered by this paragraph will be made available to the public upon request. If the City receives a public records request for materials that Contractor has identified are proprietary, the City will endeavor to provide Contractor notice prior to release of said materials, but shall not be held liable for any damages whatsoever should such notice fail or be ineffective. Except as may be ordered by a court having jurisdiction, the City will not disclose those materials that are provided by Contractor to the City under a fully executed license agreement, but any and all costs to the City arising from the City's refusal to release license materials shall be borne and reimbursed to the City by Contractor, and Contractor shall fully defend and indemnify the City in any action concerning the City's refusal to release said licensed materials. Contractor shall clearly and unambiguously mark all documents that contain proprietary information provided to the City under such license.

15.8. ASSIGNMENT UNDER PUBLIC CONTRACT CODE SECTION 7103.5.

Under Public Contract Code section 7103.5, Contractor and its Subcontractors shall conform to the following requirements:

15.8.1. In entering into the Agreement or subcontract to supply goods, services, or materials under this Agreement, Contractor or its Subcontractors offer and agree to assign the City all rights, title, and interest in and to all causes of action they may have under Section 4 of the Clayton Act (15 U.S.C. § 15) or under the Cartwright Act (chapter 2, commencing with section 16700, of part 2 of division 7 of the Business and Professions Code), arising from purchases of goods, services or materials pursuant to the Agreement or subcontract.

15.8.2. The assignment shall be made and become effective at the time the City tenders Final Payment to Contractor, without further acknowledgement by the Parties.

15.8.3. Contractor shall include the provisions of this Article in its subcontracts and purchase agreements to supply goods, services, or materials pursuant to the Agreement.

15.9. TROPICAL HARDWOOD AND VIRGIN REDWOOD PRODUCTS BAN.

Except as expressly permitted by the application of San Francisco Environment Code sections 802(b) and 803(b), Contractor shall not provide any items to the City in performance of this Contract which are tropical hardwoods, tropical hardwood wood products, virgin redwood or virgin redwood wood products. The City urges Contractor not to import, purchase, obtain, or use for any purpose, any tropical hardwood, tropical hardwood product, virgin redwood or virgin redwood wood product.

15.10. PRESERVATIVE-TREATED WOOD CONTAINING ARSENIC.

Contractor may not purchase preservative-treated wood products containing arsenic in the performance of this Agreement unless an exemption from the requirements of Chapter 13 of the San Francisco Environment Code is obtained from the Department of the Environment under **SECTION** 1304 of that Code. The term “preservative-treated wood containing arsenic” shall mean wood treated with a preservative that contains arsenic, elemental arsenic, or an arsenic copper combination, including, but not limited to, chromated copper arsenate preservative, ammoniacal copper zinc arsenate preservative, or ammoniacal copper arsenate preservative. Contractor may purchase preservative-treated wood products on the list of environmentally preferable alternatives prepared and adopted by the Department of the Environment. This provision does not preclude Contractor from purchasing preservative-treated wood containing arsenic for saltwater immersion. The term “saltwater immersion” shall mean a pressure-treated wood that is used for construction purposes or facilities that are partially or totally immersed in saltwater.

15.11. FOOD SERVICE WASTE REDUCTION REQUIREMENTS.

Contractor agrees to comply fully with and be bound by all of the provisions of the Food Service Waste Reduction Ordinance, as set forth in San Francisco Environment Code Chapter 16, including the remedies provided, and implementing guidelines and rules. The provisions of Chapter 16 are incorporated herein by reference and made a part of this Agreement as though fully set forth. This provision is a material term of this Agreement. By entering into this Agreement, Contractor agrees that if it breaches this provision, the City will suffer actual damages that will be impractical or extremely difficult to determine; further, Contractor agrees that the sum of one hundred dollars (\$100) liquidated damages for the first breach, two hundred dollars (\$200) liquidated damages for the second breach in the same year, and five hundred dollars (\$500) liquidated damages for subsequent breaches in the same year is reasonable estimate of the damage that the City will incur based on the violation, established in light of the circumstances existing at the time this Agreement was made. Such amount shall not be considered a penalty, but rather agreed monetary damages sustained by the City because of Contractor’s failure to comply with this provision.

15.12. GRAFFITI.

Graffiti is detrimental to the health, safety and welfare of the community in that it promotes a perception in the community that the laws protecting public and private property can be disregarded with impunity. This perception fosters a sense of disrespect of the law that results in an increase in crime; degrades the community and leads to urban blight; is detrimental to property values, business opportunities and the enjoyment of life; is inconsistent with the City’s property maintenance goals and aesthetic standards; and results in additional graffiti and in other properties becoming the target of graffiti unless it is quickly removed from public and private property. Graffiti results in visual pollution and is a public nuisance. Graffiti must be

abated as quickly as possible to avoid detrimental impacts on the City and County and its residents, and to prevent the further spread of graffiti. Contractor shall remove all graffiti from any real property owned or leased by Contractor in the City and County of San Francisco within forty eight (48) hours of the earlier of Contractor's (a) discovery or notification of the graffiti or (b) receipt of notification of the graffiti from the Department of Public Works. This Section 15.12 is not intended to require a Contractor to breach any lease or other agreement that it may have concerning its use of the real property. Contractor shall not be responsible for removing graffiti from Project Sites where control of the Project Site and security of the Site have not been delegated to Contractor, unless Contractor or its subcontractor(s) or employees caused the graffiti. The term "graffiti" means any inscription, word, figure, marking or design that is affixed, marked, etched, scratched, drawn or painted on any building, structure, fixture or other improvement, whether permanent or temporary, including by way of example only and without limitation, signs, banners, billboards and fencing surrounding construction sites, whether public or private, without the consent of the owner of the property or the owner's authorized agent, and which is visible from the public right-of-way. "Graffiti" shall not include: (1) any sign or banner that is authorized by, and in compliance with, the applicable requirements of the San Francisco Public Works Code, the San Francisco Planning Code or the San Francisco Building Code; or (2) any mural or other painting or marking on the property that is protected as a work of fine art under the California Art Preservation Act (California Civil Code §§ 987 et seq.) or as a work of visual art under the Federal Visual Artists Rights Act of 1990 (17 U.S.C. §§ 101 et seq.).

15.13. FIRST SOURCE HIRING.

15.13.1. The City has adopted a First Source Hiring Ordinance (Board of Supervisors Ordinance No. 264-98) that establishes specific requirements, procedures and monitoring for the hiring for entry level jobs of qualified, economically disadvantaged individuals (as defined by the Ordinance) by certain contractors/lessees doing business with the City.

15.13.2. When/If Contractor's Total Bid Price and Alternates for the Contract selected by the City exceeds three hundred fifty thousand dollars (\$350,000), Contractor and its Subcontractor(s) in accordance with the Ordinance, Contractor shall enter into a First Source Hiring Agreement with the Agency. Such Agreement will require Contractor/ Lessee to make good faith efforts to meet targeted hiring goals of qualified, economically disadvantaged individuals for work on the subject contract. The Agreement will also require the Contractor to provide the SFMTA records necessary for the SFMTA to monitor compliance with the Ordinance.

15.13.3. Contractor shall refer to Document 01021 for First Source Hiring Program and CityBuild pilot program contracting requirements and shall complete and submit Document 01021-1 (First Source Hiring Program Certificate) and Document 01021-2 (First Source Hiring Program Employer Projection of Entry-Level Job Openings).

15.14. SERVICES PROVIDED BY ATTORNEYS.

Any services to be provided by a law firm or attorney for the purposes of representing an interest of the City must be reviewed and approved in writing in advance by the City Attorney. No invoices for services provided by law firms or attorneys, including, without limitation, as subcontractors of Contractor, will be paid unless the provider received advance written approval from the City Attorney.

15.15. LIMITATIONS ON CONTRIBUTIONS.

Through execution of this Agreement, Contractor acknowledges that it is familiar with Section 15.126 of the City's Campaign and Governmental Conduct Code, which prohibits any person who contracts with the City for the rendition of personal services, for the furnishing of any material, supplies or equipment, for the sale or lease of any land or building, or for a grant, loan or loan guarantee, from making any campaign contribution to (1) an individual holding a City elective office if the contract must be approved by the individual, a board on which that individual serves, or the board of a state agency on which an appointee of that individual serves, (2) a candidate for the office held by such individual, or (3) a committee controlled by such individual, at any time from the commencement of negotiations for the contract until the later of either the termination of negotiations for such contract or six months after the date the contract is approved. Contractor acknowledges that the foregoing restriction applies only if the contract or a combination or series of contracts approved by the same individual or board in a fiscal year have a total anticipated or actual value of \$50,000 or more. Contractor further acknowledges that the prohibition on contributions applies to each prospective party to the Contract; each member of Contractor's board of directors; Contractor's chairperson, chief executive officer, chief financial officer and chief operating officer; any person with an ownership interest of more than 20 percent in Contractor; any Subcontractor and Subconsultant listed in the bid or Contract; and any committee that is sponsored or controlled by Contractor. Additionally, Contractor acknowledges that Contractor must inform each of the persons described in the preceding sentence of the prohibitions contained in section 1.126 of that Code. Contractor further agrees to provide to the City the names of each person, entity or committee described above.

15.16. COMPLIANCE WITH AMERICANS WITH DISABILITIES ACT.

Contractor acknowledges that, pursuant to the Americans with Disabilities Act (ADA), programs, services and other activities provided by a public entity to the public, whether directly or through a contractor, must be accessible to the disabled public. Contractor shall provide the services specified in this Agreement in a manner that complies with the ADA and any and all other applicable federal, state and local disability rights legislation. Contractor agrees not to discriminate against disabled persons in the provision of services, benefits or activities provided under this Agreement and further agrees that any violation of this prohibition on the part of Contractor, its employees, agents or assigns will constitute a material breach of this Agreement.

15.17. CONFLICT OF INTEREST.

Through its execution of this Agreement, Contractor acknowledges that it is familiar with the provision of **SECTION 15.103** of the City's Charter, Article III, Chapter 2 of the City's Campaign and Governmental Conduct Code, and Sections 87100 et seq. and Sections 1090 et seq. of the Government Code of the State of California, and certifies that it does not know of any facts which constitutes a violation of said provisions and agrees that it will immediately notify the City if it becomes aware of any such fact during the term of this Agreement.

15.18. NON-WAIVER OF RIGHTS.

The omission by either party at any time to enforce any default or right reserved to it, or to require performance of any of the terms, covenants, or provisions hereof by the other party at the time designated, shall not be a waiver of any such default or right to which the party is entitled, nor shall it in any way affect the right of the party to enforce such provisions thereafter. The provisions of this Section 15.18 shall survive termination or expiration of the Contract.

15.19. ASSIGNMENT OF CONTRACT.

The services to be performed by Contractor are personal in character and neither this Agreement nor any duties or obligations hereunder may be assigned or delegated by Contractor unless first approved by the City by written instrument executed and approved in the same manner as this Agreement.

15.20. SUBMITTING FALSE CLAIMS; MONETARY PENALTIES.

Contractor is hereby advised of and directed to the provisions of Article V (commencing at section 6.80) of Chapter 6 of the San Francisco Administrative Code: Violations of Administrative Code Chapter 6; False Claims; Procedures For Debarment; Monetary Penalties.

15.21. EARNED INCOME CREDIT (EIC) FORMS.

San Francisco Administrative Code Chapter 12(O) requires that employers provide their employees with IRS Form W-5 (The Earned Income Credit Advance Payment Certificate) and the IRS EIC Schedule, as set forth below. Employers can locate these forms at the IRS Office, on the Internet, or anywhere that Federal Tax Forms can be found.

15.21.1. Contractor shall provide EIC Forms to each Eligible Employee at each of the following times: (i) within thirty days following the date on which this Contract becomes effective (unless Contractor has already provided such EIC Forms at least once during the calendar year in which such effective date falls); (ii) promptly after any Eligible Employee is hired by Contractor; (iii) annually between January 1 and January 31 of each calendar year during the term of the Contract.

15.21.2. Failure to comply with any requirement contained in Section 15.21 shall constitute a material breach by Contractor of the terms of this Contract. If, within thirty days after Contractor receives written notice of such a breach, Contractor fails to cure such breach or, if such breach cannot reasonably be cured within such period of thirty days, Contractor fails to commence efforts to cure within such period or thereafter fails to diligently pursue such cure to completion,

the City may pursue any rights or remedies available under this Contract or applicable Law.

15.21.3. Any Subcontract entered into by Contractor shall require the Subcontractor to comply, as to the Subcontractor's Eligible Employees, with each of the terms of this Section 15.21.

15.21.4. Capitalized terms used in this Section 15.21 and not defined in Article 1.1 shall have the meanings assigned to such terms in Chapter 12(O) of the San Francisco Administrative Code.

15.22. PUBLIC ACCESS TO MEETINGS AND RECORDS.

If Contractor receives a cumulative total per year of at least \$250,000 in City funds or City-administered funds and is a non-profit organization as defined in Chapter 12L of the San Francisco Administrative Code, Contractor shall comply with and be bound by all the applicable provisions of that Chapter. By executing this Agreement, Contractor agrees to open its meetings and records to the public in the manner set forth in §§12L.4 and 12L.5 of the Administrative Code. Contractor further agrees to make-good faith efforts to promote community membership on its Board of Directors in the manner set forth in §12L.6 of the Administrative Code. Contractor acknowledges that its material failure to comply with any of the provisions of this paragraph shall constitute a material breach of this Agreement. Contractor further acknowledges that such material breach of the Agreement shall be grounds for the City to terminate and/or not renew the Agreement, partially or in its entirety.

15.23. GOODS NOT TO BE PRISON MADE.

No goods furnished or procured under this Contract shall have been made in a prison or by convict labor except for articles made in prisons or by convicts under the supervision and control of the California Department of Corrections and limited to goods for use by the City and County's detention facilities.

15.24. DISALLOWANCE.

If Contractor claims or receives payment from the City for a service, reimbursement for which is later disallowed by the State of California or United States Government, Contractor shall promptly refund the disallowed amount to the City upon the City's request. At its option, the City may offset the amount disallowed from any payment due or to become due to Contractor under this Agreement or any other Agreement. By executing this Agreement, Contractor certifies that Contractor is not suspended, debarred or otherwise excluded from participation in federal assistance programs. Contractor acknowledges that this certification of eligibility to receive federal funds is a material term of the Agreement. The provisions of this Section 15.24 shall survive termination or expiration of the Contract.

ARTICLE 16 -- FEDERAL TRANSIT ADMINISTRATION REQUIREMENTS

Contractor shall comply with the following requirements of the Federal Transit Administration, Department of Transportation ("FTA") contract requirements. Sections in this Article 16 that reference provisions of other Articles in the Contract shall have the force of federal and state or local law, as applicable.

16.1. DEFINITIONS.

16.1.1. Approved Project Budget means the most recent statement, approved by the FTA, of the costs of the Project, the maximum amount of Federal assistance for which the City is currently eligible, the specific tasks (including specified contingencies) covered, and the estimated cost of each task.

16.1.2. Contractor means the individual or entity awarded a third party contract financed in whole or in part with Federal assistance originally derived from FTA

16.1.3. Cooperative Agreement means the instrument by which FTA awards Federal assistance to a specific Recipient to support a particular Project or Program, and in which FTA takes an active role or retains substantial control.

16.1.4. Federal Transit Administration (FTA) is an operating administration of the United States Department of Transportation (DOT).

16.1.5. FTA Directive includes any FTA circular, notice, order or guidance providing information about FTA's programs, application processing procedures, and Project management guidelines. In addition to FTA directives, certain U.S. Department of Transportation directives also apply to the Project.

16.1.6. Grant Agreement means the instrument by which FTA awards Federal assistance to a specific Recipient to support a particular Project, and in which FTA does not take an active role or retain substantial control, in accordance with 31 U.S.C. § 6304.

16.1.7. Government means the United States of America and any executive department or agency thereof.

16.1.8. Project means the task or set of tasks listed in the Approved Project Budget, and any modifications stated in the Conditions to the Grant Agreement or Cooperative Agreement applicable to the Project. In the case of the formula assistance program for urbanized areas, for elderly and persons with disabilities, and non-urbanized areas, 49 U.S.C. §§ 5307, 5310, and 5311, respectively, the term "Project" encompasses both "Program" and "each Project within the Program," as the context may require, to effectuate the requirements of the Grant Agreement or Cooperative Agreement.

16.1.9. Recipient means any entity that receives Federal assistance directly from FTA to accomplish the Project. The term "Recipient" includes each FTA "Grantee" as well as each FTA Recipient of a Cooperative Agreement. For the purpose of this Agreement, Recipient is the City.

16.1.10. Secretary means the Secretary of the U.S. Department of Transportation, including his or her duly authorized designee.

16.1.11. Third Party Contract means a contract or purchase order awarded by the Recipient to a vendor or contractor, financed in whole or in part with Federal assistance awarded by FTA.

16.1.12. Third Party Subcontract means a subcontract at any tier entered into by Contractor or third party subcontractor, financed in whole or in part with Federal assistance originally derived from FTA.

16.1.13. U.S. DOT is the acronym for the U.S. Department of Transportation, including its operating administrations.

16.2. FLY AMERICA.

Contractor agrees to comply with 49 U.S.C. 40118 (the "Fly America" Act) in accordance with the General Services Administration's regulations at 41 CFR Part 301-10, which provide that recipients and subrecipients of Federal funds and their contractors are required to use U.S. Flag air carriers for U.S. Government-financed international air travel and transportation of their personal effects or property, to the extent such service is available, unless travel by foreign air carrier is a matter of necessity, as defined by the Fly America Act. Contractor shall submit, if a foreign air carrier was used, an appropriate certification or memorandum adequately explaining why service by a U.S. flag air carrier was not available or why it was necessary to use a foreign air carrier and shall, in any event, provide a certificate of compliance with the Fly America requirements. Contractor agrees to include the requirements of this Section 16.2 in all subcontracts that may involve international air transportation.

16.3. BUY AMERICA.

Contractor agrees to comply with 49 U.S.C. 5323(j) and 49 CFR Part 661, which provide that Federal funds may not be obligated unless steel, iron, and manufactured products used in FTA-funded projects are produced in the United States, unless a waiver has been granted by FTA or the product is subject to a general waiver. General waivers are listed in 49 CFR § 661.7, and include microcomputer equipment, software, and small purchases (less than \$100,000) made with capital, operating, or planning funds. Contractor agrees to be solely responsible for all costs relating to compliance with the Buy America requirements. Failure to comply with these requirements constitutes a material breach of this Contract for which Contractor shall be liable for all damages available under this Contract. See 49 CFR § 661.17. Contractors who intentionally or willfully fail to comply with the Buy America requirements may also be subject to debarment or suspension proceedings. 49 CFR 661.18, 661.19.

It is Contractor's responsibility to obtain any required waivers or authorizations from FTA concerning Buy America requirements. The City shall not be responsible for reimbursement or payment of any costs incurred by Contractor in seeking or obtaining waivers or certifications necessary to meet Buy America requirements. Contractor acknowledges and agrees to cooperate in any audits required to satisfy Buy America requirements prior to and/or after award of Contract or delivery of Equipment.

16.4. CARGO PREFERENCE REQUIREMENTS.

(USE OF UNITED STATES-FLAG VESSELS)

Contractor agrees: (a) to use privately owned United States-Flag commercial vessels to ship at least 50 percent of the gross tonnage (computed separately for dry bulk carriers, dry cargo liners, and tankers) involved, whenever shipping any equipment, material, or commodities pursuant to the underlying contract to the extent such vessels are available at fair and reasonable rates for United States-Flag commercial vessels; (b) to furnish within 20 working days following the date of loading for shipments originating within the United States or within 30 working days following the date of leading for shipments originating outside the United States, a legible copy of a rated, "on-board" commercial ocean bill-of-lading in English for each shipment of cargo described above to the Division of National Cargo, Office of Market Development, Maritime Administration, Washington, DC 20590 and to the FTA recipient (through the Contractor in the case of a Subcontractor's bill-of-lading.); and (c) to include these requirements in all subcontracts issued pursuant to this Contract when the subcontract may involve the transport of equipment, material, or commodities by ocean vessel.

16.5. SEISMIC SAFETY REQUIREMENTS.

Contractor agrees that any new building or addition to an existing building will be designed and constructed in accordance with the standards for Seismic Safety required in Department of Transportation Seismic Safety Regulations 49 CFR Part 41 and Contractor will certify to compliance to the extent required by the regulation. Contractor also agrees to ensure that all work performed under this Contract, including work performed by a subcontractor, is in compliance with the standards required by the Seismic Safety Regulations and the certification of compliance issued on the project.

16.6. ENERGY CONSERVATION REQUIREMENTS.

Contractor agrees to comply with mandatory standards and policies relating to energy efficiency which are contained in any state energy conservation plan issued in compliance with the Energy Policy and Conservation Act.

16.7. ACCESS TO RECORDS AND REPORTS.

16.7.1. As provided in Section 2.5 of this Agreement and as may be further required under federal law, Contractor agrees to provide the City and County of San Francisco, the FTA Administrator, the Comptroller General of the United States or any of their authorized representatives access to any books, documents, papers and records of Contractor which are directly pertinent to this Contract for the purposes of making audits, examinations, excerpts and transcriptions. Contractor also agrees, pursuant to 49 C.F.R. 633.17, to provide the FTA Administrator or his or her authorized representatives, including any PMO Contractor, access to Contractor's records and construction sites pertaining to a major capital project, defined at 49 U.S.C. 5302(a)1, which is receiving Federal

financial assistance through the programs described at 49 U.S.C. 5307, 5309 or 5311.

16.7.2. In all contracts between the City and County of San Francisco and Contractor for a capital project or improvement (defined at 49 U.S.C. 5302(a)1) entered into through other than competitive bidding, Contractor shall make available records related to this Contract to the Purchaser, the Secretary of Transportation and the Comptroller General or any authorized officer or employee of any of them for the purposes of conducting an audit and inspection.

16.7.3. Contractor agrees to permit any of the foregoing parties to reproduce by any means whatsoever or to copy excerpts and transcriptions as reasonably needed.

16.7.4. Contractor agrees to maintain all books, records, accounts and reports required under this Contract for a period of not less than three years after the date of termination or expiration of this Contract, except in the event of litigation or settlement of claims arising from the performance of this Contract, in which case Contractor agrees to maintain same until the City and County of San Francisco, the FTA Administrator, the Comptroller General, or any of their duly authorized representatives, have disposed of all such litigation, appeals, claims or exceptions related thereto. 49 CFR 18.36(i)(11).

16.8. CLEAN AIR REQUIREMENTS.

(Applicable to all contracts exceeding \$100,000, including indefinite quantities where the amount is expected to exceed \$100,000 in any year)

16.8.1. Contractor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act, as amended, 42 U.S.C. §§ 7401 et seq. Contractor agrees to report each violation to the City and County of San Francisco and understands and agrees that the City and County of San Francisco will, in turn, report each violation as required to assure notification to FTA and the appropriate EPA Regional Office.

16.8.2. Contractor also agrees to include these requirements in each subcontract exceeding \$100,000 financed in whole or in part with Federal assistance provided by FTA.

16.9. CLEAN WATER REQUIREMENTS.

(Applicable to contracts that exceed \$100,000)

16.9.1. Contractor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1251 et seq. Contractor agrees to report each violation to the City and understands and agrees that the City will, in turn, report each violation as required to assure notification to FTA and the appropriate EPA Regional Office.

16.9.2. Contractor also agrees to include these requirements in each subcontract exceeding \$100,000 financed in whole or in part with Federal assistance provided by FTA.

16.10. RECYCLED PRODUCTS.

Contractor agrees to comply with all the requirements of Section 6002 of the Resource Conservation and Recovery Act (RCRA), as amended (42 U.S.C. 6962), including but not limited to the regulatory provisions of 40 CFR Part 247, and Executive Order 12873, as they apply to the procurement of the items designated in Subpart B of 40 CFR Part 247.

16.11. DAVIS-BACON AND COPELAND ANTI-KICKBACK ACTS.

16.11.1. Minimum Wages.

A. All laborers and mechanics employed or working upon the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between Contractor and such laborers and mechanics.

B. Contributions made or costs reasonably anticipated for bona fide fringe benefits under Section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of Section 16.11.1.E; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR Part 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classifications and wage rates conformed under Section 16.11.1.C) and the Davis-Bacon poster (WH-1321) shall be posted at all times by Contractor and its Subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

C. The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under this Contract shall be classified in conformance with the wage determination. The contracting officer shall accept an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

1. Except with respect to helpers as defined as 29 CFR 5.2(n)(4), the work to be performed by the classification requested is not performed by a classification in the wage determination; and

2. The classification is utilized in the area by the construction industry; and

3. The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination; and

4. With respect to helpers as defined in 29 CFR 5.2(n)(4), such a classification prevails in the area in which the work is performed.

i. If Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

ii. In the event Contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

iii. The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs 16.11.1.C.4.i of this Section, shall be paid to all workers performing work in the classification under this Contract from the first day on which work is performed in the classification.

D. Whenever the minimum wage rate prescribed in this Contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, Contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

E. If Contractor does not make payments to a trustee or other third person, Contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided that the Secretary of Labor has found, upon the written request of Contractor, that the applicable standards of the

Davis-Bacon Act have been met. The Secretary of Labor may require Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

16.11.2. Withholding. The SFMTA shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from Contractor under this Contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by Contractor or any Subcontractor the full amount of wages required by this Contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), all or part of the wages required by this Contract, MTA may, after written notice to Contractor, or sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

16.11.3. Payrolls and Basic Records.

A. Payrolls and basic records relating thereto shall be maintained by Contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work (or under the United States Housing Act of 1937, or under the Housing Act of 1949, in the construction or development of the project). Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in Section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in Section 1(b)(2)(B) of the Davis-Bacon Act, Contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs. 3.2.287.

B. The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the MTA for transmission to the Federal Transit Administration. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under

section 5.5(a)(3)(i) of Regulations, 29 CFR part 5. This information may be submitted in any form desired. Optional Form WH-347 is available for this purpose and may be purchased from the Superintendent of Documents (Federal Stock Number 029-005-00014-1), U.S. Government Printing Office, Washington, DC 20402. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors.

C. Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by Contractor or Subcontractor or his or her agent who pays or supervises the payment of the persons employed under this Contract and shall certify the following:

1. That the payroll for the payroll period contains the information required to be maintained under section 5.5(a)(3)(i) of Regulations, 29 CFR part 5 and that such information is correct and complete;

2. That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the Contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

3. That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into this Contract.

D. The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by Section 16.11.3.C.

E. The falsification of any of the above certifications may subject the Contractor or Subcontractor to civil or criminal prosecution under Section 1001 of title 18 and Section 231 of title 31 of the United States Code.

F. The Contractor or Subcontractor shall make the records required under Section 16.11.3 available for inspection, copying, or transcription by authorized representatives of the Federal Transit Administration or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If Contractor or Subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the Contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

16.11.4.Apprentices and Trainees.

A. Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program

registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to Contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in Contractor's or the Subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator of the Wage and Hour Division of the U.S. Department of Labor determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Bureau of Apprenticeship and Training, or a State Apprenticeship Agency recognized by the Bureau, withdraws approval of an apprenticeship program, Contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

B. Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage

determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, Contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

C. Equal Employment Opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

16.11.5. Compliance with Copeland Act Requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this Contract.

16.11.6. Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the Federal Transit Administration may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. Contractor shall be responsible for the compliance by any Subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

16.11.7. Contract Termination: Debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the Contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

16.11.8. Compliance with Davis-Bacon and Related Act Requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this Contract.

16.11.9. Disputes Concerning Labor Standards. Disputes arising out of the labor standards provisions of this Contract shall not be subject to the general disputes clause of this Contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the Contractor (or any of its Subcontractors) and the SFMTA, the U.S. Department of Labor, or the employees or their representatives.

16.11.10. Certification of Eligibility.

By entering into this Contract, the Contractor certifies that the firm and any person or firm who has an interest in Contractor's firm is not a firm or a person ineligible to be awarded Government contracts by virtue of Section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

No part of this Contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of Section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

16.12. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT.

(applies to any construction contract over \$100,000)

16.12.1. Overtime Requirements. No contractor or subcontractor contracting for any part of the Work under the Contract which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of 40 hours in such workweek.

16.12.2. Violation; Liability for Unpaid Wages; Liquidated Damages. In the event of any violation of the clause set forth in paragraph A. of this Section, Contractor or and any Subcontractor responsible therefore shall be liable for the unpaid wages. In addition, Contractor and such Subcontractor shall be liable to the United States for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph A. of this Section 16.2, in the sum of Ten Dollars (\$10 for) each calendar day on which such individual was required or permitted to work in excess of the standard workweek of 40 hours without payment of the overtime wages required by the clause set forth in Section 16.12.1, above.

16.12.3. Withholding for Unpaid Wages and Liquidated Damages. The SFMTA shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by Contractor or Subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in Section 16.12.2, above.

16.12.4. Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in Sections 16.12.1 through 16.12.4, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in Sections 16.12.1 through 16.12.4.

16.13. NO GOVERNMENT OBLIGATION TO THIRD PARTIES.

16.13.1. The City and Contractor acknowledge and agree that, notwithstanding any concurrence by the Federal Government in or approval of the solicitation or award of the underlying contract, absent the express written consent by the Federal Government, the Federal Government is not a party to this Contract and shall not be subject to any obligations or liabilities to the City, Contractor, or any other party (whether or not a party to that contract) pertaining to any matter resulting from the underlying contract.

16.13.2. Contractor agrees to include the above clause in each subcontract financed in whole or in part with Federal assistance provided by FTA. It is further agreed that the clause shall not be modified, except to identify the subcontractor who will be subject to its provisions.

16.14. PROGRAM FRAUD AND FALSE OR FRAUDULENT STATEMENTS AND RELATED ACTS.

16.14.1. Contractor acknowledges that the provisions of the Program Fraud Civil Remedies Act of 1986, as amended, 31 U.S.C. §§ 3801 et seq. and U.S. DOT regulations, "Program Fraud Civil Remedies," 49 C.F.R. Part 31, apply to its actions pertaining to this Project. Upon execution of the underlying contract, Contractor certifies or affirms the truthfulness and accuracy of any statement it has made, it makes, it may make, or causes to be made, pertaining to the underlying contract or the FTA-assisted project for which this Contract work is being performed. In addition to other penalties that may be applicable, Contractor further acknowledges that if it makes, or causes to be made, a false, fictitious, or fraudulent claim, statement, submission, or certification, the Federal Government reserves the right to impose the penalties of the Program Fraud Civil Remedies Act of 1986 on Contractor to the extent the Federal Government deems appropriate.

16.14.2. Contractor also acknowledges that if it makes, or causes to be made, a false, fictitious, or fraudulent claim, statement, submission, or certification to the Federal Government under a contract connected with a project that is financed in whole or in part with Federal assistance originally awarded by FTA under the authority of 49 U.S.C. § 5307, the Government reserves the right to impose the penalties of 18 U.S.C. § 1001 and 49 U.S.C. § 5307(n)(1) on Contractor, to the extent the Federal Government deems appropriate.

16.14.3. Contractor agrees to include the above two clauses in each subcontract financed in whole or in part with Federal assistance provided by FTA. It is further agreed that the clauses shall not be modified, except to identify the subcontractor who will be subject to the provisions.

16.15. CIVIL RIGHTS REQUIREMENTS.

16.15.1. Nondiscrimination. In accordance with Title VI of the Civil Rights Act, as amended, 42 U.S.C. § 2000d, Section 303 of the Age Discrimination Act of 1975, as amended, 42 U.S.C. § 6102, Section 202 of the Americans with Disabilities Act of 1990, 41 U.S.C. § 12132, and Federal transit law at 49 U.S.C. § 5332, Contractor agrees that it will not discriminate against any employee or applicant for employment because of race, color, creed, national origin, sex, age, or disability. In addition, Contractor agrees to comply with applicable Federal implementing regulations and other implementing requirements FTA may issue.

16.15.2. Equal Employment Opportunity. The following equal employment opportunity requirements apply to the underlying contract:

A. Race, Color, Creed, National Origin, Sex - In accordance with Title VII of the Civil Rights Act, as amended, 42 U.S.C. § 2000e, and Federal transit laws at 49 U.S.C. § 5332, Contractor agrees to comply with all applicable equal employment opportunity requirements of U.S. Department of Labor (U.S. DOL) regulations, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor," 41 C.F.R. Parts 60 et seq., (which implement Executive Order No. 11246, "Equal Employment Opportunity," as amended by Executive Order No. 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," 42 U.S.C. § 2000e note), and with any applicable Federal statutes, executive orders, regulations, and Federal policies that may in the future affect construction activities undertaken in the course of the Project.

B. During the performance of this Contract, Contractor agrees as follows:

1. Contractor agrees to take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, creed, national origin, sex, or age. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

2. Contractor will, in all solicitations or advertisements for employees placed by or on behalf of Contractor, state that all qualified applicants will receive considerations for employment without regard to race, color, religion, sex, or national origin.

3. Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of Contractor's commitments under this Section 16.15.2, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

4. Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, as amended, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

5. In the event of Contractor's noncompliance with the nondiscrimination clauses of this Contract or with any of the said rules,

regulations, or orders, this Contract may be canceled, terminated, or suspended in whole or in part and Contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, as amended, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, as amended, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

6. The contractor will include the provisions of the preceding subsections B.1 and B.2 in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order 11246 of September 24, 1965, as amended, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency, Contractor may request the City and the United States to enter into such litigation to protect the interests of the City and the United States.

16.15.3.Age. In accordance with Section 4 of the Age Discrimination in Employment Act of 1967, as amended, 29 U.S.C. § 623 and Federal transit law at 49 U.S.C. § 5332, Contractor agrees to refrain from discrimination against present and prospective employees for reason of age. In addition, Contractor agrees to comply with any implementing requirements FTA may issue.

16.15.4.Disabilities. In accordance with Section 102 of the Americans with Disabilities Act, as amended, 42 U.S.C. § 12112, Contractor agrees that it will comply with the requirements of U.S. Equal Employment Opportunity Commission, "Regulations to Implement the Equal Employment Provisions of the Americans with Disabilities Act," 29 C.F.R. Part 1630, pertaining to employment of persons with disabilities. In addition, Contractor agrees to comply with any implementing requirements FTA may issue.

16.15.5.Equal Opportunity Clauses.

A. As used in these specifications:

- 1.** "Covered area" means the geographical area described in the solicitation from which this Contract resulted;
- 2.** "Director" means Director, Office of Federal Contract Compliance Programs, United States Department of Labor, or any person to whom the Director delegates authority;
- 3.** "Employer identification number" means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941.
- 4.** "Minority" includes:

i. Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);

ii. Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);

iii. Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and

iv. American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

B. Whenever Contractor, or any Subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of \$10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this Contract resulted.

C. If Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or Subcontractors toward a goal in an approved Plan does not excuse any covered Contractor's or Subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

D. Contractor shall implement the specific affirmative action standards provided in this Section 16.15 of these specifications. The goals set forth in the solicitation from which this Contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered Construction contractors performing Construction Work in geographical areas where they do not have a Federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in

notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.

E. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom Contractor has a collective bargaining agreement, to refer either minorities or women, shall excuse Contractor's obligations under these specifications, Executive Order 11246, as amended, or the regulations promulgated pursuant thereto.

F. In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by Contractor during the training period, and Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.

G. Contractor shall take specific affirmative action to ensure equal employment opportunity. The evaluation of Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:

1. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which Contractor's employees are assigned to work. Contractor, where possible, will assign two or more women to each construction project. Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

2. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when Contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.

3. Maintain a current file of the names, addresses and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to Contractor by the union or, if referred, not employed by Contractor, this shall be documented in the file with the reason therefore, along with whatever additional actions Contractor may have taken.

4. Provide immediate written notification to the Director when the union or unions with which Contractor has a collective bargaining

agreement has not referred to Contractor a minority person or woman sent by Contractor, or when Contractor has other information that the union referral process has impeded Contractor's efforts to meet its obligations.

5. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to Contractor's employment needs, especially those programs funded or approved by the Department of Labor. Contractor shall provide notice of these programs to the sources compiled subsection G.3, above.

6. Disseminate Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.

7. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other employment decisions, including specific review of these items with onsite supervisory personnel such as Superintendents, General Foremen, etc., prior to the initiation of Construction Work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

8. Disseminate Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing Contractor's EEO policy with other Contractors and Subcontractors with whom Contractor does or anticipates doing business.

9. Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, Contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

10. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide

after school, summer and vacation employment to minority and female youth both on the site and in other areas of a Contractor's work force.

11. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.

12. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.

13. Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and Contractor's obligations under these specifications are being carried out.

14. Ensure that all facilities and company activities are non-segregated, except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.

15. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

16. Conduct a review, at least annually, of all supervisors' adherence to and performance under Contractor's EEO policies and affirmative action obligations.

H. Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations (7.a through p). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which Contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under 7.a through p of these Specifications provided that Contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of Contractor. The obligation to comply, however, is Contractor's and failure of such a group to fulfill an obligation shall not be a defense for Contractor's noncompliance.

I. A single goal for minorities and a separate single goal for women have been established. Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though Contractor has achieved its goals for women generally, Contractor

may be in violation of the Executive Order if a specific minority group of women is underutilized).

J. Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.

K. Contractor shall not enter into any Subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.

L. Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any Contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.

M. Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

N. Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, Contractors shall not be required to maintain separate records.

O. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

16.16. SUBSTANCE ABUSE.

Contractor shall comply with U.S. DOT regulations, "Drug Free Workplace Requirements (Grants)," 49 C.F.R. Part 29, Subpart F, and other applicable U.S. DOT and FTA regulations and guidance pertaining to substance abuse (drugs and alcohol) that may be promulgated.

16.17. BONDING REQUIREMENTS.

See Section 10.2 of these General Conditions.

16.18. DEBARMENT AND SUSPENSION.

(applicable to contracts greater than or equal to \$25,000)

Contractor warrants that it is not currently debarred , suspended, or otherwise prohibited from receipt of a public or federally funded contract. If Contractor is so prohibited, Contractor shall be in default and this Contract shall terminate at no cost to the City. See also Sections 15.24 and 11.3.4 of the General Conditions and RFP section 10.5 (Certification Regarding Debarment, Suspension, and Other Responsibility Matters).

16.19. TERMINATION FOR CONVENIENCE OF CITY.

(required for all contracts in excess of \$10,000)

See Section 14.3 of these General Conditions.

16.20. TERMINATION FOR DEFAULT.

(required for all contracts in excess of \$10,000)

See Section 14.1 of these General Conditions.

16.21. INCORPORATION OF FEDERAL TRANSIT ADMINISTRATION (FTA) TERMS.

The preceding provisions include, in part, certain Standard Terms and Conditions required by DOT, whether or not expressly set forth in the preceding contract provisions. All contractual provisions required by DOT, as set forth in FTA Circular 4220.1F, are hereby incorporated by reference. Anything to the contrary herein notwithstanding, all FTA-mandated terms shall be deemed to control in the event of a conflict with other provisions contained in this Agreement. Contractor shall not perform any act, fail to perform any act, or refuse to comply with any (name of grantee) requests which would cause (name of grantee) to be in violation of the FTA terms and conditions.

16.22. FEDERAL CHANGES.

Contractor shall at all times comply with all applicable FTA regulations, policies, procedures and directives, including without limitation those listed directly or by reference in the Master Agreement between the City and the FTA, as they may be amended or promulgated from time to time during the term of this Contract. Contractor's failure to so comply shall constitute a material breach of this Contract.

16.23. PATENT RIGHTS.

(applicable to contracts for experimental, research, or development projects financed by FTA)

16.23.1.General. If any invention, improvement, or discovery is conceived or first actually reduced to practice in the course of or under this Agreement, and

that invention, improvement, or discovery is patentable under the laws of the United States of America or any foreign country, the City and Contractor agree to take actions necessary to provide immediate notice and a detailed report to the FTA.

16.23.2. Unless the Federal Government later makes a contrary determination in writing, irrespective of Contractor's status (large business, small business, state government or instrumentality, local government, nonprofit organization, institution of higher education, individual), the City and Contractor agree to take the necessary actions to provide, through FTA, those rights in that invention due the Federal Government described in U.S. Department of Commerce regulations, "Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements," 37 CFR Part 401.

16.23.3. Contractor also agrees to include the requirements of this clause in each subcontract for experimental, developmental, or research work financed in whole or in part with Federal assistance provided by FTA.

16.24. RIGHTS IN DATA AND COPYRIGHTS.

(Applicable to contracts for planning, research, or development financed by FTA)

16.24.1. Definition. The term "subject data" used in this Section 16.24 means recorded information, whether or not copyrighted, that is delivered or specified to be delivered under this Agreement. The term includes graphic or pictorial delineation in media such as drawings or photographs; text in specifications or related performance or design-type documents; machine forms such as punched cards, magnetic tape, or computer memory printouts; and information retained in computer memory. Examples include, but are not limited to, computer software, engineering drawings and associated lists, specifications, standards, process sheets, manuals, technical reports, catalog item identifications, and related information. The term "subject data" does not include financial reports, cost analyses, and similar information incidental to contract administration.

16.24.2. Federal Restrictions. The following restrictions apply to all subject data first produced in the performance of this Agreement.

A. Publication of Data. Except for its own internal use in conjunction with the Agreement, Contractor may not publish or reproduce subject data in whole or in part, or in any manner or form, nor may Contractor authorize others to do so, without the written consent of the Federal Government, until such time as the Federal Government may have either released or approved the release of such data to the public; this restriction on publication, however, does not apply to any contract with an academic institution.

B. Federal License. In accordance with 49 CFR 18.34 and 19.36, the Federal Government reserves a royalty-free, non-exclusive and irrevocable license to reproduce, publish or otherwise use, and to authorize others to use, "for Federal Government purposes," any subject data or copyright described below. As used in the previous sentence, "for Federal Government purposes" means use only for the direct purposes of the Federal Government. Without the

copyright owner's consent, the Federal Government may not extend its Federal license to any other party:

1. Any subject data developed under this Agreement, whether or not a copyright has been obtained; and
2. Any rights of copyright purchased by the City or Contractor using Federal assistance in whole or in part provided by FTA.
3. Notwithstanding any other provisions of this Section 16.24, the Parties do not intend that the work performed under this Contract will constitute research and development.

16.24.3.FTA Intention. When FTA awards Federal assistance for an experimental, research or developmental work, it is FTA's general intention to increase transportation knowledge available to the public, rather than to restrict the benefits resulting from the work to participants in the work. Therefore, unless FTA determines otherwise, Contractor performing experimental, research, or developmental work required by the underlying Agreement agrees to permit FTA to make available to the public, either FTA's license in the copyright to any subject data developed in the course of the Agreement, or a copy of the subject data first produced under the Agreement for which a copyright has not been obtained. If the experimental, research, or developmental work which is the subject of this Agreement is not completed for any reason, all data developed under this Agreement shall become subject data as defined in Section 16.24.1, above, and shall be delivered as the Federal Government may direct. This subsection does not apply to adaptations of automatic data processing equipment or programs for the City's use the costs of which are financed with Federal transportation funds for Capital Programs.

16.24.4.Hold Harmless. Unless prohibited by state law, upon request by the Federal Government, Contractor agrees to indemnify, save, and hold harmless the Federal Government, its officers, agents, and employees acting within the scope of their official duties, against any liability, including costs and expenses, resulting from any willful or intentional violation by Contractor of proprietary rights, copyrights, or right of privacy, arising out of the publication, translation, reproduction, delivery, use, or disposition of any data furnished under this Agreement. Contractor shall not be required to indemnify the Federal Government for any such liability arising out of the wrongful acts of employees or agents of the Federal Government.

16.24.5.Restrictions on Access to Patent Rights. Nothing contained in this Section 16.24 on rights in data shall imply a license to the Federal Government under any patent or be construed as affecting the scope of any license or other right otherwise granted to the Federal Government under any patent.

16.24.6.Application to Data Incorporated into Work. The requirements of Sections 16.24.2 through 16.24.4 do not apply to Data developed by the City or Contractor and incorporated into the work carried out under this Agreement, provided that the City or Contractor identifies the data in writing at the time of delivery of the work.

16.24.7. Application to Subcontractors. Unless FTA determines otherwise, Contractor agrees to include these requirements in each subcontract for experimental, developmental, or research work financed in whole or in part with Federal assistance provided by FTA.

16.24.8. Provision of Rights to Government. Unless the Federal Government later makes a contrary determination in writing, irrespective of Contractor's status (large business, small business, state government or instrumentality, local government, nonprofit organization, institution of higher education, or individual), the City and Contractor agree to take the necessary actions to provide, through FTA, those rights in that invention due the Federal Government described in U.S. Department of Commerce regulations, "Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements," 37 CFR Part 401.

16.24.9. Flow Down. Contractor also agrees to include these requirements in each subcontract for experimental, developmental, or research work financed in whole or in part with Federal assistance provided by FTA.

16.25. ITS ARCHITECTURE.

Contractor shall design the Project in accordance with Bay Area and national Intelligent Transportation Systems ("ITS") Architecture requirements. See RFQ/RFP Appendix 12 § 114.

16.26. RECYCLED PRODUCTS.

Contractor agrees to comply with all the requirements of Section 6002 of the Resource Conservation and Recovery Act (RCRA), as amended (42 U.S.C. 6962), including, but not limited to, the regulatory provisions of 40 CFR Part 247, and Executive Order 12873, as they apply to the procurement of the items designated in Subpart B of 40 CFR Part 247.

**RADIO SYSTEM REPLACEMENT PROJECT DESIGN BUILD SERVICES
(CONTRACT NO. 1240)**

DOCUMENT 00800: Supplemental CONDITIONS

Document 00800

Table of Contents

DOCUMENT 00801: SUMMARY OF WORK	1
DOCUMENT 00802: CONTRACT TIME AND LIQUIDATED DAMAGES	5
DOCUMENT 00803: PERFORMANCE GUARANTEES	6
DOCUMENT 00804: CONTRACT SUPERVISION AND COORDINATION	7
DOCUMENT 00805: FIELD ENGINEERING	16
DOCUMENT 00806: IDENTIFICATION SYSTEMS	19
DOCUMENT 00807: CONSTRUCTION & DEMOLITION DEBRIS COORDINATION	23
DOCUMENT 00807 - A: C & D DEBRIS RECOVERY WORKSHEET	36
DOCUMENT 00808: PROJECT MEETINGS	41
DOCUMENT 00809: PAYMENT AND ALLOWANCES	47
DOCUMENT 00810: SUBMITTALS	72
DOCUMENT 00811: TEMPORARY UTILITIES	83
DOCUMENT 00812: TEMPORARY CONSTRUCTION	86
DOCUMENT 00813: PROTECTION OF PROPERTY	88
DOCUMENT 00814: LOCAL OFFICE	97
DOCUMENT 00815: MATERIALS & EQUIPMENT	98
DOCUMENT 00816: PRODUCT SUBSTITUTIONS	102
DOCUMENT 00817: TESTIN, START UP, AND COMMISSIONING	106
DOCUMENT 00818: CONTRACT CLOSEOUT	110

DOCUMENT 00818 - A: CONTRACT CLOSEOUT RELEASE DOCUMENT 114

DOCUMENT 00819: CONTRACT RECORD DOCUMENTS 116

**DOCUMENT 00820: TRAINING PROGRAMS AND OPERATIONS AND MAINTENANCE
MANUALS 119**

DOCUMENT 00821: SPARE PARTS AND MAINTENANCE MATERIALS 126

**DOCUMENT 00822: ENVIRONMENTAL MITIGATION MEASURES AND TEMPORARY
CONTROLS 128**

DOCUMENT 00823: SOFTWARE AND TECHNOLOGY PROCURMENT 151

DOCUMENT 00824: QUALITY PROGRAM 154

DOCUMENT 00825: CADD DOCUMENT LIABILITY WAIVER AND RELEASE 182

DOCUMENT 00826: EXISTING UTILITY FACILITIES 183

DOCUMENT 00827: ARCHAEOLOGICAL CONDITIONS 188

DOCUMENT 00828: HEALTH & SAFETY 190

DOCUMENT 00829: TRAFFIC ROUTING AND TEMPORARY PAVEMENT MARKING213

DOCUMENT 00830: PROJECT SECURITY AND SITE ACCESS214

DOCUMENT 00830-A: PHOTO ID/ACCESS CARD REQUEST FORM223

DOCUMENT 00831: GEOTECHNICAL DATA225

DOCUMENT 00832: ENVIRONMENTAL ASSESSMENT INFORMATION227

DOCUMENT 00833: PROJECT MANAGEMENT & SCHEDULE REQUIREMENTS228

DOCUMENT 00834: REGULATORY REQUIREMENTS251

DOCUMENT 00835 WARRANTY AND MAINTENANCE261

DOCUMENT 00801: SUMMARY OF WORK**PART 1 - GENERAL****1.1 LOCATION OF WORK**

The Work to be done under this Contract is located within the City of San Francisco and Daly City, California.

1.2 CONTRACT DOCUMENT UNITS

The values stated in SI and U.S. units are to be regarded separately as standard. Within the text, the U.S. units are shown in brackets or parenthesis, or in separate tables or columns, unless noted otherwise. The values stated in each system are not exact equivalents; therefore, each system must be used independently of each other. Combining values from the two systems may result in non-conformance with the Specifications and Drawings.

1.3 DESCRIPTION OF WORK

Refer to Document 00900, Design Criteria, including Appendix 9 and Appendix 12

1.4 WORK BY OTHERS

- A. Refer to RFQ/RFP Section 3.2.
- B. The Contractor shall cooperate fully with others performing advanced or parallel or subsequent Work in or nearby the Project sites and shall be responsible for coordinating its Work and its construction schedule early on with the Work indicated above and with any other Work by other City departments and utility companies in the vicinity.

1.5 EXISTING WORK TO REMAIN

- A. All facilities not shown on the Drawings or specified to be removed, replaced, or altered and not in conflict with the new construction shall remain. The Contractor shall notify the Engineer ten (10) working days in advance of any plans to remove any existing Work on Site that are not shown on Drawings to be removed.

1.6 USE OF AREAS AVAILABLE TO CONTRACTOR

- A. The Contractor shall not unnecessarily limit the use, access and parking for the general public, residents, and commercial users along streets and sidewalks.
- B. The Contractor shall not use sidewalk or street parking areas for parking or storage of equipment, temporary facilities, or materials without proper permits.

1.7 SCHEDULE CONSTRAINTS

- A. The Work of this Contract must be completed within the time specified under the section 7.1 of the General Conditions
- B. In addition, Contractor must provide sufficient resources to meet the Intermediate Milestones, if any, listed in the Supplementary Conditions to demonstrate timely progress of Work towards total completion of all Work.
- C. Accordingly, Contractor shall schedule Work in anticipation of all Site constraints, the numerous coordination efforts, and all the required approvals. Close monitoring and updating of construction schedules by the Contractor will be mandatory.

1.8 WORK HOURS, NIGHT WORK, WEEKEND WORK

Refer to Document 00830 of the Supplementary Conditions.

1.9 HOLIDAY SEASON RESTRICTIONS

The Contractor shall follow the standard holiday periods established by the City.

1.10 SPECIAL INSTRUCTIONS

- A. The Contractor shall complete the following tasks or activities prior to starting any on-Site Work:
 - 1. Completion of all pre-requisite design tasks and approvals as specified in Document 00700 General Conditions Article 3, section 3.1.1.
 - 2. Completion of Escrow Bid Documents, as described in Forms 01001, 01001A, and 01002 of the Document 1000- Forms.
 - 3. Pre-construction meeting described in Document 00808.
 - 4. Safety meeting(s) of Document 00828.
 - 5. Obtain City's approval of the fully cost and resource loaded Baseline Schedule of Document 00833. Absolutely no on-Site Work will be permitted without a City-approved Baseline Schedule, and no time extensions to the Contract will be granted as a result of not starting Site Work on time.
 - 6. Contractor's Quality Control Program Plan of Document 00824.
 - 7. Site-specific Health and Safety Plan (HASP) of Document 00828.
 - 8. Site Specific Earthquake Preparedness and Emergency Response Plan as specified in Section 1.23 of Document 00822.
 - 9. Solid Waste Management Plan (SWMP) of Document 00807.
 - 10. Project signs required by Document 00812.

11. Preliminary Submittal Schedule required in Document 00810.
 12. Ordering of all long-lead items that will affect the start of the job.
- B. The Contractor shall be responsible for coordinating and cooperating with the City and other stakeholder organizations which have jurisdiction over portions of the sites. Such coordination and cooperation shall include, but not be limited to, obtaining all necessary permits for construction, informing/updating the stakeholders directly on the construction schedule and any unusual problems, providing written notices independently and immediately whenever there is a release or discharge of hazardous materials into contaminated or uncontaminated groundwater, coordinating/working harmoniously with nearby tenants, and coordinating with any contractors that may be working at the Site.
 - C. The Work of this Contract and the use of the project sites are subject to review/approvals/regulations of numerous agencies, including but not limited to, the Federal Transit Administration (FTA), the San Francisco County Transportation Authority (SFCTA), the San Francisco Municipal Transportation Agency (SFMTA), the City's Department of Public Works, the City's Department of Parking and Traffic (DPT), the City's Department of Building Inspection (DBI), the City's Public Utilities Commission/Bureau of Environmental Regulation Management (PUC/BERM), and the City's Public Utilities Commission/Bureau of Light, Heat and Power (PUC/BLHP).
 - D. It shall be the Contractor's responsibility to familiarize itself with the requirements, regulations, permit, and approval process of the above and other agencies as they pertain to the Work of this Contract. Contractor shall fully comply with all requirements of the above agencies, including, but not limited to, securing and paying for required permits/approvals, and ensuring that completed Work is accepted and approved by the respective agency without delay to the Project
 - E. Contractor is advised that Work performed under this Contract will require special Work sequencing, extensive coordination with the City, governing jurisdictions and utility agencies. Contractor shall include in their bid all costs associated with coordinating, scheduling, and Work sequencing as required.
 - F. Portions of the Work cannot be performed during normal standard daytime weekday shifts. Contractor is advised that overtime shifts including weekends off-hours, and night time Work will be required to complete all the Work within the project schedule requirements. Contractor shall furnish all equipment, resources, and staffing at no additional cost to the City as required to complete the Work
 - G. Contractor is advised that portions of the Work will be performed in commercial and residential areas. Contractor shall take every precaution to protect the public from injury. All safety measures shall be maintained on a 24-hour, seven-day basis. Dust control measures will be strictly enforced. The Contractor on a seven (7) day, twenty-four (24)-hour basis will be required to maintain the project Site and adjacent streets, roadways and waterways in such a manner as to adequately control dust.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00802: CONTRACT TIME AND LIQUIDATED DAMAGES

This section is not used; . See Articles 7 and 8 of Document 00700.

DOCUMENT 00803: PERFORMANCE GUARANTEES

This section is not used. See 00520 Design-Build Agreement, Article 4 for Performance Guarantees.

DOCUMENT 00804: CONTRACT SUPERVISION AND COORDINATION**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This Section specifies the Contractor's responsibilities concerning supervision, coordination of its Work, and coordination with other City departments, the public, utility companies, SFMTA and others during the Construction Phases; these Phases are defined as Phases 4.2-4.5 in the Contract.
- B. Nothing in this Section shall be construed as relieving the Contractor of its obligations to other jurisdictions and to other City departments with respect to obtaining required permits and approvals.
- C. No separate payment will be made for Work covered under this specification. The Work associated with this specification is considered incidental to the completion of the Work in which it pertains.
- D. For the design phase, Phase 4.1, the Contractor will submit a Project Management plan on the supervision and coordination for the design phase. It will describe the involvement of Design Manager, reporting to the Contract Project Manager, as the lead for completing the design phase. The plan will be submitted to the Engineer within ten (10) working days of the NTP for Phase 4.1 for Engineer's review and approval..

1.2 CONTRACTOR'S KEY PERSONNEL ON SITE

- A. The Contractor shall provide a dedicated staff at all times to lead, coordinate and support the Work for the entire duration of the Contract, as listed in Article 3.6.4 of the General Conditions. At a minimum, the Contractor shall provide the following types and number of Key Personnel listed below. Except as may be agreed by the SFMTA in writing no one person may double up to serve two positions, in part or in whole, except during the three (3) weeks grace period cited in paragraph C below.
 - 1. Project Manager dedicated to this Contact, whose job qualifications and responsibilities are described under Section 4.3.1(A) RFQ/RFP
 - 2. Design Manager dedicated to this Contact, whose job qualifications and responsibilities are described under Section 4.3.1(B) RFQ/RFP
 - 3. Construction Manager dedicated to this Contract, whose job qualifications and responsibilities are described under Section 4.3.1(C) RFQ/RFP.
 - 4. Project Quality Manager dedicated to this Contract, whose job qualifications and responsibilities are described under Section 6.3.2(A) RFQ/RFP

5. Communications Engineer dedicated to this Contract whose job qualifications and responsibilities are described under Section 6.3.2(B) RFQ/RFP
6. Test Director dedicated to this Contract, whose job qualifications and responsibilities are described under Section 6.3.2(C) RFQ/RFP
7. System Integration Engineer dedicated to this Contract, whose job qualifications and responsibilities are described under Section 6.3.2(D) RFQ/RFP
8. Network Engineer dedicated to this Contract, whose job qualifications and responsibilities are described under Section 6.3.2(E) RFQ/RFP
9. California Licensed Professional Engineers whose job qualifications and responsibilities are described under Section 6.3.2(F) RFQ/RFP
10. Project Scheduler
11. During construction activities in Phases 4.2-4.5, an on-Site Health and Safety Officer dedicated to this Contract.

Note: The previous lists only the Key Personnel reporting directly or indirectly to the Contract Project Manager and does not include other Contractor personnel required on the job, such as Field Engineering staff, and clerical support. With the exception of Project Scheduler, all the above Key Personnel must be stationed at the Project Office for the time required to perform their assigned duties.

- B. Within ten (10) working days of the Notice to Proceed (NTP) or as otherwise stated in the NTP, for both the Design and the Construction Phases, the Contractor shall submit the following for the Engineer's review and approval. No Work may start unless the Engineer has provided written approval to the items below:
 1. Updated resumes of all of the proposed Key Personnel highlighting key experience relevant to the Work of this Contract.
 2. Detailed job descriptions of the Key Personnel.
 3. Detailed description of the division of roles, responsibilities of the Key Personnel, including a description of the interface among the Key Personnel and the chain of command.
 4. Organization chart for the above and for Field Engineering staff.
- C. Due to the need for continuity and the schedule constraints of the project, no changes to Key Personnel shall occur without the written approval of the SFMTA. In the event that a key personnel vacates his/her assignment or is not fulfilling his/her duties/roles as described in the job descriptions and as determined by the Engineer, the Contractor shall replace the person in accordance with Article 3.6.5 of the General Conditions.

- D. The City reserves full right during to direct the Contractor to replace any key personnel within thirty (30) days whom the City finds unqualified or an impediment to the timely and successful completion of this project. The Contractor shall be responsible for any costs related to the replacement of such individual(s).
- E. The Contractor shall designate in writing before starting Work a Construction Manager who shall have the authority to represent and act for the Contractor.
 - 1. The Construction Manager shall be dedicated to the duties of the Construction Manager as described in subsection 1.3 below and in other provisions of this Contract.
 - 2. When the Contractor is comprised of two (2) or more firms, partnerships, or corporations functioning on a joint venture basis, said Contractor shall designate in writing before starting Work, the name of one (1) Construction Manager who shall have the authority to represent and act for the Contractor. Said authorized representative shall be experienced in the types of construction contemplated herein.
 - 3. The Construction Manager (or representative) shall be present at the Site of the Work at all times while Work is actually in progress on the Contract.
 - 4. During periods when the Construction Manager is absent from the Site, an Acting Construction Manager with the same authority as the designated Construction Manager shall be provided, or the Work shall be discontinued at no cost or delay to the City. The Engineer shall be informed in writing by the Construction Manager of his/her absence from the Site for more than one (1) working day, and who is the designated Acting Construction Manager.

1.3 RESPONSIBILITIES OF THE CONSTRUCTION MANAGER

The Contractor's Construction Manager's responsibilities shall include, but not be limited to, the following:

- 1. Acting as the spokesperson on behalf of Contractor in all dealings with Engineer.
- 2. Signing off on all submittals, proposed contract changes, requests for substitutions, etc., before submitting them to Engineer.
- 3. Establishing and enforcing procedures.
- 4. Coordinating the Work of employees and subcontractors.
- 5. Expediting the Work to assure compliance with the schedule.
- 6. Coordinating the Work with SFMTA, DPW, DTIS, SFFD, DPH, DBI, PUC, and other regulatory/approval agencies.
- 7. Identifying utility and service connections and coordinating the Work with PG&E, A T & T, SFWD and other utility departments and companies.

8. Assuring compliance with orders and instructions of the Engineer and requirements of the Contract.
9. Coordinating the Work with other contractors.
10. Coordinating the Work with the public.
11. Restoring pre-existing improvements.
12. Negotiating Change Orders.
13. Resolving disputes.
14. Notices of Delay and differing Site conditions.
15. Assuring temporary controls and protection of property.
16. Safety and corrective measures.
17. Security and corrective measures.
18. Construction Closeout.
19. Emergency Work.
20. Schedule Monitoring and Corrective Measures:
 - a. Enforcing compliance
 - b. Identifying potential variances between scheduled and probable dates for each activity
 - c. Resolving conflicts
 - d. Taking corrective action to meet the required completion dates
 - e. Documenting changes in schedule and submitting these changes to the Engineer, to subcontractors, and to suppliers involved
 - f. Verifying that labor and equipment are adequate to complete the Work within the time allowed
 - g. Verifying that product procurement is adequate to complete Work in the time allowed
 - h. Reporting noncompliance with the schedule and recommending changes to the Engineer
21. Controlling public and worker safety, security and traffic, including:
 - a. Securing the general public from all areas that could endanger their safety
 - b. Establishing and maintaining safe and adequate loading and unloading zones for mass transit vehicles
 - c. Establishing and monitoring worker safety procedures

- d. Establishing and maintaining temporary signals, crosswalks and traffic regulation facilities.
22. Monitoring cleaning.
 23. Maintaining cost accounting records for authorized Work performed under:
 - a. Unit prices
 - b. Force account
 - c. Other basis requiring accounting records.
 24. Maintaining reports and records at the Site and making them available to the Engineer. Making copies of requested documents at no cost to the City. Such reports and records of the Work include:
 - a. Daily reports and logs
 - b. Records:
 - Contracts
 - Purchase Orders
 - Materials and Equipment Records
 - Submittals
 - Requests for Information
 - Requests for Substitutions
 - Contract Modifications
 - Manufacturer's Instructions
 - Certificates of Compliance
 - Inspection and Test Procedures, Records and Reports, including comments by all City inspectors
 - Material Safety Data Sheets
 - Hazardous Material Disposal Records
 - Training Records
 - Notices of Non-Compliance
 - Obtaining information from subcontractors and maintaining such documents.
 25. Safety Meetings:

26. Ensuring that safety meetings are conducted before the initial start of Work at the Site, and including the Engineer, Contractor, specialty subcontractors, and regulatory agencies at such meetings.
27. Scheduling additional safety meetings at least monthly for all levels of supervisors, and as required by laws and regulations.
28. Scheduling at least one "on-the-job" or "tool box" safety meeting weekly for each field supervisor or foreman, to be attended by all employees under his/her supervision.
29. Maintaining outline reports and a permanent record of supervisors' and employees' safety meetings.
30. Notifying the Engineer in advance of all safety meetings.
31. Maintaining at the place of fabrication or manufacturer, and making available to the Engineer, record copies of all submittals, including shop drawings and product data, certificates of compliance, and shop test reports pertaining to the manufacture and fabrication.
32. Coordinating and arranging for the identification of unknown existing facilities, the protection of existing facilities, and the relocation, connection and installation of utilities.
33. Providing the Engineer a copy of any request for permanent utility service connections.
34. Ordering of all long lead items.
35. Overseeing the Work of others reporting to him/her.
36. Address community concerns over the implementation of the City Build/First Source Hiring Program.

The Contractor shall be cognizant of the general conditions of the area in which it will be working. Owners, tenants, other contractors, utilities and public agencies may need access to or be working simultaneously within and in the vicinity of the Work under this Contract.

Within thirty (30) days of the Notice to Proceed for Construction, the Contractor shall notify affected owners, tenants, contractors, utilities and agencies, including the San Francisco Fire Department, San Francisco Police Department and the public utility companies of the impending construction activities. It also shall be the responsibility of the Contractor to follow up, assist and expedite actions to be taken by owners, tenants, contractors, utilities and agencies, as required by the Work and by the schedule demands of this Contract and to cooperate and coordinate its operations with these owners, tenants, other contractors, utilities and public agencies.

1.4 COORDINATION WITH THE PUBLIC

- A. The Contractor shall post and maintain notices at all Work sites. The notice shall include the name, telephone number and address of SFMTA's Public Information Office, the name, telephone number and address of the Contractor, a description of the Work to be performed, and the duration of the Work. The notice shall be posted at least seventy-two (72) hours prior to commencement of the Work.
- B. At least thirty (30) calendar days prior to commencement of Work, the Contractor shall provide written notice delivered by United States mail to each property owner on the Block(s) within 300 feet radius of the Work and each affected neighborhood and merchant organization that is listed in the City Planning Department's Directory of Neighborhood Organizations and Service Agencies. The latest City-wide Assessor's roll for names and addresses of owners shall be used for the mailed notice. This notice shall include the same information that is required for the posted notice of paragraph A above, and the name, address, and twenty-four (24)-hour telephone number of SFMTA's Public Information Office.

1.5 COORDINATION WITH EXISTING FACILITIES

- A. The Contractor shall have full responsibility for locating all existing facilities, including buried foundations, slabs, railroad tracks, etc., identifying and determining ownership of the encountered facilities, coordinating the Work with the owner of such facilities during construction to ensure the safety and protection of the facilities, and repairing any damage to the facilities resulting from the Work, the cost of all of which will be considered as having been included in the Contract price.
- B. The Contractor shall coordinate with utilities and public agencies and allow in its schedule sufficient time for the lowering, raising and relocating of existing facilities that are in conflict with the facilities to be constructed under the contract.
- C. If, during the course of the Work, an unexpected or unidentified interference is discovered, the Contractor shall immediately call this fact to the attention of the SFWD, PG&E, AT&T, COMCAST and other known public or private utilities and public agencies. A period of seven (7) working days, beginning after the receipt of such notice, will be allowed for said utilities and public agencies to determine ownership of the unidentified facility.
- D. Any abandoned facilities that conflict with construction shall be removed as incidental Work unless indicated otherwise in the specifications.
- E. Any active governmental facilities that require removal, adjustment or relocation to avoid direct physical conflict with the facilities to be constructed under the Contract shall be relocated by the Contractor in accordance with the provisions of the Drawings and Specifications.

- F. The Contractor shall determine the routing and locations, including depths, of underground construction, so as to clear all existing facilities and maintain required clearances. The Contractor shall mark proposed routes in the field and request inspection and concurrence from the owners of other underground facilities adequately in advance of the Work to allow time for adjustments in the proposed routing and locations. The owners of underground facilities shall be allowed a minimum of 10 working days to inspect and request changes in the proposed routing and locations.

1.6 RESTORING PAVEMENT AND RELATED IMPROVEMENTS

- A. The Contractor shall restore pavement and related improvements in accordance with DPW Order Number 176,707 Regulations for Excavating and Restoring Streets in San Francisco, except as modified by the requirements of section B below.
- B. In any case in which a pavement or public right-of-way is or is caused to be excavated, the Contractor shall restore such pavement or public right-of-way. At a minimum, trench restoration shall include resurfacing to a constant width equal to a) the widest part of the excavation in a block in accordance with the Engineer's direction or to b) the full width of all traffic lanes that were partially or otherwise excavated in a block in the same direction as the trench, whichever is more.
1. Each excavation shall be backfilled and compacted within seventy-two (72) hours from the time the construction related to the excavation is completed.
 2. Replacement of the pavement base shall be completed within seventy-two (72) hours from the time the excavation is backfilled.
 3. Finished pavement restoration shall be completed within seventy-two (72) hours of replacement of the pavement base and one-hundred and forty-four (144) hours from the time the excavation is backfilled.
 4. Any facilities that were locally cracked, broken or removed because of Work performed by the Contractor shall be totally repaired and restored, and cleaned up to the Engineer's satisfaction no later than seven (7) Days after that particular Work was completed. In the event that Work was started but could not be totally completed immediately due to reasons beyond the control of the Contractor, the damage shall be neatly restored on a temporary basis and cleaned up to the Engineer's satisfaction.
 5. Existing castings, pull boxes, vaults, and meter boxes that are permitted to remain shall be adjusted to conform to the final grades of the adjacent construction.

1.7 EMERGENCY WORK

- A. If during the progress of this Contract, the Contractor is unavailable, cannot, or refuses to perform Work at a time when any condition requires emergency action in the public interest, the City shall have the right to have repairs or corrections made, as required, at the Contractor's expense.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00805: FIELD ENGINEERING**PART 1 - GENERAL****1.1 DESCRIPTION**

The Work specified in this section includes providing all field engineering required for the Work.

1.2 SUBMITTALS

Pursuant to the provisions of Document 00810, Submittals, the Contractor shall submit:

1. Survey records, notes and drawings.
2. Coordination, shop and record drawings for fabricated equipment, civil, landscaping, architectural, structural, mechanical/plumbing, fire protection, shop equipment, electrical, communication, security, fire alarm, and off-Site Work.
3. Working drawings and calculations for temporary structures or systems.
4. Record Drawings, including As-Built Drawings (Document 00819).

1.3 FIELD ENGINEERS' DUTIES

- A. The Contractor shall provide Field Engineers to be responsible for all field engineering.
 1. Before the start of any Contract Work, the Contractor shall designate in writing to the Engineer the names of the Contractor's Field Engineering staff (see Document 00804).
 2. The Field Engineer shall not serve dual roles for this Contract, i.e., the Field Engineer shall not also serve as the Contract Construction Manager, the Quality Control System staff member, the on-Site Health and Safety Officer or the Project Scheduler for this Contract.
 3. The Field Engineer shall possess a minimum of five (5) years of past field experience with similar Work.
 4. The Field Engineer shall be physically present at the Site at all times when Work is being performed. During periods when the Field Engineer is absent from the Site, an Acting Field Engineer with the same authority as the Field Engineer shall be provided.

- B. The Contractor shall be solely responsible for providing survey lines and grades on a timely basis. The Field Engineer shall coordinate all field surveys, review results of the surveys, and resolve any conflicts.
- C. On requests for Contract Changes/Notifications of Delay and Differing Site Conditions, the Field Engineer shall:
 - 1. Thoroughly review and analyze the matter
 - 2. Provide analysis to the Engineer with the request. Analysis should show responsibility of subcontractors
 - 3. Assist Engineer to analyze.
- D. Review Requests of Proposed Changes and Requests for Substitutions (also see Document 00816), before submitting them to the Engineer through the Contract Construction Manager for:
 - 1. Compliance with the Contract Documents
 - 2. Field dimensions and clearance dimensions
 - 3. Relations to available space
 - 4. Effect on the Work of other trades.
- E. Prepare shop and coordination drawings for civil, landscaping, architectural, structural, off-Site Work and other Work to assure coordination of the Work with all trades and special equipment requirements and to resolve conflicts. Provide drawings to the Engineer for comments, allowing adequate time for review.
- F. Prepare working drawings and calculations for temporary Work required for construction, but which will not become an integral part of the completed Work. This includes, but is not limited to drawings for temporary structures such as shoring, decking, temporary bulkheads, excavation support, utility support, groundwater control, forming and falsework.
- G. The Contractor shall provide copies of back-up calculations and other information needed to describe in detail the temporary structures or systems and their intended use.
- H. Prepare Record Drawings in accordance with Document 00819.

1.4 FIELD MEASUREMENTS AND ASSISTANCE

- A. Contractor shall obtain all surveying and field measurements required for the accurate fabrication and installation of the Work included in this Contract. Exact measurements are the Contractor's responsibility. Survey on an area of Work must be completed prior to start of fabrication or ordering of materials related to the Work in that particular area.

- B. For tight areas outside in the yard, inside the buildings and for congested areas of utility installations, the Contractor will be required to repeat the survey Work at least once before fieldwork is started on the particular area. These repeated surveys should include both horizontal and vertical clearance surveys.
- C. All key survey Work shall be shown on the Baseline Schedule.
- D. A copy of all survey notes shall be submitted to the Engineer within fifteen (15) Days after the completion survey of each Work area.
- E. The survey Work performed shall be under the supervision of a Land Surveyor or Civil Engineer licensed by the State of California. The survey notes shall also be signed by a Land Surveyor or Civil Engineer licensed by the State of California.
- F. Contractor shall also provide layout drawings, templates, patterns, and setting instructions as required for the installation of all Work. All dimensions shall be verified in the field.
- G. Contractor shall furnish anchor bolts and anchorage items as required, and field check to ensure proper alignment and location.
- H. The Field Engineer shall supervise placement and check embedded items for correctness of location and detail before concrete is placed.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00806: IDENTIFICATION SYSTEMS**PART 1 - GENERAL****1.1 DESCRIPTION**

The Work specified in this section includes furnishing and installing:

1. Conduit markers every 8 M (25 FT) in each space for all conduit.
2. Cable and conductor tags at each end and box for all cable and conductors.
3. Equipment nameplates for all mechanical and electrical equipment and control devices.
4. Physical hazards, safety and warning markings and signs as required by ANSI, NEMA, NFPA, CAL/OSHA and other codes and regulations in the location of cranes, hazardous material, etc.
5. Identification and Information markings and signs.
6. Information and Identification signs required by the ADA Accessibility Guidelines for Buildings and Facilities.
7. Wiring diagrams, and inspection, calibration or maintenance records for equipment and control devices.

1.2 REFERENCES

- A. **ADA Americans** with Disabilities Act.
- B. **ANSI** ANSI A13.1 Scheme American National Standards.
- C. **APWA** American Public Works Association Uniform Color Code.
- D. **California Code of Regulations (California Administrative Code), Title 8** Industrial Relations, Division 1 - Department of Industrial Relations, Chapter 4 - Division of Industrial Safety.
- E. **CALTRANS** Standard Plans and Specifications.
- F. Federal Occupational Safety and Health Act (**OSHA**).
- G. **NEMA** Standards Publications.
- H. **NFPA** National Fire Codes.
- I. **UL No. 969** Marking and Labeling System.

1.3 SUBMITTALS

Pursuant to the provisions of Document 00810, Submittals, the Contractor shall submit:

1. Shop drawings, schedules and samples of proposed labels, markings and tags, including color coding system.
2. Graphic design of permanent signs and markers mentioned in this Specification Section that are not shown on the Drawings: including sizing of the signs, lettering details, materials, painting system, as applicable, and methods of mounting and erection.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Cable, conduit and equipment marking and labeling shall be color coded and sized in accordance with ANSI A13.1 and UL No. 969.
- B. Electrical conduit markers: Rigid plastic or fiber tags with block letters on white: minimum 40 mm (1.57 inches) diameter round or 30 mm (1.2 inches) square, punched for attachment using one-piece locking nylon ties.
- C. Equipment nameplates: Engraved 0.95 mm (20 gauge) metal with baked enamel or phenolic plastic, black background with white letters, drilled for screw mounting with round head screws. Nameplates shall include information on ratings and capacities.
- D. Wire and cable identification tags: Black Natvar 400 tubing with labels deeply embedded using Kingsley White Stamping Foil. Raychem thermofit marker; Alliance Industrial Products Company white plastic marker with black code marking; Marked Flxrite Shrinkdown HT-105 tubing; or Action Craft heat-shrinkable polyolefin marker.
- E. Housekeeping markings: Black and white striped or checkered tape in accordance with CAL/OSHA; minimum 50 mm (2 inches) wide.
- F. Physical hazard markings: Black and yellow striped or checkered tape in accordance with OSHA 1910.144; minimum 50 mm (2 inches) wide.
- G. Physical hazard signs: "DANGER," "CAUTION," AND "WARNING" signs in accordance with ANSI A13.1; size, lettering and color codes as appropriate.
- H. Fire equipment location markers: NFPA No. 10, Factory Mutual approved, 18 gage metal with mounting holes; single faced or double faced and flanged to protrude from wall, where required.

- I. Underground warning tapes: Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6-inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1,750 psi lengthwise and 1,500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. The tape color shall be as specified below and shall bear a continual printed inscription describing the specific utility.
 1. CAUTION - BURIED ELECTRIC LINE BELOW (Red Color)
 2. CAUTION - BURIED TELEPHONE (COMMUNICATION) LINE BELOW (Orange Color)
 3. CAUTION - BURIED WATER LINE BELOW (Blue Color)
 4. CAUTION - BURIED SEWER LINE BELOW (Green Color)
 5. CAUTION - BURIED GAS (OIL, FUEL, DANGEROUS MATERIALS) LINE BELOW (Yellow Color)

- J. **Signs:** Shall be shop finished. Lettering shall be done by professional sign painters.
 1. **Materials** shall resist weathering, fading and vandalism; baked enamel on metal unless otherwise specified.
 2. **Size of sign**, and lettering type and size appropriate to the message and in compliance with the ADA Accessibility Guidelines for Buildings and Facilities.
 3. **Character height:** Characters and numbers on signs shall be sized according to the viewing distance from which they are to be read. The minimum height is 75 mm (3 inches) measured using an upper case X. Lower case characters are permitted.
 4. **Character Proportion:** Letters and numbers on signs shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10.
 5. **Finish and Contrast:** Characters and background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast with their background, either light characters on a dark background or dark characters on a light background.

- K. Color code for signage in accordance with ANSI A13.1 and Federal OSHA 1910.
 - 1. **Danger:** White letters on red field with black background.
 - 2. **Informational:** White letters on blue field.
 - 3. **Safety:** White letters on green field.
 - 4. **Caution:** Yellow letters on black field.
- L. Enclosures for charts, diagrams and records: heavy gage, clear vinyl frames suitable for permanent attachment outdoors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Signs shall be installed to provide optimum visibility and in compliance with the ADA Accessibility Guidelines for Buildings and Facilities. Exact locations to be determined in the field and as directed by Engineer.
- B. Provide posts and frames and mounting hardware.
- C. Install labels, markers, signs and tags as required by other Specification sections, NEMA, NFPA, and Federal OSHA 1910.
- D. Install cable and conductor identification tags on circuit conductors at each terminal.
- E. Identify all electrical cable terminations in pullboxes and all other locations specified under this Contract.
- F. Identify all new underground or existing conduits, ducts, piping and sewer lines, installed or exposed under this Contract, with underground warning tape. The tape shall be installed directly above each backfilled utility pipe, at a depth of 305 mm (1') below finished grade unless otherwise directed by the Engineer.

END OF DOCUMENT

DOCUMENT 00807: CONSTRUCTION & DEMOLITION DEBRIS COORDINATION

PART 1 - GENERAL

Contractor shall comply with City policies, requirements and guidelines, as set out below and as they may be amended, concerning waste management related to the Project and the disposal and recycling of construction waste and debris.

1.1 DESCRIPTION

This Section includes the:

1. Requirements for the recovery, re-use, and recycling of demolition and salvage material. The Work of this Contract shall provide for a minimum of 75% of the materials generated in the Work to be diverted from landfill disposal through a combination of deconstruction, salvage for reuse and recycling.
2. Requirements for ensuring compliance with San Francisco Environment Code, Chapter 7, Resource Efficiency Requirements and Green Building Standards.
3. Requirements for ensuring compliance with San Francisco Environment Code, Chapter 5, The Resource Conservation Ordinance for City Departments.
4. Requirements for ensuring the most environmentally conscious Work feasible within the limits of the contract time, contract sum, and available materials, equipment, and products.
5. Requirement of the Contractor to fulfill the City's and State's goal to achieve a minimum of 50 % diversion, enacted by Assembly Bill AB 939.
6. Stipulation that there will not be a separate payment for Work within this Section of the Specifications. All costs arising out of this section shall be incidental to other Work and be included in the overall Contract Price.

1.2 REFERENCES

- A. Mayor's Executive Directive 06-05, Recycling and Resource Conservation, October 16, 2006.
- B. San Francisco Ordinance No. 27-06 (Construction and Demolition Debris Recovery Ordinance) with effective date on July 1, 2006.

- C. San Francisco Environment Code, Chapter 5, Resource Conservation Ordinance.
- D. San Francisco Environment Code, Chapter 7, Construction and Demolition Debris Management.
- E. California Integrated Waste Management Act of 1989 (California Public Resources Code 40000 et. seq.) - Assembly Bill 939.
- F. Leadership in Energy and Environmental Design (LEED) for New Construction, Version 2.2, October 2005, US Green Building Council.
- G. Universal Waste information from the following website:
<http://www.ciwmb.ca.gov/HHW/Uwaste/>
- H. Treated Wood Waste Fact Sheet from the following website:
http://www.dtsc.ca.gov/HazardousWaste/Treated_Wood_Waste.cfm.
- I. San Francisco Board of Supervisors Resolution Nos. 530-04 and 679-02 establishing 75% diversion goal.
- J. Food Service Waste Reduction Ordinance as set forth in San Francisco Environment Code Chapter 16.
- K. Refuse Collection and Disposal Ordinance, adopted November 8, 1932.
- L. "Construction & Demolition Recycling Companies Directory", published by SF Department of the Environment.

1.3 DEFINITIONS

The following defined terms shall be used in the interpretation of the Contract in addition to those terms set out in Section 1.1 of the General Conditions (Document 00700).

1. **Class 3 Landfill:** A landfill that accepts non-hazardous waste such as household, commercial, and industrial waste resulting from construction, remodeling, repair, and demolition operations. A Class 3 Landfill must have a solid waste facilities permit from the California Integrated Waste Management Board (CIWMB) and be regulated by the Local Enforcement Agency (LEA).
2. **Construction and Demolition Waste ("C&D"):** Non-hazardous solid resources resulting from Contractor's construction, remodeling, repair, and demolition operations for the Project. This term includes, but is not limited to, asphalt, concrete, Portland cement concrete, brick, lumber, gypsum wallboard, cardboard and other associated packaging, roofing material, ceramic tile, carpeting, plastic pipe, and steel. The debris may be commingled

with rock, soil, tree stumps and other vegetative matter resulting from land clearing and landscaping or land development projects.

3. **C&D Recycling Facility:** A facility that receives only C&D material that has been separated for reuse or recycling prior to receipt, in which the residual (disposed) amount of waste in the material is less than 10% of the amount separated for reuse or recycling by weight.
4. **Disposal:** Acceptance of solid waste at a legally operating facility for the purpose of land filling. This includes Class 3 Landfills and Inert Fills. State regulations do not consider the disposal of inert materials at Inert Fills or Inert Backfill Sites to be recycling.
5. **Electronic Waste:** Radio equipment, computers, related hardware, wiring, connectors, insulation, transformers, repeaters, transmitters, receivers, radio handsets, radio vehicle sets, and other electronic devices that serve the SFMTA's existing radio communications system that are to be removed by Contractor as part of the Project.
6. **Environmental Pollution and Damage:** The presence of chemical and biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humanity; or degrade the utility of the environment for aesthetic, cultural or historical purposes.
7. **Hazardous Waste:** Hazardous waste is a waste with properties that make it potentially dangerous or harmful to human health or the environment. The universe of hazardous wastes is large and diverse. Hazardous wastes can be liquids, solids, or contained gases. They can be the by-products of manufacturing processes, discarded used materials, or discarded unused commercial products, such as cleaning fluids (solvents) or pesticides. In regulatory terms, a hazardous waste is a waste that appears on one of the four RCRA1 hazardous wastes lists (the F-list, K-list, P-list, or U-list) or that exhibits one of the four characteristics of a hazardous waste - ignitability, corrosivity, reactivity, or toxicity. However, materials can be hazardous wastes even if they are not specifically listed or don't exhibit any characteristic of a hazardous waste. For example, "used oil", products which contain materials on California's M-list, materials regulated pursuant to the mixture or

derived-from rules, and contaminated soil generated from a "clean up" can also be hazardous wastes.

8. **Highest and Best Use:** Highest and best use practices require performing both of the following: (a) Promote the following waste management practices in order of priority: (1) Source reduction. (2) Recycling and composting. (3) Environmentally safe transformation and environmentally safe land disposal, at the discretion of the city or county. (b) Maximize the use of all feasible source reduction, recycling, and composting options in order to reduce the amount of solid waste that must be disposed of by transformation and land disposal. For wastes that cannot feasibly be reduced at their source, recycled, or composted, the local agency may use environmentally safe transformation or environmentally safe land disposal, or both of those practices.
9. **Inert Fill Facility:** A facility that can legally accept inert waste such as asphalt and concrete exclusively for the purpose of disposal.
10. **Inert Solids/Inert Waste:** Non-liquid solid materials including, but not limited to, soil and concrete that do not contain hazardous waste or soluble pollutants at concentrations in excess of water-quality objectives, and do not contain significant quantities of decomposable solid materials. The water-quality objectives are those established by the Regional Water Quality Control Board pursuant to Division 7 (Section 13000 et seq.) of the California Water Code.
11. **Inert Backfill Site:** A location, other than inert fill or other disposal facility, to which inert materials are taken for the purpose of legally filling an excavation, shoring, erosion control, land filling for future development, or other soils engineering operation.
12. **Mixed Debris:** Commingled recyclable and non-recyclable materials generated at the Site.
13. **Mixed Debris Recycling Facility:** A solid resources processing facility that accepts commingled construction and demolition waste for the purpose of recovering reusable and recyclable materials and disposing of the non-recyclable residual materials. Depending on the types of materials accepted and operating procedures, a mixed debris recycling facility may or may not be required to have a Solid Waste Facilities permit from the CIWMB, or be regulated by the LEA.

14. **Recover or Recovery:** Any activity, including source reduction, deconstruction and salvaging, reuse, recycling and composting, which causes materials to be recovered for use as a resource and diverted from disposal.
15. **Recyclable Material:** Any material or product separated or capable of being separated at its point of discard or from the solid waste stream for utilization as a raw material in the manufacture of a new product.
16. **Recycling:** The process of sorting, cleansing, treating, and reconstituting materials for the purpose of using the altered form in the manufacture of a new product. Recycling does not include burning, incinerating, or thermally destroying solid waste.
17. **Recycling Facility:** An operation that can legally accept materials for processing materials into an altered form for the manufacture of a new product. Depending on the types of materials accepted and operating procedures, a recycling facility may or may not, be required to have a Solid Waste Facilities permit from the CIWMB, or be regulated by the LEA.
18. **Registered Transporter:** Anyone who is hired to remove mixed construction and demolition debris from a construction and/or demolition Site, who uses a vehicle with more than two axles or two tires per axle (such as a large pickup truck with four tires on the rear axle or three-axle dump trucks) and is hauling at least one (1) cubic yard of mixed construction and demolition debris, must be a Registered Transporter. The Registered Transporter must have applied for and received a registration from the San Francisco Department of the Environment. The Registered Transporter is obligated to take this mixed material only to a Registered Facility.
19. **Registered Facility:** Any facility that accepts mixed construction and demolition debris for processing and recycling must be registered with the City and must demonstrate an overall minimum recycling rate of 65% for mixed construction and demolition debris. A Registered Facility must have applied for and received a registration from the San Francisco Department of the Environment.
20. **Reuse:** Making new use of a material without altering its form.
21. **Salvage:** Recovering materials for on-Site reuse or for sale or donation to a third party.

22. **Source-Separated Materials:** Materials that are sorted at the Site of generation by individual material type for the purpose of reuse or recycling, e.g. demolished concrete that is separated at a Site for delivery to a base course recycling facility.
23. **Solid Waste:** Materials designated as non-recyclable and discarded for the purposes of disposal.
24. **Transfer Station:** A facility that can legally accept Solid Wastes for temporarily storing the materials for reloading onto other trucks and transporting to a landfill for disposal, or recovering some of the materials for reuse or recycling. Transfer stations have to be permitted by the CIWMB and be regulated by the LEA.
25. **Universal Waste:** (CCR Title 22, Division 4.5, Chapter 34) Hazardous wastes that are more common and pose a lower risk to people and the environment than other hazardous wastes. Universal wastes are handled with reduced management requirements. Examples of universal waste: batteries, fluorescent tubes (lamps), electronic devices (cell phones, computers, televisions), cathode ray tubes (CRTs), mercury wastes (thermometers and toys), and non-empty aerosol cans.

1.4 WASTE MANAGEMENT GOALS

- A. The Contractor shall generate the least amount of waste possible and employ processes that ensure generation of least waste possible due to error, poor planning, breakage, mishandling, contamination, and other factors. The Contractor shall also be mindful of the City's goal to achieve **a minimum of 75 % diversion waste materials from landfill**. The following waste materials, at a minimum, shall be diverted from landfill:
 1. Asphalt
 2. Concrete
 3. Stone, brick, soils and other inert materials
 4. Wood - Lumber and other wood products
 5. Paper and paper products
 6. Roofing, siding and ceiling materials
 7. Metals, ferrous and non-ferrous
 8. Beverage containers
 9. Electronic Equipment.

- B. Of the inevitable waste generated, the Contractor shall reuse, salvage, or recycle as many of the waste materials as economically feasible. The Contractor shall:
1. Minimize waste disposal in landfills.
 2. Maximize use of Salvage Source-Separated and Mixed Debris Recycling facilities.
 3. When practical, conduct recycling at the Job Site.
 4. The Contractor shall protect the environment, both on-Site and off-Site, during demolition and construction operations.
 5. The Contractor shall prevent environmental pollution and damage.
 6. The Contractor shall affect optimum control of solid waste and recoverable resources generated in the Work.
 7. Contractor shall recycle or remove, store and preserve for resale Electronic Waste as shall be directed by the SFMTA to capture for the SFMTA's benefit to the maximum extent possible the resale, salvage, and scrap value of Electronic Waste.

1.5 SUBMITTALS

Pursuant to the provisions of Paragraph 3.11 of the General Conditions and Section 00810, Submittals, the Contractor shall submit to City the following:

A. Solid Waste Management Plan (SWMP):

1. Before commencement of Construction Work at any Job Site, the Contractor shall conduct a Reuse/Recycle Assessment. This assessment shall estimate the types and quantities of materials for the Project that are anticipated to be feasible for source separation for recycling or reuse, either on-Site or off-Site, and note the procedures intended for a recycling, reuse, and salvage program. The Contractor shall refer to the most recent issue of "Construction & Demolition Recycling Companies Directory," published by the SF Environment: (415) 355-3739, for a partial list of facilities that accept these materials for recycling, re-use or salvage.
2. Before commencement of Construction Work, the Engineer will schedule and attend a meeting with Contractor and representatives of the City's Solid Waste Management and Recycling Programs. At the meeting, the Contractor shall discuss his/hers proposed solid waste management plan for construction and demolition so as to develop a mutual understanding regarding the City's recycling and

reuse policies and goals and their potential application to this project.

3. Not more than twenty (20) working days after the meeting, the Contractor shall prepare and submit a written solid waste management plan for construction and/or demolition in a format prescribed by the City. The Solid Waste Management Plan shall include, but not be limited to, the following:
 - a. The Contractor's information and Project identification.
 - b. The names, locations, and permit or license, as applicable, of recycling and reuse facilities and solid waste disposal areas, that the Contractor plans to use for this project.
 - c. Procedures for the management of construction and/or demolition waste.
 - d. List the materials and estimated quantities to be recycled reused or disposed at a landfill.
 - e. Describe procedures for source separation for the materials listed in Paragraph 1.6 - Recycling Requirement of this Document.
 - f. Source Reduction: Describe any project practices for this project, which will reduce waste at the source, such as requiring vendors to deliver materials in reusable packaging.
 - g. On-Site Processing: Describe procedures in which materials are recycled and/or reused on-Site, such as grinding materials for use on-Site, or reuse of lumber for concrete frames, etc.
 - h. The results of the Reuse/Recycle Assessment.
 - i. Other requirements listed in this Section.
 - j. Revise and resubmit the solid waste management plan for construction and demolition, as required by the Engineer.
 - k. Tonnage calculations that demonstrate the Contractor will recycle, reuse or salvage 90% of the demolition materials generated. (See the separate engineering report on the total weight of the building structure and its contents.)
4. The City's review of the Contractor's construction and demolition solid waste management plan will not relieve Contractor of responsibility for compliance with applicable laws and regulations governing control and disposal of solid waste or other pollutants.

B. Monthly Disposal and Recycling Summary Report:

1. In a format prescribed by the City, quantifying the construction and demolition waste generated and recycled, reused or disposed of at Class 3 landfill, on a monthly basis.). The Contractor shall include manifests; weight tickets, receipts, certificates of destruction/recycling, and invoices specifically identifying the Project and waste material from/to:
 - a. Source Separated Recycling Facilities.
 - b. Mixed Debris Recycling Facilities.
 - c. Class 3 Landfills.
 - d. Inert materials accepted at Class 3 Landfills as daily cover.
 - e. Inert Fill Facilities sites.
 - f. Inert Backfill sites other than Inert Fill Facilities.
2. All Hazardous and Universal Wastes shall be documented separately, and a summary of all manifests, including material description and weights, shall be provided to the Engineer.
3. This report is a condition of progress payment and failure to submit this information shall render the Application for Payment incomplete.
4. The Contractor shall submit the monthly Solid Waste Management Plan Report and the SWMP to the Engineer. The Contractor shall also send a copy of this report and the SWMP to:

City Government Recycling Coordinator

City and County of San Francisco
SF Department of the Environment
11 Grove Street
San Francisco, Ca 94102
(415) 355-3767

1.6 RECYCLING REQUIREMENTS

1. Asphalt
2. Concrete, concrete block, slump stone (decorative concrete block), and rock
3. Soil.
4. Bricks, stone(s), granite, and other finished stone-type material
5. Wall board (gypsum sheetrock)
6. Dimensional lumber, beam(s), and plywood

7. Fixtures, hardware, doors, and windows
 8. Ferrous and non-ferrous metal
 9. Corrugated cardboard
 10. Trees, cleared vegetation and cut-off or other unpainted and untreated wood scraps
 11. Carpet
 12. Electronic Waste.
- A. **Mixed Debris:** The Contractor shall develop and implement procedures for transporting commingled construction and demolition waste that cannot be feasibly source-separated for acceptance by a Mixed Debris Recycling Facility, which can meet the recycling and reporting requirements requested by the City.
- B. **Salvage and Reuse Practices:** The Contractor shall conduct a Reuse/Recycle Assessment to:
1. Identify materials that are feasible for salvage (i.e., sale as scrap).
 2. Identify materials that are suitable for preservation, storage and resale.
 3. Provide sufficient time in the schedule for implementation of the salvage component.
 4. Determine the requirements for handing and transporting to a salvage facility.
- C. **Salvage and Resource Reduction:** Describe in the SWMP, any project practices for this Project, which will reduce waste at the source, such as requiring vendors to deliver materials in reusable packaging.
- D. **On-Site Processing:** Describe in the SWMP, procedures in which materials are recycled and/or reused on-Site, such as grinding materials for use on-Site or reuse of lumber for concrete frames.

1.7 HANDLING:

1. The Contractor shall assure that materials to be recycled are free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process. The Contractor shall clean materials that are contaminated before placing it in collection containers.
2. The Contractor shall arrange for collection by or delivery to the appropriate recycling center or mixed construction and demolition (C & D) debris processing facility that accepts construction and demolition waste for purpose of recycling.

1.8 HAULING

Only Registered Transporters can remove mixed construction and demolition debris from the construction Site, and they must take this material to a Registered Facility. Materials source separated at the Site should be taken to the appropriate recycling facility. For a list of registered facilities and registered transporters refer to the website:

www.SFEnvironment.org/c&d.

1.9 DISPOSAL

- A. The Contractor shall legally transport and dispose of materials at a Transfer Station or Disposal facility that cannot be delivered to a Source-Separated or Mixed Debris Recycling Facility.
- B. The Contractor shall not burn, bury, or otherwise dispose of solid waste on or off Site except as provided in this Article.
- C. The Contractor shall participate in Re-Use Programs: For such Re-use Programs, the Contractor shall refer to the "Construction and Demolition Recycling Companies Directory", published by the San Francisco Solid Waste Management Program.

1.10 UNIVERSAL WASTES:

Contractor shall handle and dispose "Universal Wastes" in accordance with the requirements of the California Department of Toxic Substances Control (DTSC). Refer to DTSC website: www.dtsc.ca.gov. In general, universal waste may not be discarded in solid waste landfills. Contractor shall comply with all hazardous waste regulations, including, but not limited to, the following:

- A. Universal wastes shall be stored in containers so that they do not spill, leak, break, or are released into the environment.
- B. Label or mark universal wastes, or their containers, to identify their types.
- C. Send all universal waste to a facility authorized to collect, recycle or dispose of universal waste.
- D. Do not dispose of universal waste in the trash.
- E. Do not accumulate more than 5,000 kilograms of universal waste at any one time.
- F. Train employees in proper universal waste management including handling, packaging, storing and labeling the universal waste, as well as how to respond to releases. This training may be accomplished by simply giving employees written instructions about universal waste.
- G. Keep record of all shipments and receipts of universal waste for three years.

1.11 TREATED WOOD WASTE

For complete information on handling and disposal of Treated Wood Waste (TWW), refer to the fact sheet available from the DTSC website. For incidental TWW wastes generated during construction, the Contractor shall comply with the following minimum requirements:

1. Keeping TWW segregated from other materials.
2. Storing no more than 1,000 pounds of TWW for no longer than 30 days. In the event that Contractor stores more than 1,000 pounds of TWW or stores TWW for more than 30 days, Contractor shall comply with additional requirements for routine generators of TWW. Refer to DTSC fact sheet.
3. Labeling all TWW bundle/shipments with the following information:

<p><i>TREATED WOOD WASTE – Do not burn or scavenge.</i></p> <p><i>TWW Handler</i> <i>Name:</i> _____ <i>Address:</i> _____ <i>Accumulation Date:</i> _____</p>

4. Taking TWW to an authorized TWW facility. See the listings at the end of the factsheet for information on facilities who have been authorized to accept TWW in California.

1.12 WASTE REDUCTION

Contractor shall implement waste reduction measures, including, but not limited to, the following:

1. Eliminating the procurement of unneeded supplies;
2. Reduce waste by printing and copying double-sided;
3. Submit all submittals, reports, and forms in electronic format (PDF);
4. Fully participate in available and required recycling and composting programs; and
5. Purchase products made with recycled content such as paper and recycled aggregate.

1.13 JOB SITE ADMINISTRATION

- A. The Contractor shall review the environmental goals of the Project with all subcontractors and sub-subcontractors. The Contractor shall make a proactive effort to increase awareness of these goals among the Contractor's Personnel.
- B. The Contractor shall review MSDS sheets with Contractor's Personnel on the Site. The Contractor shall discuss alternatives to minimize exposure to potentially harmful substances.
- C. The Contractor shall provide recycling containers for field office wastes to separate recyclable and compostable materials from normal garbage using the City's blue, green, and black recycling system. Refer to www.sunsetscavenger.com/recycling-information.htm for more information.

1.14 PAYMENT

There will not be a separate payment for Work within this Section of the Specifications. All costs shall be incidental to other Work under the Contract and be shall included in the overall Contract Price.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00807 - A: C & D DEBRIS RECOVERY WORKSHEET

To be filled out by Contractor and submitted to City Representative.

Please complete both pages of this form.

Section 1: Project Information			
1. Project Name:		2. Project/Job Number:	3. Reporting Period:
4. Project Street Address:		5. City (if not in SF):	
6. Contractor Name			
7. Contractor Address			
8. City, State, Zip Code			
9. Office Phone:	10. Cell Phone:	11. Fax:	12. e-mail:
13. Preparer's Name:			14. Date Submitted
15. Preparer's Signature:			16. Date:

Original Management Plan*

Estimated Start Date: _____

Estimated End Date: _____

Progress Payment Report

Reporting Period (mm/yy): _____

Progress Payment No.: _____

Final Report

Date Project Completed: _____

City Representative Review:

City Representative Signature:	Date:
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Instructions for Completion of Section 2 - Debris Recovery Worksheet:

(Refer to Document 0821 for all definitions)

1. **Enter** the appropriate **Diversion Activity Code** associated with the kind of material being handled and how the material is being processed.
2. **Enter Total Tons** of material for each type of material being processed.
3. **Enter Tons Recycled** for each type of material being processed.
4. **Enter Tons Reused** for each type of material being processed.
5. **Enter Tons** diverted as **Mixed Debris**. Mixed Debris is defined as construction debris that has not been separated by material type at the Site.
6. **Enter name of facility** where material will be taken. If project is located in San Francisco, Mixed Debris must be taken to a Registered Facility authorized to process the material.
7. **Enter name of Transporter** hauling the material. If project is located in San Francisco, only Registered Transporters are authorized to haul Mixed Debris.
8. **Calculate Diversion Rate** at bottom of worksheet per formula.
9. **Submit** completed form to City Representative.

Project/Job Number: _____	Reporting Period: _____	Progress Pmt. Number: _____
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Section 2: Debris Recovery Worksheet

IMPORTANT: HAZARDOUS MATERIAL OR U-WASTE MUST BE SUMMARIZED SEPARATELY FROM THIS REPORT. DO NOT INCLUDE ANY HAZARDOUS MATERIALS AND UNIVERSAL WASTE IN THIS REPORT.

Diversion Activity Codes:

- | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> 1. Recycling of source-separated materials at a recycling facility. 2. On-Site concrete or asphalt crushing for use on Site. 3. Recycling of mixed C&D debris. | <ol style="list-style-type: none"> 4. Reuse of salvageable items. 5. Reuse of soil or dirt on Site. 6. Reuse of dirt or mixed inerts for landfill construction. 7. Other diversion - please describe: |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Worksheet:

Type of Material	Diversion	Total Tons	Tons Recycled	Tons Reused	Tons Diverted As Mixed Debris	Facility Used*	Transporter*
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
MIXED C & D DEBRIS*		A					
Source Separated Materials							
Asphalt							
Acoustical Ceiling Tiles							
Bricks, Granite, Finished Stone							

Type of Material	Diversion	Total Tons	Tons Recycled	Tons Reused	Tons Diverted As Mixed Debris	Facility Used*	Transporter*
Carpet & Padding							
Concrete							
Corrugated Cardboard							
Dimensional Lumber & Beams							
Fixtures, Hardware, Doors, Windows							
Metal							
Mixed Inerts							
Rigid Plastic							
Soil/Dirt/Rock							
Trees, Landscape Debris, Wood Scraps							
Wallboard, Gypsum Sheet Rock							
Other:							
Sub-Totals		B	C	D			
Total (E = A + B)		E					
Diversion Rate Calculation: $[C+D+(A \times 0.65)] \div E \times 100$					* If a project is located in San Francisco, Mixed C&D Debris must be taken to a Registered Facility authorized to process the material, and it must be hauled by a Registered Transporter (lists available at www.sfenvironment.org/c&d).		
Diversion Rate =	%	(h)					

DOCUMENT 00808: PROJECT MEETINGS**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies the criteria and procedures for the preconstruction meetings, the weekly and monthly Project progress meetings, and City Build/First Source meetings.
- B. The Engineer shall schedule, chair, and attend meetings with the Contractor, and shall decide the time and location of each meeting. The Engineer will prepare the minutes of the meeting when in his or her opinion, such minutes will be useful. The Contractor shall submit any exceptions to the minutes of a meeting in writing within five (5) Days of receiving the minutes.

1.2 ATTENDANCE AT MEETINGS

- A. The Contractor shall attend all meetings. Meetings may include a pre-construction meeting, monthly schedule review meetings, progress meetings, and periodic meetings with residents and property owners of an area impacted by the construction.
- B. The preconstruction meeting and the weekly progress meetings shall be attended by the Contractor's Construction Manager, the Contractor's Field Engineer, the Contractor Quality Control System Manager, the Contractor's Health/Safety Officer, the Contractor's Project Scheduler, subcontractors and suppliers as requested by the Contractor or the Engineer, and by others as invited by the Engineer. In addition, the preconstruction meeting may be attended by representatives from the City Build Program and from SFMTA's Office of Contract Compliance.
- C. Representatives of the Contractor, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity that they represent.

1.3 PRE-CONSTRUCTION MEETING

- A. The pre-construction meeting will be held prior to the commencement of field Work, but no later than ten (10) Days after the Construction Phase Notice to Proceed.
- B. Probable Agenda:
 - 1. Distribution and discussion of the construction schedule
 - 2. Critical Work sequencing
 - 3. Major long lead items, equipment deliveries and priorities

4. Project coordination and designation of responsible Personnel:
5. Roles and Responsibilities of each key staff member of the Contractor and City counterparts. Communication protocol.
6. Coordination with SFMTA, other City departments, and others.
7. Field Engineering.
8. Emergency Response.
9. Procedures and processing of:
 10. Submittals
 11. Requests for Changes and Substitutions
 12. Requests for Information
 13. Field instructions
 14. Proposed Contract Changes
 15. Contract modification
 16. Disputes
 17. Public complaints.
 18. Construction facilities and temporary controls
 19. Environmental controls
 20. Health and Safety
 21. Hazardous Waste Management
 22. Solid Waste Management
 23. Quality Control Program/Plan
 24. Coordination with the Special Inspector(s)
 25. Project Record Documents
 26. Compliance with ADA regulations – barriers, ramps, etc
 27. Traffic Regulation
 28. Contract Compliance, SBE document submittals
 29. City Build Program.

1.4 WEEKLY DESIGN PROGRESS MEETINGS

- A. Location of meetings: the Local office.
- B. Attendance:
 - 1. Project Manager, Design Manager, Construction Manager, and other Key Personnel and staff as appropriate per Project Phase.
 - 2. Contractor Quality Control System Manager as appropriate.
 - 3. Project Scheduler as appropriate.
 - 4. Others required for coordination of the Work as appropriate.
- C. Probable agenda:
 - 1. Review and approval of minutes of previous meeting
 - 2. Review Contractor submittal register; expedite as required
 - 3. Review Contractor record of pending Requests for Information; expedite as required.
 - 4. Review Design progress
 - 5. Review proposed changes to Contract Documents, including but not limited to changes in specifications, design criteria, design, Contract Sum and Contract Time
 - 6. Review Contractor record of pending Requests for Changes and Substitutions; expedite as required
 - 7. Review Contractor record of pending Submittals; expedite as required
 - 8. Review Contractor record of pending Proposed Contract Changes and Contract Modifications
 - 9. Review Contractor record of Notices of Delay, Notices of Potential Claims
 - 10. Review of Work progress and adherence to weekly plans since previous meeting; expedite as required
 - 11. Problems that impede the construction schedule; correct as required
 - 12. Review above changes for effect on Baseline and Current Schedules
 - 13. Schedules and corrective measures and procedures to regain schedule
 - 14. Schedule during succeeding Work period
 - 15. Field observations, problems, and conflicts

16. Coordination with SFMTA and others
17. Quality control and proposed corrective actions
18. Agenda for next meeting
19. Other business.

1.5 WEEKLY CONSTRUCTION PROGRESS MEETINGS

- A. Location of meetings: the Local office.
- B. Attendance:
 1. Contractor's Construction Manager, Field Engineer, Design Manager, and other Key Personnel and staff as appropriate per Project Phase
 2. Subcontractors and suppliers, as appropriate
 3. Traffic Control Supervisor, as appropriate
 4. Contractor Quality Control System Manager as appropriate
 5. Project Scheduler as appropriate
 6. Health/Safety Officer
 7. Others required for coordination of the Work.
- C. Probable agenda:
 1. Review and approval of minutes of previous meeting
 2. Review Contractor submittal register; expedite as required
 3. Review off-Site fabrication and delivery schedules; expedite as required
 4. Review Contractor record of pending Requests for Information; expedite as required
 5. Review proposed changes to Contract Documents, including but not limited to changes in specifications, design criteria, design, Contract Sum and Contract Time
 6. Review Contractor record of pending Requests for Changes and Substitutions; expedite as required
 7. Review Contractor record of pending Submittals; expedite as required
 8. Review Contractor record of pending Proposed Contract Changes and Contract Modifications
 9. Review Contractor record of Notices of Delay, Notices of Potential Claims

10. Review of Work progress and adherence to weekly plans since previous meeting; expedite as required
11. Problems that impede the construction schedule; correct as required
12. Review above changes for effect on Baseline and Current Schedules
13. Schedules and corrective measures and procedures to regain schedule
14. Schedule during succeeding Work period
15. Field observations, problems, and conflicts
16. Coordination with SFMTA and others
17. Cooperation with public
18. Field engineering
19. Safety, security, and traffic regulation
20. Quality control, testing, defective Work, punch list and proposed corrective actions
21. Agenda for next meeting
22. Other business.

1.6 MONTHLY SCHEDULE PROGRESS REVIEW MEETINGS

Monthly Schedule Progress Review Meetings are to be held separately from the Weekly Progress Meetings to review the latest Current Schedule and any impacts to the Schedule. These meetings are to be held no later than five (5) Days prior to Contractor's submission of requests for monthly progress payments. The Contractor's Construction Manager and Project Scheduler must be present at these meetings. Also see Document 00833.

1.7 MONTHLY CITY BUILD PROGRAM MEETINGS

Monthly City Build Meetings will be attended by the Contractor's Construction Manager, the Engineer, representative(s) from SFMTA's Office of Contract Compliance, and representative(s) from the designated Community Based (Job Training) Organization (CBO). The purpose of these meetings will be to discuss/evaluate the Contractor's progress and its good faith efforts towards achieving the hiring goals of the City Build/First Source Program, to review the CBO's "Apprenticeship Log Book," and to notify the CBO of future apprenticeship trade position opportunities for the Contract.

1.8 MONTHLY COORDINATION AND PROGRESS MEETINGS ON TESTING AND START-UP

Not later than one-hundred twenty (120) Days prior to the commencement of the Testing/Start-Up Phase, the Contractor's Construction Manager, Contractor's Quality Control System Manager, the Engineer, the City's independent Quality Assurance Team, representatives from SFMTA's Office of Health/Safety, representatives from the SFMTAMUNI Operations and Maintenance, and others as required shall begin meeting at a minimum of once each month to plan, coordinate, and evaluate the Testing and Start-Up Program for the Contract. The Engineer may request additional meetings during the Testing and Start Up Program. Also see Documents 00817 and 00824.

1.9 OTHER MEETINGS AS NEEDED

Contractor shall also be required to attend and to respond to other required meetings listed in the Specifications, including Quality Control or Pre-installation meetings and conferences, meeting with various governing jurisdictions/agencies, meetings with neighbors etc.

Note: Unless approved by the Engineer after having been submitted in accordance with Document 00810, the informational/materials distributed by the Contractor at any meeting, even if discussed in the meeting or referenced in the meeting minutes, shall not be construed as to having been accepted, concurred as correct or as having been approved by the City. These informational/material may include, for example, the look-ahead schedules, in-progress submittal logs, change order/modification logs, RFI logs, etc.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00809: PAYMENT AND ALLOWANCES**PART I GENERAL****1.1 DESCRIPTION**

Payments for the Work performed under this Contract will be made in the manner described in this Section and in Document 00530 Part 1—Milestone Payment Schedule, all in accordance with the restrictions set out below and in Document 00700.

1.2 INSTRUCTIONS ON PAYMENT ITEMS

- A. The payment item descriptions in this Document are general only, the descriptions are not comprehensive. Work described in the RFAP and necessary to meet the requirements of Design Criteria Package (Document 00900), but inadvertently omitted from these descriptions or from the cost breakdown shown in Document 00530 Part 2, shall be included as Incidental Work related to the appropriate listed Milestone, and separate payment shall not be made for Work so omitted. The Work, including sequencing requirements, specified in the General Conditions (00700), Supplementary Conditions (00800), and Design Criteria Package (Document 00900) and required by applicable laws, regulations, standards and permits and all costs in connection therewith shall also be included as Incidental Work.
- B. The phase descriptions and the payment item numbers identified in this Section correspond to those listed in the Milestone Payment Schedule of Document 00530 Part 1. The payment schedule for options will be mutually agreed upon prior to the exercise of an Option.
- C. Where the Milestone Payment Schedule specifies the method of payment to be on a Lump Sum (LS) basis, the City will base the payments on its estimate of the Work satisfactorily completed (Conditionally Accepted) in accordance with the Contract Documents and Lump Sum costs listed in Document 00530 Part 1, Milestone Payment Schedule.
- D. Where the Milestone Payment Schedule specifies the method of payment to be on a Unit Price basis, the City will base the unit price payments on the satisfactorily completed (Conditionally Accepted by SFMTA) measured units and unit costs listed in Document 00530 Part 1, Milestone Payment Schedule. Unit prices per unit shall not change with a change in the quantity for Mobile Equipment, Spare Parts, Options that include unit costs exercised within the option period.
- E. Equipment Installation shall be paid by unit price or by Lump Sum (LS), or Milestone basis as set out in Document 00530 Part 1, Milestone Payment Schedule.
- F. Where the Milestone Payment Schedule specifies the method of payment to be on a Milestone (MS) basis, the City will issue one single Milestone payment upon Contractor's

completion and the SFMTA's Conditional Acceptance of the Work specified for that Milestone, in accordance with the Contract Documents and in accordance with the Milestone payment amount listed in Document 00530 Part 1, Milestone Payment Schedule. Work to be compensated on a Milestone payment basis will not be compensated partially or incrementally or on a percentage of completion of Milestone basis, unless the Milestone has been specifically broken down into sub-Milestones where separate intermediate payment subitems denoted are clearly provided for in the Milestone Payment Schedule.

- G. The Milestone payment for procurement of the Stationary Equipment (Phase 4.2.4) shall be paid in accordance with sub payment milestones 4.2.4a, 4.2.4b, and 4.2.4c.

1.3 PAYMENT ITEM DESCRIPTIONS

A. PHASE 4.1 - DESIGN ENGINEERING SERVICES

Summary of scope of Phase 4.1: Design engineering services for the successful completion of Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) and all other related components as described in Design Criteria package (Document 00900) and in the Statement of Work.

MILESTONE PAYMENT ITEM 4.1.1a – Project Mobilization

Contractor's tasks and activities necessary to mobilization at the commencement of the Work that is chargeable to this payment item are listed below. The SFMTA will not make payment for this Milestone until all of the following tasks have been completed to Engineer's Satisfaction:

1. Submission of initial Baseline Schedule in accordance with Document 00833.
2. Submission of initial Contractor's Quality Control Program Plan of Document 00824.
3. Submission of initial Contractor's Preliminary Submittal Schedule as required in Document 00810.
4. Submission of initial Contractor's Project Management Plan, in accordance with Documents 00804, 00833 and Statement of Work, including the Design Management Plan in accordance with Document 00824.
5. Submission of bonds and insurance certificates
6. Conduct Contractor and/or SFMTA Safety Training.
7. Setting up Local Office.
8. Complete Project start-up meeting.

NOTE: The payment amount for this item as shown in Document 00530 Payment Milestone Schedule may or may not cover the actual or full costs of mobilization. If the payment amount under this item does not cover the actual or full costs for mobilization, then any remaining mobilization costs shall be deemed to be covered as overhead included in all other Milestones.

Payment under this item will be made on Milestone (MS) basis, when the specified Milestone as defined above has been completed.

MILESTONE PAYMENT ITEM 4.1.1b – Site Surveys

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for conducting thorough Site survey(s) and submitting report(s) for each lot of Sites as follows:

- 4.1.1b-1 Lot 1 - 10 sites (such as Radio Sites, Facilities, underground and vehicles)
- 4.1.1b-2 Lot 2 - 15 sites (such as Radio Sites, Facilities, underground and vehicles)
- 4.1.1b-3 Lot 3 - 25 sites (such as Radio Sites, Facilities, underground and vehicles)

Note: Payment will be made when quantity of site per lot is completed. Types of sites per lot may vary.

Site Survey Types:

RF Sites - 5

OCC - 2

Facility Yards - 8

Underground (Market Street / Sunset) - 12

Vehicle Type (All revenue and non-revenue survey as needed) Surveys – 23

MILESTONE PAYMENT ITEM 4.1.1c – Intermediate Design

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to bring the design to Intermediate (65%) level. The Work shall include, but is not limited to producing documents such as interface control, CDRL, construction drawings, plans, specifications, supporting the SFMTA in revising the existing FCC licenses to accommodate the design and all others as described in the Design Criteria Package (Document 0900) and Statement of Work.

MILESTONE PAYMENT ITEM 4.1.2a – Contractors' Final Design Submission

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to bring the design to Final (100%) level. The Work shall include, but is not limited to, submitting the finalized documents such as interface control, CDRL, construction drawings, specifications, plans, FCC licenses and all others as described in the Design Criteria package (Document 0900) and Statement of Work.

MILESTONE PAYMENT ITEM 4.1.2b – Final Approval Submission

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to bring the design to Final (100%) level and ready for construction. The Work shall include, but is not limited to, submitting the finalized, stamped

(professional engineer license sealed) documents such as interface control, CDRL, construction drawings, specifications, plans, FCC licenses and all others as described in the Design Criteria package (Document 0900) and Statement of Work.

4.2 - SYSTEM DEVELOPMENT, FACTORY TESTING, AND SITE CONSTRUCTION

Summary of scope of Phase 4.2: Development, customization, configuration, procurement of Stationary Equipment, and fabrication of materials for all equipment and software, and finalization of all test plans and procedures as described in the Design Criteria package (Document 0900) and Statement of Work. Phase 4.2 shall also include construction at all communications sites (above and below ground), installation of in-building transmission lines, component testing, device testing, module testing, and factory acceptance testing of all subsystems.

MILESTONE PAYMENT ITEM 4.2.1 – Integrated System Test Plan, Test Procedure and Cutover Plan

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete the development of the Integrated System Test Plan, Test Procedures, Cutover Plan, and Cutover Schedule.

MILESTONE PAYMENT ITEM 4.2.2 – Construction Above-Ground

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be for furnishing all labor, material, equipment, and Incidental Work required to successfully complete Site Construction as well as the maintenance facilities as described in the Design Criteria package (Document 0900) and Statement of Work for each lot of Sites as follows:

- 4.2.2a Complete Site Construction at Bernal Heights; Twin Peaks (CRS); Forest Hills; Potrero; Flynn.
- 4.2.2b Complete Site Construction at Cable Car Barn; Scott; Muni Metro East; Green; South Hill.
- 4.2.2c Complete Site Construction at Presidio; Woods; One Market Plaza.
- 4.2.2d Complete Legacy Equipment Removal, Disposal and Site Clean-up at Lenox Way, One Market Plaza, Bernal Heights, B of A at 555 California Street, Forest Hill, underground MUNI stations' equipment room, Maintenance facilities and vehicles.

Note: Sites identified in above lots are typical. Payment will be made when quantity of sites per lot is complete. Actual names of lots per site may vary.

MILESTONE PAYMENT ITEM 4.2.3 – Construction Below-Ground

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be for furnishing all labor, material, equipment, and Incidental

Work required to successfully complete construction of all below ground as described in the Design Criteria package (Document 0900) and Statement of Work as follows:

1. Furnish, install and test Coaxial Cable in all underground tunnels
2. Furnish, install and test all other underground equipment such as Grounding; AC Power; DC Power; UPS Backup Power to BDA's and Armored Fiber Optic Cable.

Payments will be made upon completion of work for each lot of sites as follows:

- 4.2.3a Embarcadero; Montgomery; Powell; Civic Center
- 4.2.3b Van Ness; Church; Castro; Eureka
- 4.2.3c Forest Hill; West Portal; East Portal; Carl Street Substation and complete testing of all of underground installations.

Note: Sites identified in above lots are typical. Payment will be made when quantity of sites per lot is complete. Actual names of lots per site may vary.

MILESTONE PAYMENT ITEM 4.2.4 –Procurement of Stationary Equipment.

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete delivery of the Stationary Equipment. Stationary Equipment includes, but not limited to the following:

1. 33 - Radio Control Console (see payment and cost schedule Document 530)
2. 47 – Full function CAD/AVL console, 66- CAD/AVL web client, 15 – control station with antenna (see Cost and Payment Schedule Document 00530).
3. Commercial Off-the-Shelf computer servers, network equipment, third party software and licenses, operating systems, and other utilities for functional MTMS and PSVRN systems. (see Cost and Payment Schedule Document 00530).
4. Network Switch Center and Backup Network Switch Center
5. 12 - Channel Bidirectional Amplifier
6. 24 – dual-band Remote Repeater Unit
7. 1- ISSI gateway
8. 9 - P25 Base Stations with battery system
9. 6 - OpenSky Base Stations with battery system
10. 1 - Logging Recorder with storage capability
11. 24 Stand Armored Fiber Cable
12. Antennas, Cables, Connectors and assembly kits.
13. DC power system for underground
14. DC power system for radio remote Site
15. UPS system for stations
16. 1455 Microwave hop (service, furnish, install, testing, training and warranty)
17. MTMS Wireless Bulk Data Transfer Equipment at each Vehicle Yards.
18. All equipment racks

The Milestone payment for procurement of the Stationary Equipment (Phase 4.2.4) shall be paid upon SFMTA acceptance of major system acceptance milestones across the project life cycle and as defined in the following Sub Milestones:

MILESTONE PAYMENT ITEM 4.2.4a – Factory Integration –

- (1) Delivery of Equipment no less than 95% complete to Staging Area. Equipment is physically assembled into rack; Individual Base-stations go through an alignment and verification. Frequencies are loaded. All Equipment is racked up and delivered to Staging Area
- (2) Completion of Staging per site. Switch is configured and personalities are loaded. Interrack wiring is completed. Racks are configured to mimic shelter / site layout. Site configurations are established, personalities settings of each base station are loaded. Successful completion of Integrated FAT test.

Note: Payments will be appropriately pro-rated if there are minor Equipment shortages (i.e., entire lump sum payments will not be withheld as a result of material shortages of less than 15 percent), balance of payment will be made upon delivery of shortages.

MILESTONE PAYMENT ITEM 4.2.4b- Equipment Delivery to SFMTA. Delivery of all Fixed End Equipment to SFMTA and stored at its designated bonded storage facility, fully insured, all at Contractor's cost with transfer of title of ownership to the SFMTA. Note: Payments will be appropriately pro-rated if there are minor Equipment shortages (i.e., entire lump sum payments will not be withheld as a result of material shortages of less than 15 percent), balance of payment will be made upon delivery of shortages.

MILESTONE PAYMENT ITEM 4.2.4c – Final payment for Stationary Equipment shall be made upon SFMTA's Conditional Acceptance of the mini-fleet performance test that verifies that the Stationary Equipment satisfies System functional (performance) requirements in an operational environment prior to SFMTA Beneficial Use.

MILESTONE PAYMENT ITEM 4.2.5 a– Radio System Factory Acceptance Test

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete Radio System Factory Acceptance Testing including all pre-requisite testing.

MILESTONE PAYMENT ITEM 4.2.5 b– BDA Tunnel Equipment Factory Acceptance Test

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete BDA Tunnel Equipment Factory Acceptance Testing including all pre-requisite testing.

MILESTONE PAYMENT ITEM 4.2.5 c– CAD/AVL System Factory Acceptance Test

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete CAD/AVL System Factory Acceptance Testing including all pre-requisite testing.

MILESTONE PAYMENT ITEM 4.2.5 d– Final Integrated Factory Acceptance Test

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete Final Integrated Factory Acceptance Testing including all pre-requisite testing.

4.3 - EQUIPMENT INSTALLATION, SYSTEM CONFIGURATION, AND TRAINING PROGRAM PLANNING

Summary of scope of Phase 4.3: Delivery, installation, configuration, and testing of all Stationary Equipment at the SFMTA and City sites. The Training Plan shall be finalized, including the Draft Training Schedule, Draft Training Manuals, and Draft Training Agendas.

MILESTONE PAYMENT ITEM 4.3.1 – Installation, Configuration and Functional Testing of All Stationary Equipment at all City Sites

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation made on a per lot basis for furnishing all labor, material, equipment, and Incidental Work required to successfully complete installation, configuration, and functional testing including all fix end interfaces of all Stationary Equipment at all City sites.

- 4.3.1a Microwave Link to CRS; Potrero; Flynn; Cable Car Barn; Scott; Green; Woods; Muni Metro East; Presidio
- 4.3.1b Forest Hill; CRS; Bernal Heights; One Market Plaza
- 4.3.1c Lenox Way; 1455 Market Street; CAD/AVL Equipment Install
- 4.3.1d South Hill; Underground Equipment Install - Headend Equipment, Wallmount BDA's, Station Antenna System Materials; Donor Antennas and Materials

Note: Sites identified in above lots are typical. Payment will be made when quantity of Sites per lot is complete. Actual names of lots per Site may vary.

MILESTONE PAYMENT ITEM 4.3.2 – Training Plan (Final)

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete the development of Training Plan (Final).

MILESTONE PAYMENT ITEM 4.3.3 – Training Schedule (Draft)

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment,

and Incidental Work required to successfully complete the development of Training Schedule (Draft)

MILESTONE PAYMENT ITEM 4.3.4 – Training manuals and Agendas (Draft)

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete the development of Training Manuals and Agendas (Draft)

4.4 - INTEGRATED SYSTEM TESTING

Summary of scope of Phase 4.4: Includes the remainder of integrated system testing, including but not limited to the Radio Coverage Acceptance Test, the Field Performance Test, and the Mini-Fleet Test as described in the Design Requirement Document 0900 for the Project. Phase 4.4 shall also include finalization of all training documentation as described in the Design Criteria package (Document 0900).

MILESTONE PAYMENT ITEM 4.4.1 – Radio Coverage Acceptance Test Report

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete Radio Coverage Acceptance Test with Reports submitted.

MILESTONE PAYMENT ITEM 4.4.2 – Field Performance Test Report

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete Field Performance Test with Reports submitted.

MILESTONE PAYMENT ITEM 4.4.3 – Mini Fleet Test Report

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete Mini-Fleet Test with Report submitted.

MILESTONE PAYMENT ITEM 4.4.4 – Training Schedule (Final)

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete the development of Training Schedule (Final).

MILESTONE PAYMENT ITEM 4.4.5 – Training Manual and Agendas (Final)

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete the development of Training manuals and agendas (Final).

MILESTONE PAYMENT ITEM 4.4.6 – Database Dictionary User Manuals

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete the development of Database Dictionary and User Manuals.

4.5 - TRAINING, SYSTEM CUTOVER, AND AVAILABILITY DEMONSTRATION

Summary of scope of Phase 4.5: Includes, but is not limited to, training of SFMTA staff, installation of Mobile Equipment on SFMTA's fleet of revenue and non-revenue vehicles, and distribution of portable equipment. Phase 4.5 shall also include delivery of all as-built versions of maintenance manuals and as-built system documentation. Phase 4.5 shall conclude with the System Availability Test and submittal of the test report.

MILESTONE PAYMENT ITEM 4.5.1 – Completion of the Training Program

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete the training program.

MILESTONE PAYMENT ITEM 4.5.2 – Installation of Mobile Equipment in all Revenue and Non-Revenue Vehicles

- **UNIT PRICE PAYMENT ITEM 4.5.2.A – Non-revenue Vehicle “Configuration A”**

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in non-revenue vehicles, “Configuration A” . The payment shall be made upon SFMTA having Beneficial Use of each non-revenue vehicle with newly installed equipment (see Document 00900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- **UNIT PRICE ITEM 4.5.2.b – Non-revenue Vehicle “Configuration B”**

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in non-revenue vehicles, “Configuration B”. The payment shall be made upon SFMTA having Beneficial Use of each non-revenue vehicle with newly installed Equipment (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- **UNIT PRICE ITEM 4.5.2.c – Non-revenue Vehicle “Configuration C”**

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in non-revenue vehicles, “Configuration C”. The payment shall be made upon

SFMTA having beneficial use of each non-revenue vehicle with newly installed equipment (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.d – Diesel Hybrid Electric, Orion, 30-foot

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in motor coaches of type: Diesel Hybrid Electric, Orion, 30-foot. The payment shall be made upon SFMTA having beneficial use of each Diesel Hybrid Electric, Orion, 30-foot with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.e – Diesel Hybrid Electric, Orion, 40-foot.

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in motor coaches of type: Diesel Hybrid Electric, Orion, 40-foot. The payment shall be made upon SFMTA having beneficial use of each Diesel Hybrid Electric, Orion, 40-foot with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.f– Diesel, NABI, 40-foot

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in motor coaches of type: Diesel, NABI, 40-foot. The payment shall be made upon SFMTA having beneficial use of each Diesel, NABI, 40-foot with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.g– Diesel, Neoplan, 40-foot

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in motor coaches of type: Diesel, Neoplan, 40-foot. The payment shall be made upon SFMTA having beneficial use of each Diesel, Neoplan, 40-foot with newly

installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.h – Diesel, Neoplan, 60-foot

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in motor coaches of type: Diesel, Neoplan, 60-foot. The payment shall be made upon SFMTA having beneficial use of each Diesel, Neoplan, 60-foot with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.i – Diesel, Gillig, 40-foot

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in motor coaches of type: Diesel, Gillig, 40-foot. The payment shall be made upon SFMTA having beneficial use of each Diesel, Gillig, 40-foot with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.j – Diesel, NewFlyer, 60-foot

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in motor coaches of type: Diesel, NewFlyer, 60-foot. The payment shall be made upon SFMTA having beneficial use of each Diesel, NewFlyer, 60-foot with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.k – Trolley, ETI, 40-foot

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in trolley coaches of type: Trolley, ETI, 40-foot. The payment shall be made

upon SFMTA having beneficial use of each Trolley, ETI, 40-foot with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.l – Trolley, ETI, 60-foot

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in trolley coaches of type: Trolley, ETI, 60-foot. The payment shall be made upon SFMTA having beneficial use of each Trolley, ETI, 60-foot with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.m – Trolley, NewFlyer, 60-foot

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in trolley coaches of type: NewFlyer, 60-foot. The payment shall be made upon SFMTA having beneficial use of each Trolley, NewFlyer, 60-foot with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.n and 4.5.2.o– Breda Light Rail Vehicles & Light Rail Vehicle Digital Visual and Announcement System

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment including DVAS in coaches of type: Breda Light Rail Vehicles. The payment shall be made upon SFMTA having beneficial use of each Breda Light Rail Vehicles with newly installed equipment including cubic farebox interface and Digital Visual and Announcement System (see Appendix 12, Section 3, Appendix 22, and Appendix 23).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.p– St. Louis Car, SEPTA PCC Style

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in historic street cars of type: St. Louis Car, SEPTA PCC Style. The payment shall be made upon SFMTA having beneficial use of each St. Louis Car, SEPTA PCC Style with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.g – Double-Ended PCC Style

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in historic street cars of type: Double-Ended PCC Style. The payment shall be made upon SFMTA having beneficial use of each Double-Ended PCC Style with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.r – Mini PCC 1 (1040) Style

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in historic street cars of type: Mini PCC 1 (1040) Style. The payment shall be made upon SFMTA having beneficial use of each Mini PCC 1 (1040) Style with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.s– St. Louis Car, NJT Newark PCC Style

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in historic street cars of type: St. Louis Car, NJT Newark PCC Style. The payment shall be made upon SFMTA having beneficial use of each St. Louis Car, NJT Newark PCC Style with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.t – Fiat/Breda, Milan PW Style

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in historic street cars of type: Fiat/Breda, Milan PW Style. The payment shall be made upon SFMTA having beneficial use of each Fiat/Breda, Milan PW Style with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

- UNIT PRICE ITEM 4.5.2.u – Vintage Style

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in historic street cars of type: Vintage Style. The payment shall be made upon SFMTA having beneficial use of each Vintage Style with newly installed equipment including cubic farebox interface (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed

- UNIT PRICE ITEM 4.5.2.v – Cable Cars, Powell Street Style

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in Cable Cars, Powell Street Style. The payment shall be made upon SFMTA having beneficial use of each Cable Car with newly installed equipment (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed

- UNIT PRICE ITEM 4.5.2.w – Cable Cars, California Street Style

The unit price payment item shall be full compensation for furnishing all labor; material, equipment, and Incidental Work required to supply, install, program and test Mobile Equipment in Cable Cars, California Street Style. The payment shall be made upon SFMTA having beneficial use of each Cable Car with newly installed equipment (see Document 0900, Appendix 12, Section 3.2).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed

- UNIT PRICE ITEM 4.5.2.x – Cubic Farebox Interface

The unit price payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, program, test Cubic Farebox

Interface to MTMS. The payment shall be made upon SFMTA having beneficial use of each vehicle (Revenue Vehicles, see Appendix 12, Section 3)

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity installed.

MILESTONE PAYMENT ITEM 4.5.3 - Configuration and Distribution of all Portable Equipment

- UNIT PRICE ITEM 4.5.3.a – Portable Tier I

The unit price payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, program, test Portable Tier I radios. The payment shall be made upon SFMTA having beneficial use of each Portable Tier I P25 compliant equipment for transit and PSVRN users, including antenna and battery (see Appendix 12 Section 2.7).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity delivered.

- UNIT PRICE ITEM 4.5.3.b – Portable Tier II

The unit price payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, program, test Portable Tier II radios. The payment shall be made upon SFMTA having beneficial use of each Portable Tier II P25 compliant equipment for transit and PSVRN users, including antenna and battery (see Appendix 12 Section 2.7).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity delivered.

- UNIT PRICE ITEM 4.5.3.c – Portable Tier III

The unit price payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, program, test Portable Tier III radios. The payment shall be made upon SFMTA having beneficial use of each Portable Tier III P25 compliant equipment for transit and PSVRN users, including antenna and battery (see Appendix 12 Section 2.7).

The total payment for this payment item shall not exceed the unit price multiplied by the actual quantity delivered.

MILESTONE PAYMENT ITEM 4.5.4 – All As-Built H/W Documentation, S/W Documentation and Maintenance Manuals

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete All As-Built H/W documentation, S/W documentation, and Maintenance Manuals.

MILESTONE PAYMENT ITEM 4.5.5 – Deliveries of All Program Source Code; Execution of the S/W Escrow Agreement

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully deliver all Program Source Code; execution of the S/W Escrow Agreement.

MILESTONE PAYMENT ITEM 4.5.6 – System Availability Test Report

The payment amount shown under Document 00530 Milestone Payment Schedule for this Milestone payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to successfully complete System Availability Test with Reports submitted.

LUMP SUM PAYMENT ITEM "W" - WARRANTY

The lump sum payment items shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to provide Two (2) years of Warranty Support for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with six (6) 800 MHz MTMS data/voice channels and nine (9) 700 MHz P-25 compliant PSVRN voice channels (See Document 00835 Warranty and Maintenance). SFMTA will make payments for warranty on a Lump Sum quarterly basis, for Work performed to SFMTA's satisfaction in accordance with the Terms of the Warranty. Payment shall be made no later than 30 Days after the commencement of the applicable quarter.

UNIT PRICE PAYMENT ITEM "S": SPARE PARTS

The unit price payment item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply spare parts as described in the 530 Payment and Cost Schedule.

A. Base System Spare Parts: Upon delivery and Conditional Acceptance by SFMTA, payment shall be based on Unit Price.

ALLOWANCE PAYMENT ITEM "A": ALLOWANCE

Allowance for use by the City to address unforeseen Site construction and fixed-equipment installation issues, unforeseen vehicle equipment installation issues, interface issues, reimbursable expenses, community relations, traffic control, travel and lodging for SFMTA employees to witness various off-Site tests or other services. Work shall be ordered in writing by the Engineer by means of a written Change Order. Contractor shall perform any extra work (Additional Work) or incur expenses for which it will seek reimbursement that have not been authorized by a written Change Order. The SFMTA shall have no obligation to pay for work that has not been properly authorized. Payment for Work authorized by a written Change Order shall be based on a combination of Lump Sum and Unit Price

See Sections 1.4 and 3.1 below for further descriptions on Allowances.

OPTIONSBID ITEM O1

The unit price bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test Over the Air Re-keying for portable radios (see Design Criteria Package, Document 0900, Appendix 12 Section 2.17)

BID ITEM O2

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test key management facility (KMF) server to support the over the air re-keying.

BID ITEM O3

The unit price bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test Encryption feature for the portable radios (see Design Criteria package (Document 0900) Appendix 12 Section 2.17)

BID ITEM O4

The unit price bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, and test Intrinsically Safe portable radio, Tier II (see Design Criteria package (Document 0900) Appendix 12 Section 2.17)

BID ITEM O5

The unit price bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test Automatic Passenger Counting System Interface in Design Criteria package (Document 0900 Appendix 12 Section 3.3)

BID ITEM O6

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test Track Layout and Turnaround Layer feature in Design Criteria package (Document 0900 see Appendix 12 Section 3.3)

BID ITEM O7

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test Headway Control feature (see Appendix 12 Section 3.3)

BID ITEM O8

The Milestone bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test "Crush-Load" Detection with Wheelchair Priority Pickup feature (see Appendix 12 Section 3.3)

BID ITEM O9

The unit price bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test Capture Vehicle Load Using Real-Time Automatic Passenger Count Input (see Appendix 12 Section 3.3)

BID ITEM O10

The unit price bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test Predictive Arrival and Departure Information System (see Appendix 12 Section 3.3)

BID ITEM O11

The unit price bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test Predictive Subsystem and Web Services API (see Appendix 12 Section 3.3)

BID ITEM O12

The unit price bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test Mobile Dispatch Computers (see Appendix 12 Section 3.3)

BID ITEM O13

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test MTMS Development Environment (see Appendix 12 Section 3.3)

BID ITEM O14

The unit price bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test Yard Management System for 995 vehicles (see Appendix 12 Section 3.3) at the following vehicle maintenance Facilities - Potrero, Muni Metro East, Presidio, Green, Woods, Flynn, and Islais Creek (planned)

BID ITEM O15

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to perform design, Site construction, and equipment installation at Lenox Way to establish a backup operation control center (OCC) for radio system. If the SFMTA exercises this Option 15, Contractor shall complete that Work within the Contract Time. Contractor is not required to complete the Work under this Option 15 within the period provided for Substantial Completion and shall not be subject to Liquidated Damages assessed for failure to complete that Option Work within said period. However, if Contractor fails to complete the Work under this Option 15 within the Contract Time, Contractor shall be subject to liquidated

damages for delay in the amount of Five Thousand Dollars (\$5,000) per Day of each Day of unexcused delay, as provided in Section 8.1.4 of the General Conditions.

BID ITEM O16

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to provide Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with six (6) 800 MHz MTMS data/voice channels and nine (9) 700 MHz P-25 compliant PSVRN voice channels. – Year 1 (See Document 00835 Warranty and Maintenance).

BID ITEM O17

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to provide Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with six (6) 800 MHz MTMS data/voice channels and nine (9) 700 MHz P-25 compliant PSVRN voice channels. – Year 2 (See Document 00835 Warranty and Maintenance).

BID ITEM O18

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to provide Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with six (6) 800 MHz MTMS data/voice channels and nine (9) 700 MHz P-25 compliant PSVRN voice channels. – Year 3 (See Document 00835 Warranty and Maintenance).

BID ITEM O19

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to provide Three (3) Year Extended Support Program for eight (8) additional P-25 compliant 700 MHz PSVRN voice channels. – Year 1 (See Document 00835 Warranty and Maintenance).

BID ITEM O20

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to provide Three (3) Year Extended Support Program for eight (8) additional P-25 compliant 700 MHz PSVRN voice channels. – Year 2 (See Document 00835 Warranty and Maintenance).

BID ITEM O21

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to provide Three (3) Year Extended Support Program for eight (8) additional P-25 compliant 700 MHz PSVRN voice channels. – Year 3 (See Document 00835 Warranty and Maintenance).

BID ITEM O22

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to provide Additional "Hindsight-P25/OpenSky Recorder Assistant" licenses for Exacom logging recorder for remote viewing of the recorder only.

BID ITEM O23

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to provide equipment to Upgrade from Exacom fault-tolerant to Exacom redundant logging recorder.

BID ITEM O24

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to provide feature on Logging Recorder to Enable Recording of encrypted calls on Exacom

BID ITEM O25

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test A turnkey NICE logging recorder installation with third party storage and server hardware.

BID ITEM O26

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test the installation of Islais Creek Facility Console and Bulk Data Transfer.

BID ITEM O27

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test the installation of Kirkland Facility Console and Bulk Data Transfer.

BID ITEM O28

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install and test radiating transmission line throughout the Stockton Tunnel

BID ITEM O29

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test radiating transmission line throughout the Yerba Buena Tunnel

BID ITEM O30

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test radiating transmission line throughout the Broadway Tunnel

BID ITEM O31

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test radiating transmission line throughout the MacArthur Tunnel

BID ITEM O32

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test bi-directional amplifier (BDA) for Cable Car Barn basement area.

BID ITEM O33a

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to design, supply, install, and test Traffic Signal Priority (TSP) pilot system for 6 Intersections, and a TSP management server by using a 5.9 GHz, DSRC radio.

BID ITEM O33b

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test TSP D4 protocol integration with the vehicle logic unit (VLU).

BID ITEM O33c

The unit price bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test TSP Onboard Equipment - Pilot Onboard Equipment

BID ITEM O34

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test to replace a 60 feet Tower at South Hill. The Work shall include, but is not limited to obtain permit, perform structural analysis, furnishing and installing the tower, cable installation, move and cutover all antennas on the existing tower to the new tower.

BID ITEM O35

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test 312 – strand armored fiber cable in the tunnel. All strands are to be tested and terminated at all station locations as well as fully tested and in water and dust tight splice cases. The item includes the installation of fiber and all other parts necessary for operation. This is additional cost compared to the 24 – strand armored fiber cable in the base.

BID ITEM O36

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, configure and test eight (8) additional 700 MHz P-25 compliant PSVRN channels at all Radio Sites as well as in all the underground rail tunnel, platform and storages tracks, and two (2) years of Warranty Support.

BID ITEM O37

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to remove the legacy equipment at McLaren Park.

BID ITEM O38

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test MTMS - Next Bus Interface, including, but is not limited to Provide an interface to the Nextbus Standard Product Application Programming Interface.

BID ITEM O39

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test MTMS - Transit Safe, including, but is not limited to development and testing of an interface with the existing TransitSafe system as described in Design Criteria package (Document 0900).

BID ITEM O40

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test MTMS - Translink, including, but is not limited to development and testing of an interface for Translink as described in Design Criteria package (Document 0900).

BID ITEM O41

Relocate three (3) dispatch workstation with integrated radio consoles from other locations (such as Cable Car Machinery, Command Coach and Potrero) to Lenox Way OCC without additional cost.

BID ITEM O42

The lump sum bid item shall be full compensation for furnishing all labor, material, equipment, and Incidental Work required to supply, install, and test the installation of bulk data transfer at Green south lot.

1.4 ALLOWANCES

This Section describes allowances and procedures for performing Allowance Work. Allowances provide payment for:

- a. Addressing unforeseen Site construction and fixed-equipment installation issues that have changed since the time of Proposal submittal.
- b. Addressing unforeseen vehicle equipment installation conditions for individual vehicle(s) of the same type
- c. Additional Work that may be required to relocate existing City facilities that were not included in the contract, and required to secure the Site or protect the workers as a result of a natural disaster, emergency or situation that is beyond the control of the Contractor.
- d. Other reimbursable expenses defined in the Contract.

A. Scope of Allowances:**1. Differing Site Conditions**

This allowance provides for costs of Work related to encountering different Site conditions from that observed during the pre-bid Site tours. Differing Site conditions are defined as surface, subsurface or latent physical Site conditions differing materially from those indicated in this Contract and unknown physical Site conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in Work of the character provided for in this Contract. Utility facilities, known or unknown, whether active or abandoned, are normal in this Work and are not considered a differing Site condition. The following shall apply:

- a. The Contractor shall promptly notify the Engineer of differing Site conditions upon discovery and before such conditions are disturbed, in the same manner as described in the General Conditions entitled "Notice of Delay".
- b. The Engineer shall promptly investigate the conditions. If the Engineer finds that a differing Site condition causes an increase or decrease in the Contractor's cost of, or the time required for the performance of the Work under this Contract, the Engineer will propose an equitable adjustment to the Contract.

- c. No claims of the Contractor for differing Site conditions shall be allowed unless the Contractor has given the notice above.

2. Unforeseen Vehicle Equipment Installation Conditions

This allowance provides for costs of Work related to encountering different conditions for individual vehicle(s) of the same type. Examples include missing or unusable components necessary for on-board equipment operation, including but limited to carbody wiring, speakers, or circuit breakers.

- a. The Contractor shall promptly notify the Engineer of differing Site conditions upon discovery and before such conditions are disturbed, in the same manner as described in the General Conditions entitled "Notice of Delay".
- b. The Engineer shall promptly investigate the conditions. If the Engineer finds that a differing vehicle condition causes an increase or decrease in the Contractor's cost of, or the time required for the performance of the Work under this Contract, the Engineer will propose an equitable adjustment to the Contract.
- c. To expedite this process, the City and Contractor may arrive at a known schedule of values to remedy commonly occurring vehicle conditions (e.g. speaker replacement).

3. Reimbursable Expenses

This allowance provides for reimbursement to the Contractor for payments as defined below:

- a. Utility Service Connection charges by utility companies to connect for permanent Facilities constructed under this contract.
- b. The City's share of partnering expenses
- c. Excavation, Removal and Disposal of Buried Tanks, Drums, and Other Buried Items. This allowance provides for the Work associated with the excavation, handling, transportation, and disposal of buried items not identified in the contract documents or reference documents.

4. Community Relations Support

This allowance provides for the Work associated with community relations support not identified in the contract documents.

5. Traffic Control

This allowance provides for Traffic Control by Off-Duty San Francisco Police Officers not identified in the Contract documents. Contractor will be reimbursed under this allowance for invoices received from the San Francisco Police Department for providing off-duty SF police officers. The Contractor shall be paid the actual invoice from the SFPD plus 5%.

6. SFMTA Services

This allowance provides for SFMTA Services not identified in the Contract documents.

7. Temporary Facilities

This allowance provides for temporary facilities not identified in the Contract documents.

8. Signage and Stripping

This allowance provides for signage and stripping not identified in the Contract Documents.

9. Specialty Services

This allowance provides for specialty services not identified in the Contract Documents.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

3.1 ALLOWANCES

Allowance Work shall be ordered in writing by the Engineer by means of a written Change Order. No extra Work shall be performed or expenses incurred that have not been authorized by a written change order. Work that has not been so authorized will not be paid for.

3.2 FORCE ACCOUNT

For additional Work, it shall be done on a Force Account basis as per Section 6.7 of the General Conditions. The type and amount of labor, material and equipment used must be agreed to in writing by both the Contractor and Engineer on each day the Work is performed.

3.3 REIMBURSABLE EXPENSES

- D. For reimbursable expenses, the City will reimburse the Contractor the actual direct cost thereof without any mark-up for profit, overhead, supervision or other such cost.
- E. The Contractor shall furnish detailed itemized cost receipts, records and complete documentation of such costs prior to requesting payment therefore.

END OF DOCUMENT

DOCUMENT 00810: SUBMITTALS**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The Work specified in this Section includes general requirements and procedures for preparing, reviewing, and transmitting data to the Engineer for information or appropriate action.
- B. No separate payment will be made for Work covered under this specification. The Work associated with this specification is considered incidental to the completion of the Work in which it pertains.

1.2 SUBMITTALS

- A. The Contractor shall submit Submittals Schedule, as specified in 1.7 herein.

1.3 GENERAL REQUIREMENTS

- A. Shop drawings, engineering calculations, product data, samples, test reports, manufacturer's instructions, and other data shall be provided as specified in this Section.
- B. All written information on shop drawings, product data and samples, and other data shall be in the English language, and all numerical data shall use SI customary units with the corresponding U.S. customary units in brackets or parentheses adjacent to the SI units or in separate tables or columns. The values stated in SI and U.S. units are to be regarded separately as standard.
- C. Clearly identify in the submittal, and attach a written explanation of, any and all deviations from the requirements of the Contract.
- D. Submittals for proposed alternative Work methods and/or materials cannot be reviewed until a Request for Substitution has been tentatively approved according to the procedure in Document 00816.
- E. Submittals shall not be used as a vehicle to request approval of substitutions of equipment and materials specified to be installed under the Contract. Requests for approval of substitute equipment and materials will only be considered pursuant to the procedure specified in Document 00816.
- F. Submittals shall be transmitted using forms furnished by the Engineer and filled out by the Contractor as directed by the Engineer.

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall provide separate submittals for each section of the Specifications, each system, and each major piece of equipment. Any submittal that includes items from more than one Specification section may be automatically rejected by the Engineer at his/her sole discretion. Contractor shall then be required to resubmit the submittal(s).
- B. Submittals shall show information supplementary to the Drawings and Specifications.
- C. The Contractor shall furnish all submittals and resubmittals to the Engineer in an orderly manner and avoid providing multiple submittals at the same time, which may hinder the Engineer's timely review. Submittals shall be provided sufficiently in advance to allow time for review, resubmittal and appropriate action prior to the beginning of Work, as shown on the Current Schedule.
- D. Before furnishing submittals, the Contractor shall ensure that the products comply with the Contractor's signed Buy America Certificate submitted at time of the bid and that the products will be available in the quantities needed and in time to complete the Work within the time allowed.
- E. Prior to submitting them to the Engineer, the Contractor shall review and approve submittals for conformance with the Contract Documents, including checking field conditions and verifying field measurements and compatibility of Work with clearance requirements, available space and utilities, and Work of other trades and adjoining Work.
- F. Each submittal shall bear the appropriate approval stamp and signature to indicate Contractor's approval, either the signature of Contractor's Construction Manager, Quality Program Manager, or Field Engineer, depending on the submittal. Items without a stamp and signature will not be considered submitted and may be returned to the Contractor without review. Should any submittal, even if bearing the Contractor's approval stamp, be incomplete or non-conforming to the requirements of the Contract, the Engineer shall reject the submittal without further review. The Contractor shall then be fully responsible for resubmitting these submittals.
- G. Contractor must obtain written approval from the Engineer on a proposed Contract change, as applicable, prior to offering submittals that involve alternative Work methods or products.
- H. Contractor shall submit detailed shop drawings for off-Site fabricated items.
- I. Contractor shall provide six (6) copies of the submittal, unless specified otherwise herein.

- J. Contractor shall prepare a submittal form containing the following information:
1. Contract title and number
 2. Contractor's name, address, and telephone number
 3. Submittal number and date
 4. Subject identification, including applicable Specification section and subsection numbers
 5. Contractor's approval stamp and signature.
- K. Contractor shall not start any Work for which submittals are required until the submittals are approved by the Engineer.
- L. Contractor shall not construe reviewer's comments on submittals (including comments on Requests for Information) as changes to the Contract. If Contractor believes that review comments received from the City constitute change(s) to the Contract, Contractor shall notify the Engineer in writing. Contractor shall not proceed with a possible change until the Engineer issues a written Contract change order.
- M. After a submittal reviewed by the Engineer has been returned to the Contractor, it shall distribute reproductions of shop drawings and product data that show the Engineer's approval to:
1. Jobsite files
 2. Affected manufacturers, fabricators, suppliers, subcontractors, and Construction Manager and other supervisory personnel.
- N. Delays caused by incomplete or rejected submittals or resubmittals are Contractor-caused delays.

1.5 ENGINEER'S REVIEW

- A. Submittals will be reviewed by the Engineer for conformance to requirements of the Contract: marked, signed, and stamped with the date of review.
- B. Approval of a separate item will not constitute review of the assembly in which the item functions.
- C. After review, the Engineer will return one reproducible copy of each shop drawing, one copy of product data, and will keep any samples submitted.
- D. The Engineer will diligently attempt to review and return all submittals and resubmittals to the Contractor as follows: within **twenty (20) Working Days** for product data unless otherwise noted; **twenty (20) Working days** for samples, test reports, manufacturer's instructions, operations and maintenance manuals unless

otherwise noted; fifteen (15) working days for shop drawings, design documents, and Requests for Substitution, unless otherwise noted. Additional time may be required for complex or large submittals. The Engineer will discuss and come to agreement with the Contractor as to the reasonable additional time required to review large/complex submittals. If the City's review of submittals takes more time than provided herein, Contractor may request an extension of time for the additional review period as provided in Document 0833.

- E. For the Work related to 1.5 Engineer's Review, sub-section D, the term "working days" shall not include December 26 thru December 31. This is in addition to the definition stated in the General Provisions.
- F. Where there are numerous submittals submitted to the Engineer in a given two-week period, the above days for City review will be extended based on negotiations between the Engineer and the Contractor.
- G. Submittals requiring no action by the Engineer will not be returned.
- H. The Baseline Schedule must take into account the City's review time as indicated above or as otherwise agreed by the parties.
- I. Approval of submittals, other than a Request for Substitution, shall not indicate approval of substitute products or Work methods.
- J. Approval of a submittal is not an authorization for or a request for a Contract change.
- K. On every submittal that the Engineer approves conditionally with comments or notes ("Approved as Noted"), and where resubmittal is not required, the Contractor must provide documentation that it complied with the noted conditions. Such documentation must be verified by both the Engineer and Contractor Quality Control System Manager before proceeding with the related Work. Any delays resulting from not adhering to this requirement shall be considered as Contractor-caused delays.

1.6 RESUBMITTALS

- A. The Contractor shall revise and resubmit submittals in accordance with comments from the Engineer within twenty (20) working days.
- B. The Contractor shall ensure that resubmittals only contain items included in the original submittal. Resubmittals shall be indicated by adding a sequential alphabetic letter to the original submittal number.
- C. The Contractor shall explain all changes that have been made in addition to those requested by the Engineer in an enclosed memo or by other readily identifiable means.

- D. The Contractor shall be fully responsible for resubmittals required for any reason. City shall consider any delays to the progress of construction resulting from having to resubmit submittals as Contractor-caused delays, for which the City will grant no time extension to the intermediate Milestone dates or to the time allowance for completion of all Work

1.7 SUBMITTALS SCHEDULE

- A. The Contractor shall prepare a detailed schedule/log, which will list all submittals required by the Contract, including, but not limited to, written plans, shop drawings, engineering calculations, product data, samples, test reports, permits, certificates of compliance, manufacturer's instructions/recommendations, and any other submittals required by the Contract. In addition, the Contractor shall provide activity numbers if the submittals are related to construction activities or product deliveries. The Contractor shall also include the Specification section number related to each submittal.
- B. The Contractor's schedule/log shall show the scheduled date(s) for each of the following events:
1. Submittal received by the Contractor, from subcontractor or supplier
 2. Submittal reviewed and stamped by the Contractor
 3. Submittal delivered to the Engineer
 4. Submittal reviewed and returned by the Engineer and approval status
 5. Follow-through of comments/notes on conditional approved submittals
 6. Resubmittal due to Engineer.
- C. The submittals schedule shall be coordinated with the Baseline Schedule of Document 00833. All key submittals shall also be shown on the Baseline Schedule. The submittals schedule and the Baseline Schedule shall allow time for resubmittals of major or large submittals and time for any other appropriate action prior to commencement of the portion of Work for which the submittal is required.
- D. The Contractor shall provide the submittals schedule as follows:
1. **Preliminary Submittals Schedule:** Contractor shall provide a detailed preliminary submittals schedule no later than the date of the preconstruction meeting and prior to any on-Site Work. This preliminary submittals schedule must be comprehensive and shall list all submittals required under this Contract and shall include the approximate date that each submittal will be ready to be submitted for Engineer's review. Submittals shall be scheduled in advance to allow time for City review, for possible resubmittal, and for other appropriate actions required to begin Work.

2. **Approved or Final Submittals Schedule:** The City shall comment on the Preliminary Submittals Schedule within fifteen (15) working days. Within twenty (20) working days after receiving the City's comments on the preliminary submittals schedule, the Contractor shall revise the schedule and resubmit it (in hard copy and electronic file) for the Engineer's final approval.
3. The City may decline to approve the submittals schedule if multiple submittals are scheduled within a short time of each other and the City would thereby not have sufficient time to review all submittals. The City will not approve the submittals schedule if there are submittals scheduled to be submitted beyond the time frame specified in 1.7D below. No on-Site Work will be allowed to commence prior to completion of an approved submittal schedule. Any delays to the progress of construction as a result of delay in submitting a complete detailed acceptable submittals schedule shall be considered as Contractor caused delays and no time extension will be granted to the intermediate Milestone dates or to the time allowance for completion of all Work as specified in the General Provisions.

Monthly Update Submittals Schedule: Contractor shall submit an updated submittals schedule each month accompanying the monthly updated construction schedule. The Monthly Update Submittals Schedule shall log clearly the status of each submittal, including the status of action taken in response to any comments on submittals returned to the Contractor. Contractor agrees to waive right to any claims of City delays in responding to a submittal if Contractor fails to submit the monthly update submittals schedule indicating the updated schedule of the submittal.

4. All submittals required under this Contract shall be submitted in accordance with the approved Submittals Schedule.

1.8 DRAWINGS

A. Drawing Types:

1. **Shop Drawings:** As referred to in Document 00819 of the Supplementary Conditions, shop drawings shall be defined as coordination and detail drawings, diagrams, schedules and other data specifically prepared for permanent portions of the Work by the Contractor or any subcontractor, manufacturer, supplier or distributor, to illustrate and detail such portion of the Work. Shop drawings shall be presented in a clear and thorough manner. Contractor shall identify details by reference to sheet and detail, schedule or location shown on the Contract Drawings, or applicable Specification section.
2. **Working Drawings:** Working drawings shall be defined as drawings prepared by the Contractor, or any of its subcontractors (at any tier), suppliers or

distributors, illustrating Work required for construction, but which will not be an integral part of the completed Work. This includes, but is not limited to: drawings for temporary structures such as decking, temporary bulkheads, excavation supports, utility support, groundwater control, forming and falsework, and underpinning. Working drawings and calculations shall be prepared, stamped and signed by an engineer of the involved discipline licensed in the State of California.

B. Identification Requirements: Contractor shall mark each shop drawing, working drawing and calculation with the following:

1. Contract title and number.
2. Date and revision date.
3. Names of Contractor, subcontractor, manufacturer or supplier preparing the drawing.
4. Identification of the product by generic description, manufacturer's name and model number, style number, serial number or lot number.
5. Respective Contract Drawing and detail numbers.
6. Calculations: Stamped and signed by an appropriate licensed professional engineer.

C. Furnish reproducible and six (6) copies of each for review.

D. Preparation Requirements:

1. Outline and installation drawings shall include overall dimensions, arrangements, assembly, piping, wiring and controls for fabrications and equipment furnished.
2. Drawings shall include construction and installation details and materials and tolerances, foundations of structures; locations and size of lifting connections or lugs; anchor bolts, base plates, and other methods of installation.
3. Drawing sizes shall be ANSI size C, D or E. Lettering shall be legibly readable when reduced to half size. Reproducible drawings shall be vellum or mylar with black markings.
4. Contractor shall clearly identify field dimensions.
5. Drawings shall show relation to adjacent facilities or critical features of the Work or materials.
6. Contractor shall clearly identify deviations from the Contract.
7. The drawings shall include 130mm x 130mm (5-inch x 5-inch) blank space in the lower left corner for the Engineer's review comments and in the lower right corner for the Engineer's future use.
8. The title block shall show:

- a. Contract title and number
- b. Drawing number, date and revision date
- c. Names of the Contractor, subcontractor, manufacturer or supplier.

1.9 PRODUCT DATA

- A. Product data shall include the manufacturer's standard illustrations, schedules, performance charts, instructions, brochures, diagrams, qualification test reports and other information furnished by the Contractor to illustrate a material, product or system for some portion of the Work.
 1. Contractor shall modify drawings, diagrams and catalog cuts to delete all information not applicable to the Work.
 2. Contractor shall supplement standard information with specific information applicable to the Work.
- B. Identification Requirements:
 1. Contractor shall mark the product data with the following: Contract title and number, submittal number, and item number on each page.
 2. Contractor shall indicate on the transmittal the applicable Specification section and subsection numbers, and Contract Drawing and detail numbers for each submittal item.
 3. Contractor shall submit product information with the following:
 - a. Identification of pertinent products or models clearly designated.
 - b. Performance characteristics and capacities.
 - c. Required dimensions and clearances.
 - d. Wiring and piping diagrams and controls.
 - e. Identification of deviations from the Contract.
- C. Contractor shall furnish four (4) copies and four (4) originals of the product data.

1.10 SAMPLES

- A. Samples are physical examples that illustrate materials, equipment, or workmanship and establish standards by which the Work will be judged.
- B. **Contractor shall identify the samples as follows:**
 1. Indicate on the transmittal form the following: Contract title and number, submittal and item numbers.

2. Indicate on transmittal form the applicable Specification section and subsection numbers and Contract Drawing and detail numbers for each submittal item.
 3. Manufacturer's or supplier's name.
 4. Identification of the product by generic name, brand name and model style, serial number or lot, as applicable.
 5. Number, size and quantity of sample submittals.
 6. Applicable reference standards.
 7. The Contractor's approval stamp.
 8. Identification of deviations from the Contract Documents.
- C. **Size and Quantity:** Contractor shall furnish samples in the sizes and quantities specified in the Specifications.
1. Samples shall be of sufficient size and quantity to illustrate clearly:
 - a. Functional characteristics of the product with integrally related parts and attachment devices.
 - b. Full range of colors, textures and patterns, where applicable.
- D. **Contractor shall furnish a minimum of three (3) of each sample required.**

1.11 TEST REPORTS

- A. Contractor shall submit test reports as specified in the applicable Specification sections.
- B. **Identification Requirements:** Contractor shall mark test reports with the following:
1. Contract title and number.
 2. Name of Contractor and subcontractor performing the testing.
 3. Material or equipment represented.
 4. Source of material.
 5. Name of producer and brand, if any.
 6. Applicable Specification section, and subsection numbers.
 7. Location of Work.
 8. Name, address and telephone number of organization performing tests.
 9. Date of tests.
 10. Certification signature of the testing laboratory.
- C. **Furnish six (6) copies** of test reports in addition to those required to be furnished with Certificates of Compliance.

1.12 MANUFACTURER'S INSTRUCTIONS

- A. If the manufacturer of any materials or equipment that is to be incorporated into the Work provides printed instructions on installation methods and procedures, the Contractor shall furnish these instructions to the parties involved in the installation, and to the Engineer, no later than twenty (20) working days prior to the scheduled installation.
- B. Identification Requirements: Contractor shall mark manufacturer's instructions with the same identification information specified for product data in subpart 1.09 above.
- C. Contractor shall submit the same number of copies of manufacturer's instructions as specified for product data in subpart 1.9 above.
- D. Contractor shall review information for conformance with the Contract Documents, adjoining Work and the Work of other trades.
- E. Contractor shall note any conflicts between the manufacturer's instructions and the Contract Documents in a transmittal to the Engineer. The Engineer may or may not comment on manufacturer's recommendations at his/her discretion.

1.13 MANUFACTURES AND APPLICATORS WARRANTIES

- A. Manufacturer and applicator warranties and guarantees shall be delivered to the Engineer no later than twenty (20) working days prior to the scheduled installation.
 - 1. The warranties and guarantees are extended warranties and guarantees specified in the Contract Documents that exceed the requirements under the Performance Bond and Payment Bond (see Documents 10.2 of the General Conditions), which include State of California Statutes of Limitations for patent defects (currently four (4) years) and latent defects (currently ten (10) years).
 - 2. Manufacturer and applicator warranties and guarantees that are submitted and do not equal or exceed the Contract requirements will be consider non-binding for the deficient terms and conditions.

1.14 CERTIFICATE OF QUALIFICATIONS

- A. If the Specifications require a particular level of experience in order for a firm or person to qualify to perform any portion of the Work, Contractor shall submit a Certificate of Qualification to the Engineer in accordance with the required schedule for submitting the qualification as specified in the various sections of the Specifications or no less than thirty (30) days prior to start of such Work. The Certificate shall state that the identified firm or person has the specified experience; document the actual experience; identify project owners for whom Work was performed, and include names of owner's or Contractor's employees or officers witnessing or possessing knowledge of the claimed experience.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00811: TEMPORARY UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Work specified in this Section includes providing and maintaining temporary utilities required for construction and removal of them on completion of the Work. This Work also includes the furnishing, installation and removal of all necessary service connections, piping, conduit, wiring and appurtenances.
 - 1. Maintain and operate systems to assure continuous service.
 - 2. Modify, relocate and extend systems as Work progress requires.
- B. The Contractor shall not interrupt existing utility services to the public and businesses unless equivalent temporary services are provided, subject to advanced notification and planning, acceptance of the affected public agency, business and the utility company, and approved by the Engineer.
- C. No separate payment will be made for Work covered under this specification. The Work associated with this specification is considered incidental to the completion of Work in which it pertains.

1.2 RELATED SECTIONS

- A. Drawings, General Conditions and the following sections within the Supplementary Conditions, apply to the Work of this section.
- B. Document 00810
- C. Document 00833
- D. Document 00824.

1.3 QUALITY ASSURANCE

Comply with utility companies' requirements, as applicable.

1.4 SUBMITTALS

- A. Pursuant to the provisions of Document 00810, Submittals, the Contractor shall submit:
 - 1. Before commencing the Work, the Contractor shall submit in writing to the Engineer a description and detailed schedule of his intended operations relative to keeping utilities in operation as specified and show such operations in the schedules of Document 00833.

PART 2 – PRODUCTS

2.2 MATERIALS

Provide as required.

PART 3 – EXECUTION

3.4 ELECTRICITY AND LIGHTING

- A. Arrange with the local utility company to provide all services required for electrical power and lighting.
- B. Install circuit and branch wiring with area distribution boxes and do all Work necessary so that normal traffic signal operation, power and lighting are available and maintained throughout the construction Site, including the Engineer's field office.
- C. Provide adequate artificial lighting for all areas of Work when natural light is not adequate for Work, safety, or traffic routing.
- D. Street Lighting: Street lighting shall be kept in operation by the Contractor throughout the life of the Contract. Such lighting shall be accomplished by keeping existing street lighting in operation; by furnishing approved temporary lighting; or any satisfactory combination thereof, as required to maintain intensity of illumination which existed prior to the start of Work.

3.5 WATER

- A. Provide water for construction purposes. The Contractor shall pay all costs for the installation, metering, maintenance and removal and for all service charges for water used.
- B. Install branch piping with taps located so that water is available throughout the construction Site by using hoses as needed. Protect piping and fittings against freezing.
- C. Provide potable water for domestic use.
- D. Ordinance #175-91. Article 21, Sections 1100-1107 of the San Francisco Public Works Code restricts the use of potable water for soil compaction and dust control activities.
- E. Also see Document 00822, 1.7.

3.6 REMOVAL

- A. Completely remove temporary materials and equipment when their use is no longer required.
- B. Clean and repair damage caused by temporary installations or use of temporary facilities.
- C. Restore permanent facilities used for temporary services to original condition unless otherwise specified.

END OF DOCUMENT

DOCUMENT 00812: TEMPORARY CONSTRUCTION**PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The Work specified in this section includes providing all construction required in the execution of the Contract Work that is temporary and is not shown to be part of the completed Facilities to be provided under this Contract.
- B. There will be no separate payment for the Work of this section.

1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO).
- B. Department of Public Works, City and County of San Francisco, Standard Specifications (SFSS).

PART 2 – PRODUCTS**2.1 MATERIALS**

- A. Materials may be new or used, but shall be in good condition and adequate for the required usage, shall not create unsafe conditions, and shall not violate requirements of applicable codes and standards.
- B. Temporary Paving:
For asphalt surfaces, temporary paving shall be asphalt concrete. For other surfaces, 10 MPa (1500 psi) concrete shall be used.

PART 3 – EXECUTION**3.1 TEMPORARY PAVING**

- A. Vehicular or pedestrian traffic over unpaved and unbridged areas will not be permitted. The Contractor shall construct, before use by vehicular or pedestrian traffic, and thereafter satisfactorily maintain, a smooth, regular, temporary wearing surface, not less than 75 mm (3 in). Temporary paving shall be placed on subgrade compacted to 95% relative density.
- B. In the event that Work was started, but will be delayed 36 hours, that portion of the sidewalk or street shall be totally cleaned up and restored with temporary paving.

- C. The edges of castings pavement base, plates, bridges and existing and new pavement shall be feathered with temporary paving wedges (1:18 maximum slope). Renew feathering when worn.
- D. Where cross traffic is allowed over concrete base at an angle (i.e. at street intersections), the entire width shall be feathered with temporary paving.
- E. The requirements of DPW Standard Specification Section 212.06 shall apply to this Work.

3.2 MAIN PROJECT SIGNS

- A. The Contractor shall furnish, erect and maintain project signs, satisfactory to the funding agency, identifying the Contract. Sign details and dimensions shall be as shown in Appendix A and as directed by Engineer.
- B. There shall be two (2) project signs which shall be placed as directed by the Engineer.
- C. The signs shall be complete and in place at Site prior to start of any Work.
- D. Contractor shall replace signs to accommodate changes to the names listed as directed by the Engineer. Contractor shall assume a minimum of 3 cycles for sign replacement due to name, text and logo changes. The cost shall be included in the bid price.
- E. Prior to shop submittal, fabrication or construction, Contractor shall verify with the Engineer the names listed, all text and logos on the sign shown in See Appendix A.

3.3 REMOVAL

- A. Completely remove temporary materials and equipment when their use is no longer required.
- B. Clean and repair damage caused by temporary installations or use of temporary facilities.
- C. Restore permanent Facilities used for temporary services to original condition unless otherwise specified.

END OF DOCUMENT

DOCUMENT 00813: PROTECTION OF PROPERTY**PART 1 – GENERAL****1.1 DESCRIPTION**

- A. Work Included:
1. Protection from damage and loss by the Contractor of City-furnished materials and existing Facilities not required to be removed and disposed, including but not limited to: streets, walks, concrete surfaces, existing utilities, conduits, cables, antenna structures, onboard vehicle equipment, control points and benchmarks, structures, and related appurtenances.
 2. Safeguarding of existing trees, including their existing root systems, leaves, branches and trunks.
 3. Cleaning and removing of all construction residues from any Work sites within the tree canopy. Concrete slurry, asphalt and other materials used during construction and excavated material shall not be deposited under the trees or bushes.
 4. Support, Work around and protect existing utility facilities.
- B. The Contractor shall use such methods and shall take adequate precautions to prevent damage to existing Facilities and other improvements during the prosecution of the Work.
- C. The Contractor shall protect and maintain existing Facilities so as not to interfere with the safe operation and use of the existing Facilities.
- D. The Contractor shall protect the Work from vandalism, damage and other loss until acceptance to the extent that Contractor has exclusive control of the Site. The Contractor shall provide security systems, devices and enclosures and guard services, as needed to protect the Work, and Contractor tools and equipment to the extent that Contractor has exclusive control of the Site. The City shall not under any circumstances be responsible for loss or damage to Contractor's tools and equipment..
- E. Whenever reference is made to "Pacific Telephone and Telegraph (PT&T Co.)" in these specifications, such reference shall be construed to mean "AT&T." Similarly whenever reference is made to the "Television Signal Corporation (Tel. Sig. Corp.)", such reference shall be construed to mean "AT&T."
- F. The majority of existing SFMTA manhole frames and covers are labeled "HHWP" (Hetch Hetchy Water and Power) or "SFMTA RWY".

- G. Check for sub-basements under the sidewalk prior to construction in the sidewalk area. If there is a sub-basement, stop construction and notify the Engineer
- H. No separate payment will be made for Work covered under this specification. The Work associated with this specification is considered incidental to the completion of the Work in which it pertains.

1.2 REFERENCES

- A. California Code of Federal Regulations (California Administrative Code), Title 8 - Industrial Relations, Division 1 - Department of Industrial Relations, Chapter 4 - Division of Industrial Safety, Subchapters 4 and 7 - Construction Safety Orders (CSO) and General Industry Safety Orders (GISO).
- B. Department of Public Works, City and County of San Francisco, Standard Specifications (SFSS)
 - 1. Section 105.03 Damage to Work on Property.

1.3 JOINT SURVEY TO ESTABLISH AUTHENTICITY OF POSSIBLE DAMAGE CLAIMS

- A. After the Contract is certified and before the commencement of Work, the Contractor shall arrange for a joint examination of existing structures, Facilities and other improvements within the construction area and in the vicinity of the Work which might be affected or damaged by the Contractor's operations.
- B. The examination of existing structures, Facilities, and other improvements located within or adjacent to the construction shall be made jointly by authorized representatives of the Contractor and the City under the supervision of the Engineer. The scope of each examination shall include, but is not limited to, recording of damaged and undamaged conditions, cracks in structures, settlement, leakage, sprinkler system operation, exteriors and interiors of structures, and the like.
- C. Document and submit two copies of the joint survey in the form of photos from negatives, digital photos and/or videotapes. Digital photos shall also be stored in a non-rewritable CD-R format. These pictorial surveys shall contain narratives, either written or verbal, describing the content of each photo or video segment. Another complete set of the survey shall be kept by Contractor.
- D. The 24-inch encased VCP traversing the Site shall be inspected by a specialized Contractor prior to and after construction. Two copies of a video tape showing the conditions of the line within the Site shall be submitted to the Engineer.
- E. Each copy of the survey document or media shall be jointly signed and dated by the Contractor and the Engineer.

- F. The above records are intended for use as indisputable evidence in ascertaining the extent of any damage which may occur and are for the protection of the adjacent property owners, the Contractor, and the City, and will be a means of determining whether and to what extent damage occurred during the Contract Work.
- G. This Work is considered incidental Work and no separate reimbursement will be made.

1.4 UTILITY PROTECTION

Support, Work around and protect utility facilities.

In advance of all excavations and trenches, Contractor shall as incidental Work, pothole to determine exact location and depth of all utilities and other existing facilities which may be encountered during excavation.

While excavating and trenching, Contractor shall probe material to be removed to verify the absence of utilities or other existing facilities before the material is removed. If the Contractor cannot verify the absence of utilities and other existing facilities, excavation or trenching shall proceed by hand until the Contractor can again verify the absence of utilities and existing facilities.

- A. Contractor shall verify and mark all locations of existing utility facilities. Contractor shall continually hand probe and excavate in advance of underground Work until exact location and depth of expected underground facilities have been determined.
 - 1. Contractor shall conform to CAC Title 8, General and Construction Safety Orders, including notifying all known owners of underground facilities, and where applicable, using the USA-North one-call notification service 72 hours before any underground Work.
 - 2. Should the Contractor damage or displace any PUC, SFWD, PG&E, AT&T, or other existing facility, the appropriate utilities shall be notified immediately by calling:
 - SFWD
 - PG&E
 - AT&T

B. Third Party Insurance

The Contractor shall provide third party insurance naming the affected utility company or utility companies in addition to the City as an additional insured or loss payee against claims for property damage and personal liability arising directly or indirectly from utility Work performed by the Contractor.

C. Duct Structure

Duct structure is one or more ducts, conduits or pipes, of any size, or a combination of such ducts, conduits or pipes, which are grouped together but which may or may not be banded, encased in concrete, or otherwise incorporated into a solid unit.

D. Nested Utility Facilities

Nested utility facilities are defined as facilities 100 mm (4 inches) or less in outside diameter or width which are less than 910 mm (3 feet) clear distance from each other regardless of ownership. In the case of nested facilities, each crossing shall be paid for according to the "Cost of Utility Crossing" Schedule reduced by 33-1/3 percent.

E. Sewer System

The Contractor shall take adequate measures to prevent the impairment of the operation of the sewer system. He shall prevent construction materials or debris from entering, impairing and damaging, and prevent construction methods from damaging any sewer, sewer structures, catch basins and storm water inlets.

F. Water Department – Underground Facilities

San Francisco Water Department facilities, if encountered, shall be supported as follows:

1. Push-on joint pipes: Pipes shall be supported by a minimum of one cable with turnbuckle, a pipe clamp and a beam spanning the trench; however, where a joint falls within a trench area, a cable with turnbuckle and pipe clamp shall be placed on each side of the joint.
2. Copper tubing and plastic pipes (service pipes 2 inches or smaller in diameter): If the trench is less than 8-foot wide, no support is required. For trenches wider than 8 feet, one support is required for every additional 8 feet or part thereof.
3. Steel welded pipes: Pipes shall be supported in a manner satisfactory to the General Manager of the Public Utilities Commission of the City and County of San Francisco.
4. Contractor shall submit support designs for approval and start Work only with approved support designs."

G. Not Used**H. Pacific Gas & Electric Co. (PG&E) – Underground Facilities**

The requirements for supporting, working around, and protecting existing Pacific Gas and Electric Company (PG&E) underground electric, gas and steam facilities are as follows:

For pipe and conduit in sizes up to and including 6 inches inside diameter, spans of less than 6 feet shall be considered self-supporting unless otherwise directed by the

City or by the PG&E inspector through the Engineer. Spans of 6 feet and more, but not to exceed 12 feet, shall be supported by a beam with at least one cable and turnbuckle. For spans over 12 feet, an additional cable and turnbuckle shall be installed for each additional 6 feet or fraction thereof of span. Cables and turnbuckles shall be located to support joints, valves and other fittings. Cast iron joints and valves, where encountered, shall be supported on both sides.

For pipe and conduit in sizes larger than 6 inches inside diameter, spans shall be supported by beams with cables and turnbuckles located at intervals not to exceed ten times the diameter of the pipe measured in inches, unless otherwise directed by the City or PG&E inspector through the Engineer. Cable and turnbuckles shall be located to support joints, valves, and other fittings. Cast iron joints and valves, where encountered, shall be supported on both sides.

Concrete-encased duct lines and/or concrete-encased steam lines shall not be considered as self-supporting, but may be so designated by the City or PG&E inspector through the Engineer, upon a visual examination of the concrete envelope.

Beams, cables and turnbuckles for supporting steel pipe and/or conduit shall be adequately sized to limit the deflection so as not to exceed length of span in feet divided by 360.

Length of span in feet

Beams, cables and turnbuckles used for supporting cast iron pipe shall be adequately sized to insure that no deflection will occur.

Beams, cables and turnbuckles used for supporting concrete encased duct lines and/or concrete encased steam lines shall be adequately sized and spaced to insure that no deflection will occur.

For multi-way conduits, spacers shall be placed to maintain conduit separation at point of support. 2-inch x 4-inch wood softeners shall be used with all cable slings to prevent damage to pipe, coating, wrapping or concrete encasement. However, slings supporting unreinforced concrete encased pipe must also incorporate strongbacks to prevent cracking of concrete.

Contractor shall exercise due care to avoid damage to pipe and pipe coatings, wrapping or concrete encasement. Should Contractor damage or displace any PG&E facility Contractor shall notify the PG&E immediately by calling Gas Dispatch at (gas and electric facilities). Repairs or replacements will be made by the PG&E. However, all expenses in connection therewith shall be borne solely by Contractor. Contractor shall notify the PG&E Inspection Department at one week prior to excavating so that all crossings can be verified.

I. Existing PacBell Telephone Company D/B/A AT&T California (AT&T) Underground Facilities

General

The requirements for supporting, working around, and protecting existing AT&T underground facilities are as follows:

Requirements for Supporting AT&T Ducts

A single duct spanning less than 6 feet shall be considered self-supporting unless otherwise directed by the City or by the AT&T inspector through the Engineer.

A single duct spanning more than 6 feet shall be supported by a beam with at least one cable and turnbuckle. For spans over 12 feet, an additional cable and turnbuckle shall be installed for each additional 6 feet or fraction thereof of span. Cables and turnbuckles shall be located to support duct joints.

Duct structures consisting of 2 or more single ducts not encased in concrete and spanning more than 4 feet, shall be banded with at least 2 bands and supported by a beam with at least one cable and turnbuckle. For spans over 8 feet, an additional set of bands, cable and turnbuckle shall be installed for each additional 4 feet or fraction thereof of span. Banding of ducts shall be done in such a manner as to not distort the normal configuration of the structure.

Duct structures consisting of 2 or more single ducts, encased in concrete and spanning more than 4 feet, shall be supported by a beam with at least one cable and turnbuckle. For spans over 8 feet, an additional cable and turnbuckle shall be installed for each additional 4 feet or fraction thereof of span.

Multiple-duct structures of vitrified clay and/or concrete shall be supported for the complete width of the trench. The support shall consist of planking or beams equal in width to the width of the structure and banded to it. This structure in turn shall be supported by a beam with at least one cable and turnbuckle placed every 4 feet or fraction thereof so as to maintain the existing position and alignment of the duct structure.

Duct structures consisting of dissimilar conduit materials shall be supported in the manner applicable to the most fragile portion of the structure.

Requirements for Protecting AT&T Ducts

Single ducts shall be protected if required. This determination will be made by the City or by the AT&T inspector through the Engineer.

Duct structures having top and bottom wood planking or encased in concrete will not require additional protection unless otherwise directed by the City or by the AT&T inspector through the Engineer.

All other multiple duct structures, with the exception of steel pipe in good condition, shall be protected by the placement of wood planking or sheeting no less than 1/2-inch in thickness and equal in width to the width of the structure.

Damage or Displacement of AT&T Facilities

Should Contractor damage or displace any AT&T owned facility, the Cable Maintenance Department of AT&T shall be notified immediately by calling 863-6906. Repairs or replacements will be made by AT&T. However, all expenses in connection therewith shall be borne solely by Contractor.

J. Existing Comcast Corp (Comcast) Underground Facilities**General**

The requirements for supporting, working around, and protecting existing Comcast underground facilities are as follows:

Requirements for Supporting Comcast Corp. Ducts

A single duct spanning less than six (6) feet shall be considered self-supporting, unless otherwise directed by the Comcast engineering coordinator or the Comcast inspector, through the Engineer.

A single duct spanning more than six (6) feet shall be supported by a beam with at least one cable and turnbuckle. For spans over twelve (12) feet, an additional cable and turnbuckle shall be installed for each additional six (6) feet or fraction thereof of span. Cables and turnbuckles shall be located to support duct joints.

Duct Structures consisting of two (2) or more single ducts spanning more than four (4) feet shall be banded with at least two (2) bands and supported by a beam with at least one (1) cable and turnbuckle. For spans over eight (8) feet an additional set of bands, cable, and turnbuckle shall be installed for each additional four (4) feet or fraction thereof of span. Banding of ducts shall be done in such a manner as to not distort the normal configuration of the structure.

Duct structures consisting of dissimilar conduit materials shall be supported in the manner applicable to the most fragile portion of the structure.

Requirements for Protecting Comcast Ducts

Single ducts shall be protected if required. This determination will be made by the Comcast engineering coordinator or by the Comcast Corp. inspector, through the City Representative.

Duct Structure having top and bottom wood planking will not require additional protection unless otherwise directed by the Comcast engineering coordinator or the Comcast Corp. inspector through the Engineer.

All other multiple duct structures shall be protected by the placement of wood planking or sheeting no less than 1/2-inch in thickness and equal in width to the width of the structure.

Damage or Displacement of Comcast Facilities

Should Contractor damage or displace any Comcast owned facility the proper authorities shall be notified immediately by calling 863-8500 Ext. 390. Repairs or replacements will be made by Comcast. However, all expenses in connection therewith shall be borne solely by Contractor.

K. SFMTA – Underground Facilities**General**

The requirements for supporting, working around, and protecting existing SFMTA Transit Power (MTP) underground conduit and ducts are as follows:

Requirements for Supporting MTP Conduits and Ducts

Steel conduit spanning less than six feet shall be considered self-supporting unless otherwise directed by the City or by the MTP inspector through the Engineer.

Steel conduit spanning six feet and more shall be supported by a beam with at least one cable and turnbuckle. For spans over 12 feet, an additional cable and turnbuckle shall be installed for each additional six feet or fraction thereof of span. Cables and turnbuckles shall be located to support duct joints.

Beams, cables and turnbuckles for supporting steel conduit shall be adequately sized to limit the deflection so as not to exceed length of span in feet divided by 360.

Spacers shall be placed between multiple conduits in a manner to maintain conduit separation at points of support.

Concrete-encased ducts spanning more than four feet shall be supported by a beam with at least one cable and turnbuckle. For spans over eight feet, an additional cable and turnbuckle shall be installed for each additional four feet or fraction thereof of span for the complete width of the excavation.

Beams, cables and turnbuckles for supporting concrete-encased duct lines shall be adequately sized and spaced to insure that no deflection will occur.

Contractor shall provide adequate support and protection to prevent differential movement at the juncture of manholes and duct banks.

Duct structures consisting of dissimilar conduit materials shall be supported in the manner applicable to the most fragile portion of the structure.

Requirements for Protecting MTP Conduits and Ducts

Steel conduit shall be protected if required. This determination will be made by the City or by the MTP inspector through the Engineer.

Duct structures having top and/or bottom wood planking or encased in concrete will not require additional protection unless otherwise directed by the City or by the MTP inspector through the Engineer.

All other duct structures, such as unprotected tile and the like, shall be adequately protected by the placement of wood planking or sheeting no less than 1/2-inch in thickness and equal in width to the width of the structure. The top, bottom and sides shall be covered as necessary, depending on Contractor's operations and the conditions of the Work.

Damage or Displacement of MTP Facilities

Should Contractor damage or displace any MTP-owned facility, the General

Superintendent of Facilities Maintenance shall be notified immediately by calling 554-9221. Repairs or replacements will be made by MTP. However, all expenses in connection therewith shall be borne solely by Contractor.

Conduits to Pole Risers to be Considered as Services

For the purpose of payment, conduits that run directly from a manhole or pull box to a pole riser shall be considered to be a service and will be paid for according to the Cost of Utility Crossing Schedule.

1.5 REPLACEMENT

Should any structures or property during construction be damaged or missing, including items to be salvaged or reused, the Contractor shall immediately notify the property owners and the Engineer, and shall arrange for immediate restoration with the same or equivalent materials, design and construction, at the Contractor's expense.

1.6 PROTECTION OF EXISTING UTILITIES AND STRUCTURES DURING PILING OPERATIONS

Contractor shall use extreme care and take all necessary precautions to protect existing utilities and structures from damage during pile driving operations. If piles are driven from grade, Contractor shall carefully pothole at each pile location to the necessary depth to locate all existing utilities and other improvements prior to pile driving operations.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00814: LOCAL OFFICE

PART 1 - GENERAL

1.1 DESCRIPTION

The Contractor shall provide and maintain a Local Office as described in RFQ/RFP Section 3.4.

1.2 PROTECTION OF PROPERTY

The Contractor shall be responsible for the safety, and shall be liable for the replacement, of any property of the City or its employees while that property is in the Local Office. The Contractor shall replace in kind within thirty (30) calendar days of notice, any property of the City or of its employees that is removed from the Local Office without authorization from the owner.

1.3 REIMBURSABLE EXPENSES

All costs related to the Work, equipment, services, supplies, and tools and other items specified within this Section shall not be separately reimbursed by the City but shall be included as part of the Contractor's mobilization.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00815: MATERIALS & EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

The Work specified in this section includes the general requirements for the following:

1. Materials and Equipment incorporated into the Work
2. Transportation and handling
3. Storage and protection
4. Spare parts and maintenance manuals
5. Manufacturers Warranties.

1.2 REFERENCES

- A. Department of Public Works, City and County of San Francisco Standard Specifications.
- B. Underwriters Laboratory, Inc.

1.3 SUBMITTALS

Pursuant to the provisions of Document 00810, Submittals, the Contractor shall submit:

1. Product Data for all material and Equipment furnished
2. Shop drawings for all Equipment furnished
3. Maintenance manuals for fixtures and finishes
4. Manufacturer's warranties for all Equipment furnished and/or installed.

1.4 MATERIAL AND EQUIPMENT

- A. Except for temporary facilities and as specifically indicated or specified, all material and Equipment shall be new.
- B. For material and Equipment specifically indicated or specified to be reused in the Work:
 1. Use special care in removing, handling, storing, and reinstallation to assure proper operation in the completed Work.
 2. Transport, store and handle products with extreme care which require off-Site storage, rework, restoration, or renovation.

3. Where Equipment has been put into revenue service, Contractor shall not be responsible for loss or damage of Equipment caused by misuse by SFMTA, its employees or other third parties. But Contractor shall be responsible for defective installation or defects in Equipment put into revenue service (which shall be covered under applicable warranties) and the correction of such defects.
- C. Unless otherwise indicated, provide materials and equipment, which are the standard products of manufacturers regularly engaged in the production of such materials and Equipment. Provide the manufacturer's latest standard design that conforms to these Specifications.
 - D. Environmental Conditions: Material and Equipment shall be designed to ensure satisfactory operation and operational life in the environmental conditions, which will prevail where they are being installed.
 - E. Conform to applicable Specifications and Standards.
 1. Furnish materials and Equipment bearing evidence of UL listing and label where UL standards exist, except for materials and equipment which UL does not list or provide label service for. (Also see Document 00824).
 2. Applicable sections of Department of Public Works, City and County of San Francisco Standard Specifications to the extent that they do not conflict with the Contract Documents.
 3. Size, make, type and quality specified, or as specifically accepted in writing by the Engineer.
 - F. Manufactured and fabricated products:
 1. Designed, fabricated and assembled in accordance with the best engineering and shop practices, including restrictive tolerance and precision workmanship as specified.
 2. Manufacture like parts of duplicate units to standard sizes and gages, to be interchangeable.
 3. Two or more items of the same kind shall be identical and by the same manufacturer.
 4. Products shall be suitable for service conditions.
 5. Equipment capacities, sizes and dimensions shown or specified shall be adhered to.
 - G. Materials or equipment shall not be used for any purpose other than that for which it is designed or specified.

1.5 TRANSPORTATION AND HANDLING

- A. Arrange deliveries of products in accordance with construction schedules and coordinate them to avoid conflict with the Work, SFMTA operations, and conditions at the Site.
 - 1. Deliver products in undamaged condition, in the manufacturer's original containers or packaging with identifying labels intact and legible.
 - 2. Immediately upon delivery, inspect shipments to assure compliance with the requirements of the Contract Documents and approved submittals, and check that the products are properly protected and undamaged.
- B. Provide equipment and personnel to handle products using methods to prevent soiling or damaging products and packaging.
- C. When items are specified to be embedded or built into concrete, masonry or carpentry, arrange delivery in sufficient time to meet the construction schedule. Provide setting drawings and templates.

1.6 STORAGE AND PROTECTION

- A. Store, handle and protect products in accordance with the manufacturer's instructions, with seals and labels intact and legible.
 - 1. Store products subject to damage by the elements in watertight enclosures.
 - 2. Maintain indoor storage temperatures and humidity within the ranges required by the manufacturer's instructions. Store hazardous and flammable materials in containers and enclosures specifically designed for that purpose.
- B. Exterior storage:
 - 1. Store fabricated products above the ground, preferably in secured shipping containers; prevent soiling or staining. Cover products subject to deterioration or which absorb moisture with impervious sheet coverings. Provide adequate ventilation to avoid condensation.
 - 2. Protect loose granular materials from mixing with foreign matter.
- C. Storage shall provide easy access for inspection. Make periodic inspections of stored equipment and materials to assure that products are maintained under the specified conditions and free from damage or deterioration.
- D. Protection after installation: Provide covering and fencing as necessary to protect installed products from damage from the elements, traffic, vandalism and subsequent construction operations. Remove coverings and fencing when no longer needed.

- E. These storage requirements also apply to City-furnished, Contractor installed equipment and materials and spare parts and tools. The Contractor shall be responsible for transporting the City-furnished equipment and materials from City designated storage sites to either the Contractor's storage Site or to the Work Site.
- F. The Contractor shall be responsible for obtaining classification of storage required for all equipment, dimensions and weights of delivered equipment, and for providing timely storage facilities and maintenance during storage as required.
- G. Maintain accessibility for inspection by the Engineer.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00816: PRODUCT SUBSTITUTIONS

PART 1 - GENERAL

1.1 DESCRIPTION

The Work specified in this Section includes the general requirements for selecting products and requesting substitutions or changes.

1.2 SUBSTITUTIONS

- A. Performance Standard: For products specified only by reference standard, Contractor shall select products that meet that standard.
- B. Specified product/Approved Equal: For products specified by naming one or more products or manufacturers, Contractor shall select one of the products or manufacturers, or within sixty **(60)** Days after the effective date of the Notice to Proceed for Phase 4.2, submit a formal "Request for Substitution" on the form provided by the Engineer for any product or manufacturer not specifically named that complies with the Specifications and is equal or superior to the named products or manufacturers. Requests for substitution shall be submitted in accordance with the procedure specified in subpart 1.3 below.
- C. For a period of sixty **(60)** Days after the effective date of the Notice to Proceed for Phase 4.2, the Engineer will consider written requests from the Contractor for substitution or changes.
- D. After sixty **(60)** Days of the Notice to Proceed for Phase 4.2, requests for substitution or changes will not be considered, unless it is a resubmittal of the same request that was first submitted within the initial sixty **(60)** Day period.
- E. Contractor shall submit a separate request for each substitution or change, supported with complete data, calculations, drawings, catalogue reference cuts, test results, performance records, samples and other appropriate information and data, to demonstrate that the proposed substitution is superior or equal to the named product or manufacturer, including:
 1. A detailed comparison of the qualities of the proposed substitution with the product or manufacturer named in the Specifications, including differences in appearance, size, weight, heat load, power, ventilation and cooling requirements, effectiveness, reliability, estimated life, estimated maintenance, energy consumption, noise, vibration, performance capacity, salvageability, interchangeability,

accessibility requirements, compliance with safety requirements, and other differences.

Note: The burden of proof that the substitution is equal or better than the named product/manufacturer is the responsibility of the Contractor. The Engineer shall be the sole judge as to the quality and suitability of the substitution and the Engineer's decision shall be final. Any delay to the construction schedule as a result of a rejected substitution shall be the Contractor's sole responsibility.

2. Clearances to new and existing facilities; access for maintenance, repair, replacement or removal.
3. Any changes required to existing facilities or in other elements of the Work that would result from the substitution.
4. Effect on the construction schedule.
5. Effect on the original design and any need for redesign by the Contractor or for changing or revising the Contract Documents at the expense of the Contractor.
6. Any required license fees or royalties.
7. Any permits and/or approval from any governing jurisdiction.
8. Availability of maintenance service and the source of replacement materials.
9. Compatibility with SFMTA's existing system.
10. Whenever a classification, rating or other certification such as UL, NEMA or FM is a part of the Specifications for any product or material, proposals for the use of an alternative product or material shall provide a certification from the listed or approved independent testing laboratory indicating compliance. Such testing and certifications shall be at the expense of the Contractor and shall not delay the construction schedule
11. Designation of brand names, components and/or equipment in the Specifications shall not relieve the Contractor from their responsibility for performance in accordance with contractual requirements. The Contractor is responsible for notifying the Engineer of any inappropriate or outdated brand name, model number, component, and/or equipment that may be called for in the Specifications and to propose a suitable substitution in accordance with above.

12. **For the cases where there are already two or more products/manufacturers named in the Specifications or Drawings**, Contractor agrees to compensate the City for the cost of processing a request for substitution, based on cost data comparing the proposed substitution with what was specified. If the request for substitution is approved, the City's compensation shall be 50% of the difference in cost between what was specified and the proposed substitution or **\$1,500**, whichever is greater.

1.3 SPECIAL REQUIREMENTS

The Contractor's request for a substitution or change constitutes a representation that the Contractor:

1. Has investigated the proposed product, material or method and has determined that it is equal or superior in all respects to that specified.
2. Will provide the same warranties and bonds for the substitution or change as for the product specified.
3. Will coordinate the installation of an accepted substitution or change into the Work and make such other changes at the Contractor's own expense, including changes to the drawings/original design, as may be required to make the Work complete in all respects.
4. Waives all claims for additional costs resulting from such substitution or change, and shall be responsible for any such additional costs that may subsequently become apparent as a result of an accepted substitution or change.

1.4 ENGINEER'S REVIEW

- A. The Engineer will review requests for proposed substitutions or changes and will notify the Contractor of the results within twenty-five (25) working days after the satisfactory receipt of all requested information from the Contractor.
- B. The Engineer's approval of a Request for Substitution is a prerequisite for submission of related shop drawings for the applicable Section of the Specifications. There is no exception.
- C. Any Request for Substitution **that are incomplete or that are not accompanied by adequate comparison/analysis** shall be automatically rejected by the Engineer, in his/her sole discretion. The Contractor may resubmit the request with complete and

adequate information. The Engineer reserves the right not to review or consider any inadequate or incomplete Request for Substitution that was rejected more than once due to incompleteness.

- D. The Contractor shall include in its Baseline Schedule and in the Submittal Schedule sufficient time to allow for the process of Contractor submitting, resubmitting, City reviewing, and Contractor incorporating Requests for Substitution. Any delays to the construction schedule as result of Requests of Substitution being denied or being rejected **for resubmittal**, or as a result of implementing the proposed substitution, shall be considered as Contractor-caused delays, for which there will be no time extension granted to the intermediate Milestone dates or time allowance for completion of all Work.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00817: TESTIN, START UP, AND COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Work specified in this section includes the requirements for the testing, start-up and commissioning of the complete Project.
- B. The testing, start-up and commissioning activities provide the necessary linkage between the system's construction and operational phases. The Work specified in this section furnishes a comprehensive means to help assure that all elements of the system meet the design, construction and installation specifications.

1.2 REFERENCES

Not Used.

1.3 RELATED SECTIONS

- A. Document 00808 - Project Meetings
- B. Document 00810 - Submittals
- C. Document 00833 - Project Management & Schedule Requirements
- D. Document 00824 - Quality Control
- E. Document 00818 - Contract Closeout
- F. Document 00821- Spare Parts and Maintenance Materials
- G. Appendix 12 Section 7 - Testing and System Acceptance.

1.4 DEFINITIONS:

A. **Factory Tests**

Factory Tests are the responsibility of the Contractor and may include Design Qualification Tests or Production Verification Tests. Design Qualification Tests verify the performance of new engineering designs. Production Verification Tests confirm that equipment and materials are manufactured in accordance with accepted workmanship standards, specifications and function as intended.

B. Construction Inspection Tests

Construction Inspection Tests are the responsibility of the Contractor and include in-process acceptance tests conducted to confirm that supplied materials or equipment meet specified standards, and that fixed facilities are constructed in accordance with specified workmanship standards and industry codes. Examples include continuity tests, soil compaction tests and concrete strength tests.

C. Installation Verification Tests

Installation Verification Tests are the responsibility of the Contractor and include in-process acceptance tests conducted at the subsystem or assembly level during the installation of each element. Examples may include shop electrical power distribution wiring continuity tests and local field acceptance tests of communications subsystems.

D. Acceptance Tests

Acceptance Tests are the responsibility of the Contractor and are conducted at the system and subsystem level to verify that the performance of each element and system/subsystem/assembly is in compliance with specification requirements. These tests are performed on-Site and are pre-requisites to the System Integration Tests.

E. System Integration Tests

System Integration Tests are the responsibility of the Contractor and are conducted to confirm that all elements of the complete Project will function properly as an integrated system. They test end-point-to-end-point verification of the system's functionality when more than one subsystem is involved.

1.5 LIST OF SUBMITTALS AND REQUIRED FORM OF SUBMITTALS

A. List of Deliverables. The Contractor shall submit SFMTA all Contract Deliverables Requirements List items as specified and described in Document 00900 Design Criteria.

B. Integrated System Test Plan:

1. An organizational chart clearly showing lines of authority, and names and responsibilities for all noted personnel. It shall identify all participants necessary to perform and complete the testing and illustrate their reporting relationships to the Contractor's management team.
2. The experience level and qualifications of personnel involved in managing, coordinating and monitoring the testing program.

3. The internal methods and communications to be used to control the program schedule, technical performances, program changes, subcontracts or purchase orders, material procurement, and field service support.
 4. An Integrated System Test Plan schedule (Gantt chart) showing key Milestones and events. Include sufficient detail to show when each type of testing begins and ends, including Factory Tests, Construction Inspection Tests, Installation Tests, Acceptance Tests, and System Integration Tests. This master program schedule must be incorporated and be consistent with the Baseline Schedule.
 5. A flow chart/critical path method (CPM) schedule of all project tasks indicating interaction of Testing and Commissioning of systems or subsystems from suppliers.
 6. Requirements and recommendations for witnessing by the Agency or its designated representative.
- C. **Test Procedures.** Submit Test Procedures as specified and described in Appendix 12 Section 7.
- D. **Test Reports.** Submit Test Reports as specified and described in Appendix 12 Section 7. Test Reports must contain all the data obtained during tests, and analysis of the data and conclusions relating to the test pass/fail criteria outlined in the test procedure. A test that fails must be repeated and any corrective action taken to pass the re-test must be outlined in a new test procedure. Each Test Report shall include all items as specified and described in Appendix 12 Section 7.
- E. **Monthly Test Program Progress Reports.** The Contractor's Monthly Progress Report shall include an assessment of the Integrated System Test Program. The assessment shall clearly show the state of the test program relative to approved schedules and identify the critical paths to project completion. A printout of the schedules to show progress to date (in chart format) describing equipment or system test activities, assigning a test identification number, status of the test, start and finish dates, and comments shall be included. The Monthly Progress Reports shall provide detailed information in narrative form on the following:
1. Test Procedures submitted for approval.
 2. Test Procedures approved for testing.
 3. Tests in progress.
 4. Tests completed.
 5. Major problems (i.e., delays incurred) and action items.
 6. Progress against the approved program schedule.
 7. Technical performance variations from the technical specification requirements.

8. Organizational changes.
9. Subcontractor programs progress.

1.6 SCHEDULING & COORDINATION

- A. The Contractor's Baseline Schedule shall include all levels of testing, start-up and commissioning prescribed in this Section. The project shall not be considered completed if the requirements of this Section, and all other sections, are not fully completed and accepted by the Engineer.
- B. Contractor shall coordinate all testing and start-up activities such that they occur in logical, related sequences.
- C. Document 00808, paragraph 1.8 on monthly coordination and progress meetings for start-up activities.

1.7 ENGINEER TO WITNESS TESTS

- A. The Engineer, having been notified by the Contractor at least 72 hours in advance, shall be present at each and every on-Site test intended to demonstrate compliance with this Contract. Any on-Site test shall not be considered valid unless it was witnessed by the Engineer and/or his/her designated staff.
- B. Contractor shall provide ample time for Engineer to witness tests outside of Site that call for the Engineer's presence based on the approved Testing and Start up Program Plan:
 1. Any tests outside of the Site but within the Bay Area: one (1) week advanced written notice
 2. Any tests outside the Bay Area: One (1) month advanced written notice.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00818: CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 DESCRIPTION

The Work specified in this Section includes the requirements for closing out the Project.

1.2 FINAL CLEANING

- A. Before final inspection by the Engineer and before the Engineer's acceptance of the Work, Contractor shall clean up all Job Sites and Work Areas.
- B. In addition to removal of all temporary facilities, Contractor shall remove all waste, debris and surplus materials from Site; remove stains, spills, and foreign substances from installations and paved areas, including haul routes; clean grounds and sweep clean all areas; and restore damaged pavement, sidewalk and facilities.
- C. Contractor shall adjust, lubricate, and clean all operating equipment and clean exposed surfaces.
- D. Contractor shall clean transparent and glossy surfaces to a polished condition and polish reflective surfaces to a clean shine.
- E. Contractor shall sweep clean all areas.
- F. Contractor shall vacuum all carpets.
- G. Contractor shall clean the exterior of the building.
- H. Contractor shall clean the interior and exterior faces of all glazing.
- I. Contractor shall remove dust or other foreign matter from all surfaces, and from within all duct Work.
- J. Contractor shall clean all pre-existing facilities to their original condition before construction, as documented in the pre-construction survey.

1.3 PRE-FINAL INSPECTION

Note: This Pre-Final Inspection by the Engineer (see Document 00824) is not the same as the final inspection performed independently by the Building Permit Agency or any other governing jurisdiction (see Document 00834).

- A. When Contractor considers the construction Work to be Substantially Complete, as defined in the Special Provisions, it shall submit written certification ("Certification of Completion") to the Engineer that:
 - 1. Contractor has reviewed the Contract Documents.

2. The Work has been inspected for compliance with the Contract Documents and in the Contractor's opinion is Substantially Complete.
 3. All Equipment and systems have been tested in the presence of the Engineer and are operational.
 4. Preliminary Punch List Work identified by Contractor's own Quality Control team has all been satisfactory completed (see Document 00824).
 5. All Non-Compliance Notices have been resolved and the Work has been corrected in accordance with the Contract Documents.
 6. All training of City personnel as specified is completed including records of completed training as required under Document 00820
 7. All Operations and Maintenance manuals have been submitted and accepted by the City.
 8. All Phase 4 deliverables have been accepted by SFMTA
 9. All as-built or record documents have been submitted and have accepted by the City.
 10. All spare parts, maintenance materials and other items as specified have been delivered and accepted by the City.
 11. All testing reports and records.
 12. All special inspections as required by the Department of Building Inspection and/or other governing jurisdictions have been cleared and accepted by the governing jurisdiction.
 13. The electrical and mechanical permits have been finalized as required by the Department of Building Inspection.
 14. Permits associated with equipment and other items constructed under this contract. Verification that these permits have been finalized and cleared by the governing jurisdiction.
 15. The Work is ready for pre-final inspection by the Engineer.
- B. After receipt of Contractor's Certificate of Completion, and in accordance with Document 00824, Engineer will perform a pre-final inspection to determine whether the Work is Substantially Complete.
- C. Should the Engineer consider that the construction Work is not Substantially Complete or defective in any manner:
1. The Engineer will promptly notify the Contractor in writing, listing the incomplete or defective Work (pre-final punch list items). The Engineer's list of incomplete or defective Work does not relieve the Contractor of their responsibilities to complete all Work as specified.

2. The Contractor shall remedy the stated deficiencies, and send a written certification to Engineer that the construction Work is complete.
3. The Engineer will re-inspect the Work, and the Contractor will further correct any deficiencies noted by the Engineer before the Engineer issues a Notice of Substantial Completion.

1.4 ITEMS REQUIRED TO BE PROVIDED FOR FINAL COMPLETION

A. Contractor shall provide the following items at the Final Completion of the Contract Work:

1. Evidence of compliance with requirements of all governing authorities, including the Certificate of Final Completion required under Document 00818 - A.
2. Evidence that all deficiencies (all remaining punch list Work items) have been satisfactory completed.
3. All warranty records/certificates.
4. Final Inspection sign-off by the Building Permit Agency with the issuance of the Final Certificate of Completion and Occupancy.
5. Delivery of the Performance Bond, in accordance with General Condition 10.2.
6. Delivery of Contract Record Documents (See Document 00819).
7. Following substantial completion and prior to the City's final acceptance inspection (see specification 1.5 below), the Contractor shall:
 - Replace all the filters and/or serviceable elements for all the systems and equipment constructed or installed under this contract
 - Check and re-fill all the fluids for all the systems and equipment constructed under this contract
 - Phase and align the radio communications system and perform any other scheduled maintenance as recommended by the manufacturer
 - Perform any routine maintenance on Mobile Equipment as recommended by the manufacturer
 - Perform any routine maintenance on portable equipment as recommended by the manufacturer
 - Perform any routine maintenance on data base as recommended by the manufacturer
 - Perform a complete system backup for all user and configuration data

- Generate back-up images of all servers and Work stations to be filed in system configuration library.

1.5 FINAL ACCEPTANCE BY CITY

Upon the satisfactory completion of all the above, the City will perform the Final Acceptance Inspection in accordance with this Document.

1.6 FINAL CLOSEOUT RELEASE

As a condition precedent to Final Acceptance by the City, final payment and release of funds retained, Contractor shall execute the form set out as Document 00818-A.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00818 - A: CONTRACT CLOSEOUT RELEASE DOCUMENT**RELEASE AND CERTIFICATE OF FINAL PAYMENT**

With reference to Agreement Between San Francisco Municipal Transportation Agency (hereinafter referred to as SFMTA) and Harris Corporation, a Delaware Corporation, through its RF Communications Division , (hereinafter referred to as CONTRACTOR) and each and every amendment thereto, for providing professional services, CONTRACTOR hereby certifies and represents that it has made full payment to all persons and entities of all approved costs, charges and expenses incurred by it or on its behalf for services supplied to CONTRACTOR by such persons and entities in connection with its performance of Work under said Agreement.

CONTRACTOR further certifies that to its best knowledge and belief, each of its subcontractors and suppliers has made full payment of all approved costs, charges and expenses incurred by them or on their behalf for Work, labor, services, materials and equipment supplied and/or used by them in connection with CONTRACTOR's Work under said Agreement.

In consideration of the receipt, and of which receipt is hereby acknowledged, of a total aggregate amount of \$_____ paid in monthly billed amounts under the provisions of the Agreement, including the final adjusting payment, if any, CONTRACTOR hereby unconditionally releases and forever discharges SFMTA and its premises and property from all claims, liens and obligations of every nature arising out of or in connection with the lack of payment for the performance of Work under said Agreement and all amendments thereto except as set forth herein:

EXCEPTIONS:

As additional consideration for all payments mentioned above, including the final adjusting payment, if any, CONTRACTOR agrees to indemnify and hold harmless SFMTA from and against all costs, losses, damages, claims, causes of action, judgments and expenses, including attorneys' fees, arising out of the lack of payment for the performance of the Work under the Agreement which may be asserted by CONTRACTOR or any of its suppliers, subcontractors of any tier, or any of their representatives, officer, agents or employees, excepting those claims listed above.

Nothing contained in this Release and Certificate of Final Payment shall have any effect upon, nor be construed in any way to relieve CONTRACTOR of its obligations under the provisions of the above Agreement, as amended, which by their nature survive completion of the Work including, without limitation, warranties, guarantees and indemnities.

Executed this _____ day of _____, 20_____

CONTRACTOR

END OF DOCUMENT

DOCUMENT 00819: CONTRACT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Work specified in the section includes furnishing Project record documents, including copies of all required record drawings, as-built drawings, conformed drawings and others.
- B. No separate payment will be made for Work covered under this Document 00819. The Work associated with this specification is considered incidental to the completion of the Work in which it pertains.

1.2 SUBMITTAL

- A. Pursuant to provisions of Document 00810 of the Supplemental Conditions , “Submittals,” the Contractor shall submit:
 - 1. Record documents including as-built drawings.
 - 2. As-Built Schedule, Certificates of Compliance. Guarantees, Warranties Test reports and records. Survey notes and sketches.

1.3 RECORD DRAWINGS

- A. Record drawings are defined as drawings produced by the Contractor, including coordination and shop drawings, and field sketches, showing the Work, revised (conformed) to show as-built conditions and field surveys and measurements.
- B. Record drawings shall be conformed to accurately document all Work performed during construction including any dimension, installation, location, detail, elevation and all other information not shown on the original Contract Drawings, with particular emphasis on the location and depth of underground utilities and facilities.
- C. All record drawings shall be prepared by a skilled draftsman, working under the supervision of the Prime Contractor’s Field Engineer, including record drawings for Work performed by a sub-Contractor.

- D. As the Work progresses, the Contractor's Field Engineer shall prepare record drawings on a day-to-day basis. Information will be recorded on the day it becomes known. Original data that is superseded shall be lined out and still remain legible. Extensive changes which cannot be made on the original plan sheet shall be made on a new Contractor prepared drawing. Each change shall be dated and initiated by the Contractor's Field Engineer. No Work shall be permanently concealed until the information has been recorded on record drawings.
- E. For fabricated material and equipment, Record Drawings showing installation layouts and details, as well as the wiring and connection diagrams with the appropriate marking and coding of wires, conduit and pipes.
- F. At anytime, the record drawings shall be available for the inspection of by the Engineer. Such review by the Engineer shall not relieve the Contractor of its responsibility for keeping the record drawings current and complete.
- G. At the completion of the Work, the Contractor shall deliver to the Engineer the complete set of the originals of the record drawings. Each such drawing shall be signed and dated by the Contractor's Field Engineer and he/she shall attest thereon that these records are complete, accurate and represent as-built conditions. Each completed record drawings shall be transmitted to the Engineer as soon as the Work on that drawing is completed.
- H. The size and format of the Contractor-furnished record drawings shall match the requirements for shop drawings with space for the City's title block.
- I. The Contractor shall submit to the Engineer at Final Completion, the complete set of record drawings, covering his/her and his/her sub-Contractor's Work. The Engineer will review that set for up-to-date completeness and will return the set to the Contractor within ten (10) working days after receiving the submittal. On a monthly basis, the Contractor shall make available for review, the complete set of record drawings as stated above.
- J. If Record Drawings are not updated as the Work progresses, are not accurate or complete, or are not furnished, progress payments, and if necessary, final payment will be withheld.

1.4 AS-BUILT DRAWINGS

- A. The Contractor shall legibly mark-up the Contract Drawings for as-built conditions.
- B. Full size Contract Drawings shall be used for as-built purpose.
- C. At anytime, the as-built drawings shall be subject to inspection by the Engineer.

1.5 AS-BUILT SCHEDULE

As-built schedule shall be submitted in both print format and CD format in accordance with Document 00833.

1.6 MAINTENANCE OF RECORD DRAWINGS

- A. Store Project Record Drawings apart from documents used for performing the Work; keep in a dry, legible condition, and in good order. Label each document "RECORD DRAWINGS - JOB SET" in large, neatly printed letters. Contractor shall not use Record Drawings for construction at any Job Site.
- B. Record neatly on the Record Drawings all changes made by clarifications, Change Orders, and other modifications to the Contract Documents.
 - 1. Clearly describe changes on Drawings by note as required.
 - 2. Date all entries, calling attention to the entry by a "cloud" drawn around the area or areas affected.
 - 3. Record in each Specification Section the manufacturer, trade name, catalog number, and supplier of each product and equipment item incorporated into the Work.
 - 4. Furnish reproducible record drawings made from final shop drawings that have been updated to show actual conditions. Furnish additional drawings as necessary to record deviations from the sizes, locations, and other features of the Work and to locate piping, conduit, ductwork, and similar elements of utility installations by dimensions referenced to permanent accessible features of the Work.
 - 5. Show on the job set of Record Drawings, by dimension accurate to within one inch, the centerline of each run of conduits, circuits, piping, ducts, and similar items which are shown schematically on the Drawings but where the final physical arrangement is determined by Contractor, subject to the Engineer's approval.

END OF DOCUMENT

**DOCUMENT 00820: TRAINING PROGRAMS AND OPERATIONS
AND MAINTENANCE MANUALS**

PART 1 – GENERAL

1.1 DESCRIPTION

- A. The Contractor shall prepare and conduct a Training Program and provide Training Materials in accordance with the requirements of Document 00900, Design Criteria, **Appendix 12 Section 8.**
1. The Contractor shall prepare and conduct a Training Program for the City's personnel to educate/train these personnel in the proper operation and maintenance tasks required for the referenced equipment and systems
 - a. Present training course /sessions with emphasis on safety, operation, and preventive and corrective maintenance activities, including troubleshooting methodology, and simulated conditions and situations for repair.
 - b. Provide all instructors, documentation (e.g., operations and maintenance manuals and schematic drawings of the equipment and systems), and supplies necessary to train personnel.
 2. Training on the actual system equipment is encouraged; however, such use shall not proceed prior to the Contractor's completion of testing and verification activities. Upon completion of each training course the equipment shall be returned to its original condition.
- B. The Contractor shall provide Operations and Maintenance Manuals for all referenced materials, equipment & systems in accordance with the requirements of Appendix 12 Section 9. These manuals shall include product data, shop drawings and related information appropriate for the City's operation and maintenance of the equipment and systems provided under this Contract

Prepare the Operations and Maintenance Manual documentation as specified in this section and as referenced in other sections of the specifications:

- a. The Operations and Maintenance Manual shall be comprehensive and of sufficient detail so that it can be used as a basic text for course instruction. It shall explain in full detail all aspects of operation and maintenance for the equipment and systems.
- b. The Operations and Maintenance Manual shall be organized to permit the City personnel to develop, within its own organization, the capacity to continue the education of its personnel.

1.2 REQUIREMENTS SPECIFIED ELSEWHERE

- A. Section 00810: Submittals
- B. Section 00815: Materials and Equipment
- C. Section 00817: Facility Testing, Start-Up, and Commissioning
- D. Section 00818: Contract Closeout
- E. Appendix 12 Section 8: Training, Support, and System Maintenance
- F. Appendix 12 Section 9: Project Management and Documentation

1.3 QUALITY ASSURANCE

- A. The Training Program shall be designed to be delivered by qualified Instructors familiar with the equipment and systems provided under this Contract.
 - 1. Ensure that the Instructors are familiar with the safety precautions, installation, Testing, and Start up procedures for all equipment and systems. Refer to Section 00817.
 - 2. Provide to the Engineer the instructors resumes identifying qualifications and teaching experience.
 - 3. The Instructors shall assume no prior knowledge of the features of the supplied equipment on the part of the SFMTA personnel. However, the Contractor may assume that the City personnel have the basic skills pertinent to their crafts.
- B. Preparation of Operations and Maintenance Manuals data shall be done by qualified personnel.
 - 1. The personnel shall be trained and experienced in the maintenance and operation of the described equipment, systems or products.
 - 2. The manuals shall be developed by a skilled technical writer to the extent required to communicate essential data with skilled drafters competent to prepare required drawings.

1.4 LIST OF SUBMITTALS AND REQUIRED FORMAT OF SUBMITTALS

- A. Training Program Plan:

The Contractor shall provide a comprehensive Training Plan for the review and acceptance by the City, as specified in Appendix 12 Section 8. The primary objectives of the training program shall be to develop within the City capability to perform operations and maintenance activities.

 - 1. Include as a minimum the following:

- a. A narrative description of the objectives, scope, and depth of the training program.
 - b. A statement of the experience of the personnel having prime responsibility for the preparation and implementation of the program and resumes of all proposed instructors.
 - c. A detailed narrative description and summary matrix of the training courses to be conducted, including but not limited to:
 1. Curriculum outline including various levels of training and any courses to be offered more than once.
 2. Lesson plan outline for each course.
 3. Delivery strategies for each course i.e., (classroom presentations versus hands-on-practice or combination).
 4. Schedule and estimated time for presenting the course material, differentiating between hours for classroom training versus hands-on-practice.
 5. List of training aids. Indicate which aids are to be City-furnished
 6. Description of facility requirements and estimated time of use.
 7. Training reports format.
 8. Number of training manuals for each course.
2. The City will comment on the Training Plan. The Contractor shall revise the Training Plan and resubmit to Engineer within twenty (20) calendar days of receipt of comments.
- B. Lesson Plans:
The Contractor shall submit lesson plans in accordance with the Training Plan for each course no later than sixty (60) days prior to the commencement of training. Include in the lesson plans an in-depth outline of the materials to be presented for each course and a description, drawing, or photograph of the training aids to be used and sequence of learning activities. The lesson plans will be required to be of sufficient depth and comprehensiveness to be used by the City for subsequent training.
- C. Training Reports:
The Contractor shall submit training reports in accordance with the approved Training Plan. Submit biweekly reports from start of Training Program to the end of Training Program. The Training Reports shall discuss, in narrative format, the following:
- a. Status of training courses in progress to the reporting date.

- b. Training courses completed. Attach attendance logs of all completed courses including the name of the course, date and place of training, instructors' names, training manuals and sign in attendance list.
 - c. Problem e.g., (program delays, equipment malfunctions, etc.).
 - d. Action items.
 - e. The Training Reports shall include a current assessment of Training Program progress against the Baseline Schedule.
- D. Operations and Maintenance Manuals:
The Contractor shall prepare the Operations and Maintenance Manuals for safety, preventive and corrective maintenance and fault troubleshooting.
- 1. Format of Operation and Maintenance Manuals:
 - a. Drawings numbered and indexed.
 - b. Electronic documentation.

1.5 GENERAL REQUIREMENTS FOR TRAINING PROGRAM AND TRAINING PROGRAM PLAN

- A. The Training Plan shall include familiarization with the equipment operation and performance, and detailed instructions in operation, maintenance and test procedures for all equipment and systems.
- B. The Training Program Plan shall include detailed training requirements for all equipment and systems noted in Appendix 12 Section 8.
 - 1. Training shall consist of both classroom and hands-on training.
 - 2. Training shall emphasize safety, operations, testing, troubleshooting, repairs, operation procedures, and maintenance activities.
- C. The Training Program shall include the equipment Operation and Maintenance Manual as a basic text for instruction. Additional Training materials may be required for complex system and equipment and shall be included as part of the Program. The program shall be organized to permit the City to develop, within its own organization, the capability to continue the education of its personnel in the proper operation, maintenance and repair of the equipment. The Contractor shall assume no prior knowledge of the equipment on the part of the City personnel.
- D. Training Courses are specified in Appendix 12 Section 8.

1.6 TRAINING CLASS SIZE

Training class size is specified in Appendix 12 Section 8.

1.7 TRAINING SCHEDULE

The Contractor's proposed dates for training shall be reflected in the Baseline Schedule of Document 00833 and contained in the Training Plan. The training schedule development shall include:

1. Designing the courses of sufficient length to properly cover the material in an in-depth manner to respond to any questions posed by the students.
2. Contractor shall provide training to SFMTA personnel working all shifts, but training for all three shifts may not be provided on a single day.
3. Schedule the beginning of the courses to coordinate with Document 00817.

1.8 FACILITIES AND EQUIPMENT

The Contractor shall provide all training equipment. The following equipment and facilities will be provided by the City. Training facilities are described in Appendix 12 Section 8.

1.9 GENERAL REQUIREMENTS FOR OPERATIONS AND MAINTENANCE MANUALS

- A. The following Operations and Maintenance Manuals shall include detailed requirements for each of the following equipment and systems.
 1. Provide detailed Operations and Maintenance Manual requirements for all equipment and systems.
 2. The Operations and Maintenance Manuals shall discuss safety, operations, testing, troubleshooting, repairs, operation procedures, and maintenance activities.
- B. Submit the Manufacturer's Operations and Maintenance Manuals giving complete instructions relative to assembly, installation, operation, adjustment, lubrication, and maintenance activities.
- C. Complete parts list shall be included for every item of machinery and equipment furnished by the Contractor.
- D. Operations and Maintenance Manuals furnished may be the manufacturer's standard publications in regard to size and binding, provided they comply with the specified requirements relative to quantity and quality of information and data. All material not specific to the installed equipment shall be removed or crossed out.
- E. Manuals shall be bound in binders as specified in 1.04.D. Illustrations shall be clear. Printed matter, including dimensions and copy on drawings, shall be easily legible. Larger drawings may be folded into manuals to page size.

Manuals shall contain the following:

1. Table of Contents, in numerical order.
2. Index, in alphabetical order.
3. Manufacturer's literature describing each piece of equipment and giving the manufacturer's model number and drawing number.
4. Operation instructions including a step-by-step preparation for starting, testing, operation, troubleshooting, shutdown and draining.
5. Control diagrams, as installed by the manufacturer.
6. Sequence of operation by the control manufacturer.
7. Record shop drawings, as approved.
8. Wiring diagrams as-installed and color-coded, of electrical motor controllers, connections and interlock connections.
9. Diagrammatic locations, functions and tag numbers of each valve.
10. Maintenance instructions: A detailed program and procedure to include recommended daily, weekly, monthly and annual preventive maintenance. Give hours required for maintenance and repair Work and required skill levels.
11. Possible breakdowns with instructions for repair.
12. The manufacturer's parts list of all functional components, control diagrams and wiring diagrams, giving the manufacturer's model number and the manufacturer's part number.
13. "Long-Lead-Time" spare parts list for all spare parts not readily available on the open market or for which it is anticipated ordering a delivery time will exceed ten (10) days.
14. List of nearest local suppliers of all equipment parts, with phone numbers.
15. Lubricating schedule including type and frequency of lubrication.
16. Information on the projected maintenance activities, frequency, duration and skill level required, presented in matrix form.
17. Manufacturer's warranty and guarantee data.
18. Spare parts data as follows:
 - a. Compile list of parts and supplies, with current unit prices and sources of supply.
 - b. List of parts and supplies that are furnished at no extra cost with the purchase of equipment, or specified herein to be furnished as part of the Contract.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00821: SPARE PARTS AND MAINTENANCE MATERIALS**PART 1 - GENERAL****1.1 REQUIREMENTS INCLUDES**

- A. Spare parts and accessories.
- B. Tools used for maintenance and repair.

1.2 RELATED REQUIREMENTS

Each section of Specifications that specifies spare parts, accessories, lubricants, insulating oil or like products, and maintenance tools.

1.3 SUBMITTALS

- A. Submit in accordance with Document 00810.
- B. Submit manufacturer's recommended spare parts and maintenance tools lists with Product Data submittals for approval of systems and equipment.
 - 1. Include with submittals information the quantities, unit prices, storage and protection requirements, and quantities to be furnished as part of the Contract.
 - 2. Prominently display manufacturing dates on products with "useful life" properties.
- C. Spare parts and tools shall be provided in accordance with Document 00815.
- D. Transportation, handling, inspection and acceptance of spare parts and maintenance materials shall be in accordance with Document 00815.
- E. Provide warranties for component spare parts in accordance with provisions of the Contract.
- F. Comprehensive list of spare parts as required in Appendix 12 Section 8. List shall include the following information.
 - a. Description of item including manufacturer and manufacturer contact information
 - b. Quantity
 - c. Specify the location of delivered items
 - d. Name of City personnel that accepted the items
 - e. Spare parts specified to be provided in various sections of the Specifications shall be manufacturer's standard commercial products, new, free from defects, of the grade and quality specified, and delivered as original equipment.

Delivery, storage and protection of spare parts shall be in accordance with Document 00815.

1.4 SPARE PARTS AND MAINTENANCE MATERIALS

Spare parts and maintenance materials of the type and quantity indicated in the Specifications shall be delivered to the Engineer at the Site prior to final testing and acceptance of the subject equipment. Where applicable, accessories and maintenance tools shall be included with the spare parts delivered in accordance with Document 00815.

1. Package and label separately in containers plainly marked
2. "SPARE PARTS" and "MAINTENANCE MATERIALS"
3. Provide as maintenance material six (6) month's supply of lubrication materials and other consumables used in operation of equipment and systems and any maintenance or repair tools that are not manufactured by more than three manufacturers.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF SECTION

DOCUMENT 00822: ENVIRONMENTAL MITIGATION MEASURES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 DESCRIPTION

- A. This section includes special project conditions and requirements for construction including but not limited to, water, noise, vibration, debris, and providing for barricades and accessibility. This Section also includes mitigation measures to control dust, and Asbestos Airborne Toxic Control Measure for Construction.
- B. No separate payment will be made for Work covered under this specification. The Work associated with this specification is considered incidental to the completion of the Work in which it pertains.

1.2 CITED REFERENCES

- A. Ordinance # 175-91, Article 21, Section 1100 to 1107 of the San Francisco Municipal Code (Public Works Code).
- B. San Francisco Department of Public Works "Guidelines for the Placement of Barricades at Construction Sites" (DPW Order No. 167,840).
- C. Chapter 44 of the San Francisco Building Code.
- D. The California Building Code (Title 24, Part 2, Accessibility Standards), and the Americans with Disabilities Act.
- E. The Dust Control Order No.171, 378 of the Regulation for Excavating and Restoring Streets in San Francisco.
- F. San Francisco Noise Control Ordinance (Article 29 of the San Francisco Police Code, Ordinance # 274-72).
- G. The Final Regulation Order of the California Code of Regulations (CCR) Title 17, Public Health, Section 93105, on Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying, and Surface Mining Operations (<http://www.arb.ca.gov/toxics/atcm/asb2atcm.htm>).

1.3 SUBMITTALS

- A. The Contractor shall submit the Plans listed below, and have the Plans approved by the Engineer at least ten (10) working days before any dirt disturbing activity, and no later than thirty (30) calendar days after the Notice to Proceed for Construction.

- B. Pursuant to the provisions of Document 00810, Submittals, the Contractor shall submit the following as separate submittals, and as per specification:
1. A Health and Safety Plan as per Document 00828, Health and Safety Criteria.
 2. Air Pollution Control Plan (APCP) for Dust Control as per Part 1.16 in this Section.
 3. Asbestos Dust Mitigation Plan (ADMP), as per Article 1.17 in this Section.
 4. Vibration Control Plan (VCP)
 5. Excavated Soil Management Plan
 6. Ground Water Dewatering and Storm Water Control, Storm Water Pollution Prevention Plan (SWPPP), Best Management Practice, and Erosion and Sediment Control Measures as per Document 00834.
- C. On approval of the above Plans, and in addition to eight (8) hard copies, the Contractor shall provide two copies of each Plan on a disc, in Microsoft Word format.

1.4 CONTRACTOR'S FACILITIES

Locations of sanitary facilities, storage areas, parking and other Contractor facilities shall be subject to the prior approval of the Engineer.

1.5 TEMPORARY WATER SERVICE

- A. Potable Water:
1. Arrange with the San Francisco Water Department to provide potable water obtained by connecting to City water systems. Contact the Water Department for arranging such water service.
 2. Water may be available from fire hydrants located in the streets. Obtain permission from and fill out an application to use water from a hydrant with the San Francisco Water Department.
 3. Pay the costs of permit fees, connection fees, meters, and all water usage furnished by the San Francisco Water Department under the water service account established above. The City will not reimburse these costs.
- B. The Contractor is advised that Ordinance # 175-91, Article 21, Section 1100 to 1107 of the San Francisco Municipal Code (Public Works Code), restricts the use of potable water for soil compaction or dust control activities, to the extent not directly in conflict with any applicable federal, state and local law.
1. In consideration for potential health concerns, an exemption may be allowed for the use of potable water for soil compaction or dust control

activities when human contact and exposure exists. Such exemption will be considered and may be granted on a case-by-case basis.

2. Should the Contractor seek to use potable water for soil compaction or dust control activities, the Contractor, shall apply for, and obtain an exemption pursuant to Ordinance #175-91, Article 21, prior to its use. The application for such use of potable water is to be sent to Ken Sato of the Department of Public Health, Bureau of Environmental Health Services, 1390 Market St, Suite 210 San Francisco, CA 94102. Pursuant to Ordinance #175-91, Article 21, the General Manager of the Water Department may grant permission for such use.
- C. Reclaimed Water: The Contractor shall fill out an application with the Southeast Water Pollution Control Plant (SEWPCP) to obtain reclaimed water for dust control. Reclaimed water is available at no cost to the Contractor at the SEWPCP from 8:00 A.M. to 5:00 P.M. on weekdays and Saturdays.
1. Arrangements can be made for access to reclaimed water at other times.
 2. A permit is required to obtain reclaimed water from the City. Contact the Watch 6 Chief at least three (3) days prior to the date that reclaimed water is required. Processing the application for reclaimed water may take longer than three days if its use is for other than dust control.
 3. The Contractor is responsible for the handling and transportation of reclaimed water as well as any permit and discharge fees.
- D. Is responsible for all connections, hoses, materials and equipment required to access the water and any damage to the systems as a result of making temporary connections.
- E. Is required to provide and maintain its own distribution piping, water tankers, hoses, and all appurtenances necessary to supply water at the Site.
- F. Hoses crossing traveled roadways shall be buried beneath the roadway or be ramped over.

1.6 SURFACE WATER CONTROL

- A. Provide methods to control surface water to prevent damage to the Work, and adjoining public and private property.
- B. Direct surface drainage away from crosswalks, sidewalks, excavations and construction areas. Direct drainage to storm drains. Prevent silt runoff to public roadways by installing sandbags or other controlled measures.
- C. Provide, operate and maintain pumping equipment of adequate capacity to control water to protect public and private property and allow the Work to proceed as scheduled.

- D. Ensure soil stockpile covering is secured with visqueen prior to anticipated storm events.
- E. Place silt fences, straw bales or other appropriate means along low-elevation boundaries of the Site to restrict soil-laden runoff from the Site.
- F. Refer to Document 00834 – Ground Water Dewatering and Storm Water Control, Storm Water Pollution Prevention Plan (SWPPP), Best Management Practice, and Erosion and Sediment Control Measures.
- G. Provide a plan for the cleanout of concrete trucks during concrete placement operations and document such plans in the SWPPP. Washout of concrete trucks shall not occur on Site nor shall it be allowed into the sewerage.
- H. Provide a means to vacuum slurry (generated from saw cutting operations), so as to prevent it from going into the storm drains, and document such means in the SWPPP.

1.7 TEMPORARY SANITARY FACILITIES

Provide and maintain required toilet facilities and enclosures for all Contractors' personnel. The location of facilities is to be approved by the Engineer.

1.8 PLACEMENT OF BARRICADES

- A. Take all necessary precautions to isolate and protect the public from hazardous conditions by using protective barricades during construction and with warning lights during darkness.
- B. Erect and maintain a security fence along the boundary of the MUNI Site to control Site access, prevent unsafe entry to construction areas, and to protect existing facilities and adjacent properties from damage from construction operations.
- C. A dust curtain shall be placed around the entire perimeter of the project Site to control dust within the excavation area. Dust enclosures and collectors shall be used as needed under direction of the Project Engineer.
- D. Comply with the requirements of the San Francisco Department of Public Works "Guidelines for the Placement of Barricades at Construction Sites" (DPW Order No. 167,840), and additional mitigation measures outlined in the SMP.
- E. Refer to Document 00829 - Traffic Routing and Temporary Pavement Markings.

1.9 ACCESSIBLE PATH OF TRAVEL (PUBLIC THOROUGHFARE)

- A. Except as indicated or otherwise approved by the Engineer; the Contractor's construction operations shall not occupy public sidewalks except where

pedestrian protection is provided in accordance with the requirements of Chapter 44 of the San Francisco Building Code and the regulations of public authorities having jurisdiction. In no event, shall the Contractor place materials or equipment in the path of travel.

- B. When Work is to be performed over an active public thoroughfare (path of travel) such as a sidewalk, the Contractor shall close the thoroughfare if possible, or take other precautions such as installing screens or barricades.
 - 1. When exposure to heavy falling objects may exist, the Contractor shall provide special protection of the type detailed in 29 CFR 1910/1926 and as required by Cal/OSHA.
 - 2. Provide temporary fencing, barricades, or other barriers with a solid continuous bottom rail such as 2x4's or other material of high contrast attached to its base. The purpose of this is to direct visually impaired and/or disabled pedestrians to and through a path for temporary travel through the construction area and to protect them from obstacles and hazards.
 - 3. Provide proper barricades and temporary curb ramps (max 1:12 slope) at all closed crosswalks and curb ramps.
 - 4. Provide 45-degree beveled smooth, non-tripping transitions at all path-of-travel height changes that is equal to or more than ¼-inch in height, but not exceeding ½ inch.
- C. Maintain at least one accessible travel path for persons with disabilities and pedestrians around the construction Site that conforms to the requirements of federal, state, and local laws, including the California Building Code (Title 24, Part 2, Accessibility Standards), and the Americans with Disabilities Act. The Contractor shall remove debris and other construction material from pedestrian walkways.
- D. Do not store, stockpile, or place any equipment, materials, or supplies in public streets and sidewalks without obtaining prior written approval from the Engineer, and in accordance with Document 00829 - Traffic Regulation.

1.10 MAINTENANCE OF THE WORK AREA AND DEBRIS CONTROL

- A. Maintain Work areas under its control and adjacent public right-of-ways in a safe condition, and remove all accumulations of debris and surplus materials at the end of each working day. The Contractor shall restore it to its original condition that existed prior to the start of Work. At completion of the contract, the Contractor shall leave it in a clean and orderly fashion.
- B. Cleaning during Construction: Control the accumulation of waste materials and debris; collect waste from construction areas and the project Site, daily. The Contractor shall also:

1. Comply with requirements of NFPA 241 for removal of combustible waste material and debris.
2. Maintain Work areas and adjacent areas free of dust and other contaminants during construction.
3. Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose these types of materials in a lawful manner.
4. Maintain the Site and all adjacent public areas in a clean and orderly condition. Maintain the Site, equipment, fences and signs free of graffiti. Remove all graffiti daily, using methods, which cause no damage to the Work and existing facilities.
5. Sweep all pedestrian walkways and dispose of debris around the Site perimeter on a daily basis, and as often as determined by the Engineer.
6. Keep all debris, hazardous/contaminated material, surplus concrete and excavated materials, etc., off the roadway, sidewalks and sewers at all times in all areas under the Contractor's control and adjacent public right-of- ways.
7. Remove trash (waste oil, oil rags, etc.) and debris from the Site at frequent intervals or as directed by the Engineer, so that its presence will not delay the progress of the Work or cause a nuisance.
8. Storage areas: Ensure that materials to be used for construction are stored in designated structures or areas by the appropriate trades. Maintain such areas or structures in a clean condition for the life of the Contract.
9. Provide and maintain proper storage with secondary containment for lubrication oil, hydraulic fluids, waste oils, fuels, solvents and other hazardous or toxic materials and wastes.
10. Supervision: Oversee all cleaning of areas by trades using them and ensure that resulting accumulations are deposited in appropriate containers.
11. Burying or burning of trash and debris on the Site is not permitted.
12. Removed materials, trash, debris shall become the property of the Contractor and shall be removed from the Site and disposed of in a legal manner.
13. Contractor shall be responsible for cleaning and removing debris it brings or causes at any Site. Contractor shall not be responsible for the removal of graffiti from a Site except where Contractor has exclusive control of the Site or where Contractor has negligently failed to secure the Site.

- C. Initiate and maintain a specific daily program to prevent the accumulation of debris at the construction Site, storage, and parking areas, and along streets, roads and haul routes. The Contractor shall:
 - 1. Provide containers for the deposit of debris.
 - 2. Prohibit overloading of trucks to prevent spillage.
 - 3. Inspect traffic areas and haul routes to enforce requirements.
- D. Immediately remove materials deposited outside of approved storage areas.
- E. On a daily basis, remove all debris from all areas, including haul routes, caused directly or indirectly by the Contractor's operations.

1.11 HAZARDOUS MATERIALS USED IN THE WORK

- A. General: Minimize the use of hazardous materials in performing the Work. When materials containing hazardous substances or mixtures are necessary to perform the Work, then material usage shall be:
 - 1. In strict adherence to Cal/OSHA's safety requirements
 - 2. The manufacturer's warnings and application instructions shall be listed on the Material Safety Data Sheet (MSDS) provided by the product manufacturer.
- B. The Contractor is responsible for coordinating the exchange of MSDS or other hazard communication information between the Engineer, its employees and subcontractors at the Site as per federal, state and local regulations.
- C. The Contractor shall notify the Engineer when a specific product or equipment, or their intended usage, may be unsafe prior to ordering the product or equipment or prior to the product or equipment being incorporated in the Work.
- D. Known carcinogenic materials in any form or application shall not be used in the construction of this project.
- E. Should hazardous substances be used, provide the Engineer with its information, and clearly indicating:
 - 1. Area or areas where the hazardous substances are to be stored and to be used.
 - 2. The Contractor's preventative measures, means, and facilities to prevent spillage and contamination of soil, water and atmosphere by the discharge of noxious substance.
- F. The City and County of San Francisco is not responsible for any such material brought to the Site by the Contractor, subcontractor, suppliers, or anyone else for whom the Contractor is responsible.

- G. Hazardous Materials Certificate of Registration: The Contractor shall obtain, pay, and keep current a hazardous materials certificate of registration and implement the hazardous materials plan submitted with the registration application, as per Articles 21, 21A, and 22 of the San Francisco Public Health Code. Contact the SFDPH/HMUPA. The Hazardous Materials Certificate of Registration includes and is not limited to:
1. A chemical inventory
 2. An emergency response plan
 3. A training program for employees in safety procedures in the event of a release or a threatened release of hazardous materials.
 4. A Site map showing where the hazardous materials are located
- H. The Contractor shall obtain, pay for, and keep current a Flammable/combustible material storage permit from SFFD.
- I. The Contractor shall not use any building materials that contain Asbestos Containing Construction Materials (ACCM). ACCM is defined by Cal/OSHA, 8 CCR 1529 (q) and (r), as any manufactured construction material that contains more than one-tenth of one percent (0.1%) asbestos by weight.
- J. The Contractor shall not use any building materials that contain lead-based paint (LBP). LBP is defined by Title 17, CCR, Division 1, Chapter 8, Section 35033, as paint or other surface coatings that contain an amount of lead equal to, or in excess of one milligram per square centimeter (1.0 mg/cm²) or more than half of one percent (0.5%) by weight.
- K. Should the City tests of the building material results in a concentration above those mentioned above for asbestos and lead, the Contractor shall be responsible and liable for the damages and cost incurred by the City, and for the cost of the removal, abatement, and replacement of the building material.

1.12 SEWER POLLUTION CONTROL

- A. Do not dispose of construction material, concrete, debris, sediments, wastes, effluent, chemicals, or other such substances into catch basins, manholes, storm drains, and sanitary sewers. Section 123 of Article 4.1 of the Public Works Code prohibits the discharge of solids into the City's sewerage system.
- B. Washing out of concrete trucks into the sewerage system or into the excavation is not permitted.
- C. Control sewage and contain it within covered conduits. Dispose of properly.
- D. Schedule catch basin maintenance to clean out debris/sediment build-up.
- E. Move stockpiles away from curbs and catch basin inlets.

- F. Refer to Document 00834 – Groundwater Dewatering and Storm Water Control for other requirements.

1.13 AIR POLLUTION CONTROL

- A. 1.13 A apply to any Work performed pursuant to the contract, including any air pollution control rules, regulations, ordinances and statutes specified in Section 11017 of the California Government Code.
- B. In the absence of any applicable air pollution control rules, regulations, ordinance, or statutes governing solvents, all solvents, including but not limited to the solvent portion of paints, thinners, curing compounds, and liquid asphalt used on the project shall comply with the applicable material requirements of the Bay Area Air Quality Management District. All containers of paint, thinner, curing compound or liquid asphalt shall be labeled to indicate that the contents fully comply with said requirements.
- C. Implement the specific air pollution controls to reduce exhaust emissions of particulate matter and other pollutants from construction and related equipment, to a less significant level, by:
1. Preventing the accumulation of toxic concentrations of chemicals.
 2. Preventing harmful or obnoxious dispersal of pollutants into the atmosphere.
 3. Limiting vehicle speed limit on unpaved roads to fifteen (15) miles per hour (mph).
 4. Prohibiting idling motors when equipment is not in use or when trucks are waiting in queues. The idling time of all construction equipment used at the Site shall not exceed five (5) minutes.
 5. Limit the hours of operation of heavy-duty equipment and/or amount of equipment in use to what is needed.
 6. All equipment shall be properly tuned and maintained in accordance with the manufacturer's specifications.
 7. Alternative fuel or electrical construction equipment shall be used at the project Site. See Special Provisions
 8. Use the minimum practical engine size for construction equipment.
 9. Gasoline-powered equipment shall be equipped with catalytic converters, where feasible.
 10. Implementing specific maintenance programs to reduce emissions from equipment that would be in frequent use for much of the demolition and construction periods.

1.14 DUST CONTROL

- A. San Francisco DPW will monitor dust generation during construction at the MUNI Site. Results of the monitoring will be used by the construction Contractor for determining appropriate dust control practices, in accordance with the criteria listed in Order No. 173,378 of the *Regulations for Excavating and Restoring Streets in San Francisco* (DPW, 1999).
- B. Prior to starting Work at the Site, and before commencement of soil moving activities, the Contractor shall submit an Air Pollution Control Plan (APCP) to the Engineer for his/her approval. The Air Pollution Control Plan (APCP) is the Contractor's preventive program to minimize potential public health impacts associated with visible dust emissions, respirable nuisance dust (PM10) and air quality pollutants. The Air Pollution Control Plan (APCP) shall include the following, and the all the provisions of Article 1.16 of this Section:
1. Measures to minimize visible dust emissions.
 2. Product description and MSDS of the chemical to be used to amend the water used for misting.
 3. Methods to prevent the accumulation of dirt or mud on adjacent streets.
 4. Watering resources to be used to provide continuous water misting during dust generating activities.
 5. Description of wheel washers or other engineering controls to be used to wash off tires, tracks and spoils trucks before they re-enter City streets. Vehicles and equipment wash down facilities shall be designed to be accessible and functional during both dry and wet conditions
 6. Sample form to log wet sweeper schedule for daily cleaning of streets, and sidewalks, during excavation and dirt moving activities.
 7. Additional engineering controls or other mitigation control measures to be implemented if air quality project action levels are exceeded.
 8. Copies of service records that construction equipment has been tuned and maintained in accordance with the manufacturer's specifications
 9. Mitigation and engineering controls to be used to prevent excessive emissions of diesel exhaust fumes.
 10. Administrative and engineering controls in the event the AAQPAL criteria (below) are exceeded.
- C. Ambient Air Quality Project Action Levels (AAQPAL): the Contractor in its construction activity shall not exceed action levels for airborne contaminants (dual units not applicable, as these are field and monitoring instrument measurements):

1. Total Particulate 0.12 mg/m³
2. Respirable Particulate (PM₁₀) 0.09 mg/m³
3. Lead Dust 0.75 µg/m³

***The above threshold levels are neither health screening nor risk-based criteria, but is a means of monitoring the Contractor's implementation and adherence to environmental mitigation measures referenced and specified in the Contract. The City will monitor air quality as part of the environmental monitoring process. The Contractor shall implement more stringent air pollution and dust controls as directed by the City. The Contractor shall be assessed liquidated damages if it exceeds any one of the above project action levels.

- D. Practice care during construction to minimize dust generation. Furnish all labor, equipment and means required to carry out effective measures whenever and as often as necessary to prevent its operation from producing dust in amounts damaging to property or cultivated vegetation, or causing a nuisance to local residents. Is responsible for any damage resulting from dust originating from its operations.
- E. Observe and adhere strictly to all of the following specific dust control measures so as to achieve a goal of "NO VISIBLE DUST EMISSIONS." This means that the Contractor shall not emit particles from any operation in sufficient number to cause annoyance to any other person, which particles are large enough to be visible as individual particles at the emission point or of such size and nature as to be visible individually as incandescent particles (BAAQMD Regulation 6-305, Particulate Matter and Visible Emissions, (<http://www.baaqmd.gov/regs/rg0600.pdf>).
- F. Treat water for dust control with a biodegradable, non-polluting, non-toxic dust control chemical. The water so treated becomes "amended" water. As part of the Air Pollution Control Plan (APCP), the Contractor shall include the MSDS and other related information on the dust control chemical(s) used.
- G. Provide continuous water misting using as fine a spray or mist as possible in any area of land clearing, earth movement, excavation, drillings and other dust generating activity. All active construction areas shall be watered at least three times per shift per day.
- H. Wheel washers shall be installed and used to clean all trucks and equipment leaving the construction Site. Tires or tracks and spoils trucks shall be washed off before they re-enter City streets to minimize deposition of dust-causing materials.
- I. Minimize the amount of excavated material or waste materials stored at the Site.
- J. Water down areas around soil improvement operations, excavation and trenching, grading, compaction and paving, visibly dry disturbed soil surface

areas, and visibly dry disturbed unpaved driveways, at least three times per shift per day. All unpaved access roads, parking areas, and staging areas at the construction Site shall be paved; otherwise, water or non-toxic soil stabilizers shall be applied to all unpaved access roads.

- K. During all excavation and dirt moving activities, wet sweep/vacuum the streets, sidewalks, paths and intersections where Work is in progress at least three times per shift per day. Once at the end of the shift or as directed by the Engineer.
- L. For wet sweeping use a vacuum sweeper vehicle with sufficient suction to ensure that the vehicle does not blow dust towards neighboring businesses or residences. The Engineer will evaluate the effectiveness of the Contractor's vacuum sweeper vehicle and, if necessary, will require the Contractor to provide a more powerful and effective vehicle.
- M. Use reclaimed water for dust control as described in City Ordinance # 175-91, Article 21, Section 1100 to 1107 of the San Francisco Municipal Code (Public Works Code).
- N. A dust curtain shall be placed around the entire perimeter of the project Site to control dust in the excavation area. Dust enclosures and collectors shall be used as needed at no additional cost to the City.
- O. Any stockpile of excavated materials, backfill material, import material, gravel, sand, road base and soil shall be placed on, and covered with 10 mils (0.01 inch) polyethylene plastic or visqueen tarp and braced down. The Contractor shall maintain this cover throughout its use.
- P. Haul trucks carrying excavated material and other non-excavated material shall be loaded such that the material does not touch the front, back, or sides of the cargo compartment at any point less than six inches from the top and that no point of the load extends above the top of the cargo compartment. All trucks hauling soil, sand and any other loose materials shall be tightly covered with tarpaulins or other effective covers before the haul trucks leave the loading area. Wet prior to covering if directed by the Engineer.
- Q. Dust curtains, plastic tarps, windbreaks or tree windbreaks shall be installed and planted on windward and downwind sides of construction areas, in addition to the perimeter dust curtain (item above) as necessary at no additional cost to the City.
- R. R. Vehicles entering or exiting construction areas shall travel at a speed, which minimizes dust emissions. This speed shall be no more than 15 mph.
- S. Hydro-seed or apply non-toxic soil amendments, stabilizers, and emulsions to inactive construction areas, including previously graded areas that are inactive for at least ten (10) calendar days.

- T. Excavation and grading activities shall be terminated when wind speeds exceed 25 miles per hour (mph). Drop distances should be minimized as a method of control of excavation techniques.
- U. Limit the area subject to excavation, grading, and other construction activities at any one time.
- V. The Contractor shall also comply with:
 - 1. The requirements of the California Air Resource Board and the Bay Area Air Quality Management District (BAAQMD) Regulation 6 (for particulate matter and visible emissions, <http://www.baaqmd.gov/regs/rg0600.pdf>); Regulation 7 (Odorous Substances); and Regulation 11 (Hazardous Pollutants, <http://www.baaqmd.gov/regs/rulereg.htm>).
 - 2. The California Health and Safety Code, Division 26 (Air Resources), Chapter 3 (Emission Limitations) Section 41700 (Prohibited Conduct), Section 41701.5 (Diesel pile driving hammers) and related regulations.
 - 3. The Dust Control Order No.171, 378 of the Regulation for Excavating and Restoring Streets in San Francisco, issued by The Department of Public Works, Bureau of Street-Use and Mapping.
- W. The Contractor is responsible and shall pay for cleanup of any spillage (including clean soils) on City Street, directly or indirectly caused by actions of employees of the Contractor or his/her subcontractors.
- X. If the Contractor fails to provide adequate dust and other air pollutant control as determined by the Engineer, the Engineer reserves the right to have the necessary Work performed by others and to deduct or withhold all monies required therefore.

1.15 ASBESTOS DUST MITIGATION PLAN AND ASBESTOS AIRBORNE TOXIC CONTROL MEASURE FOR CONSTRUCTION

- A. The Contractor shall comply with the final regulation in California Code of Regulations, Title 17, Section 93105 - Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying, and Surface Mining Operations (www.arb.ca.gov/toxics/atcm/asb2atcm.htm).
- B. The Contractor shall submit an Asbestos Dust Mitigation Plan (ADMP) as asbestiform-containing soils are known to be present beneath the project Site. The Contractor shall also submit the ADMP to, and obtain approval from the Bay Area Air Quality Management District (BAAQMD), before the start of any construction or grading activity. The Contractor shall have to obtain the necessary permits for Work involving screening, crushing or grinding, and use of abatement devices. For information on the permit requirements and application forms check the web page at www.baaqmd.gov,

<http://www.baaqmd.gov/permit/handbook/default.htm>, and
<http://www.baaqmd.gov/permit/forms.htm>, or contact:
(BAAQMD) at (415) 749-4990.

- C. The Contractor is hereby notified that screening or crushing operations cannot proceed without the appropriate BAAQMD, and Cal-EPA/DTSC permits.
- D. Asbestos Dust Mitigation Plan: The Asbestos Dust Mitigation Plan shall specify dust mitigation practices which are sufficient to ensure that no equipment or operation emits dust that is visible, and must include one or more provisions addressing **each** of the topics listed in Article 1.17, sub-sections E through N, as follows:
- E. The provisions of the asbestos dust mitigation plan shall be implemented at the beginning, and maintained throughout the duration of the construction or grading activity.
- F. Basic Construction and Grading Operations control measures shall include:
 - 1. Construction vehicle speed at the Work Site shall be limited to fifteen (15) miles per hour or less;
 - 2. Prior to any ground disturbance, sufficient water shall be applied to the area to be disturbed to prevent visible emissions from crossing the property line;
 - 3. Areas to be graded or excavated shall be kept adequately wetted to prevent visible emissions from crossing the property line;
 - 4. Excavated material shall be laid on a 10 mils (0.01 inch) polyethylene plastic or equivalent tarp as directed by the Engineer. Maintain this throughout its use.
 - 5. Storage piles shall be kept adequately wetted, treated with a chemical dust suppressant, or covered when material is not being added to or removed from the pile. Securely brace down the cover, and maintain this brace throughout its use;
 - 6. At the end of each workday, all exposed areas shall be covered with a 10 mils (0.01 inch) polyethylene plastic, equivalent tarp, or other means acceptable by the Engineer, and braced down. Maintain this cover, and brace throughout its use, including during periods of Work stoppages, overnight, weekends and holidays.
 - 7. Equipment shall be washed down before moving from the property on to a paved public road; and
 - 8. Visible track-out on the paved public road shall be cleaned using wet sweeping or a HEPA filter equipped vacuum device within twenty-four (24) hours.

- G. Track-out prevention and control measures shall include:
1. Removal of any visible track-out from a paved public road at any location where vehicles exit the Work Site; this shall be accomplished using wet sweeping or a HEPA filter equipped vacuum device at the end of the Work day, and at least two additional times per 8-hour shift; and
 2. Installation of one or more of the following track-out prevention measures:
 - a. A gravel pad designed using good engineering practices to clean the tires of exiting vehicles;
 - b. A tire shaker;
 - c. A wheel wash system;
 - d. Pavement extending for not less than fifty (50) consecutive feet from the intersection with the paved public road; or
 - e. Any other measure as effective as the measures listed above.
- H. Keeping active storage piles adequately wetted, stored on, and covered with 10-mil (0.01-inch) polyethylene plastic or equivalent tarps.
- I. Control for disturbed surface areas, and storage piles that will remain inactive for more than seven (7) days, shall include one or more of the following:
1. Keep the surface adequately wetted.
 2. Establishment and maintenance of surface crusting.
 3. Application of chemical dust suppressants or chemical stabilizers according to the manufacturers' recommendations.
 4. Covering with tarp(s) or vegetative cover.
 5. Installation of wind barriers of fifty (50) percent porosity around three (3) sides of a storage pile.
 6. Installation of wind barriers across open areas, or
 7. Any other measure as effective as the measures listed above.
- J. Control for traffic on on-Site unpaved roads, parking lots, and staging areas, which shall include:
1. A maximum vehicle speed limit of fifteen (15) miles per hour or less, and
 2. One or more of the following:
 - a. Watering every two hours of active operations or sufficiently often to keep the area adequately wetted.
 - b. Applying chemical dust suppressants consistent with manufacturer's directions.

- c. Maintaining a gravel cover with a silt content that is less than five (5) percent and asbestos content that is less than 0.25 percent, as determined using an approved asbestos bulk test method, to a depth of three (3) inches on the surface being used for travel, or
 - d. Any other measure as effective as the measures listed above.
- K. Control for earthmoving activities, which shall include one or more of the following:
 - 1. Pre-wetting the ground to the depth of anticipated cuts;
 - 2. Set up a containment with a continuous misting system to prevent the release of asbestos fibers when screening of serpentine, or ultramafic rock
 - 3. Suspending grading operations when wind speeds are high enough to result in dust emissions crossing the property line, despite the application of dust mitigation measures;
 - 4. Application of water prior to any land clearing; or
 - 5. Any other measure as effective as the measures listed above.
- L. Control for off-Site transport. The Contractor shall ensure that no trucks transport excavated material off-Site unless:
 - 1. Trucks are maintained such that no spillage can occur from holes or other openings in cargo compartments; and
 - 2. Loads are adequately wetted and either:
 - a. Covered tightly with tarps; and
 - b. Loaded such that the material does not touch the front, back, or sides of the cargo compartment at any point less than six inches from the top and that no point of the load extends above the top of the cargo compartment.
- M. Post construction stabilization of disturbed areas. Upon completion of the project, disturbed surfaces shall be stabilized using one or more of the following methods:
 - 1. Establishment of a vegetative cover.
 - 2. Placement of at least three (3.0) inches of non-asbestos-containing material.
 - 3. Paving.
 - 4. Any other measure deemed sufficient to prevent wind speeds of ten (10) miles per hour or greater from causing visible dust emissions.
- N. Additional Asbestos Dust Mitigation
 - 1. Additional Asbestos Hazard Dust Mitigation measures shall include, but not be limited to the following:

- a. Employee/worker notification, safety, and monitoring shall be performed in accordance with applicable agency laws and requirements (e.g., California Code of Regulations (CCR), Title 8 section 1529 et al).
- b. During disturbance activities, the Contractor shall maintain onsite records of watering schedules, locations of asbestiform containing soils, daily logs of dust mitigation and air monitoring activities (if required) at the construction Site. All such records shall be presented to the Engineer at the weekly progress meetings.
- c. Copies of all test results, and locations of asbestiform containing soils shall be submitted to the Engineer upon completion of coverage, retained at the construction Site and upon request, be readily available Engineer.
- d. Non-asbestiform cover soil or other material shall cover asbestiform containing soils placed within fills.
- e. Asbestiform containing soils uncovered during the construction of utilities shall be appropriately covered such as by placement within deep fills. Utility trenches shall be backfilled with non-asbestiform cover materials.
- f. Asbestiform containing soils moved off-Site shall be managed in accordance with appropriate laws and requirements.
- g. Inform the City in writing and obtain City approval prior to any sale, supply, or offer to sell any excavated material. The Contractor shall similarly comply with BAAQMD's Regulation 11, Rule 14 for asbestos-containing serpentine (Additional information may be found at <http://www.baaqmd.gov/regs/rg1114.pdf>), the California Air Resource Board Advisory #161 (<http://www.arb.ca.gov/cd/advs161.htm>), and Title 17, Section 93106 of the California Code of Regulation (CCR). In such a case, the Contractor at his/her own expense shall perform any and all engineering and chemical testing as required by the City and by federal, state and local statutes, laws, regulations and policies.
- h. Comply with the advisory from the State of California, Air Resource Board on the use of asbestos-containing materials/serpentine rock on schoolyards, playgrounds and other surfaces (ARB Fact Sheet #2). Additional information may be found at <http://www.arb.ca.gov> and <http://www.arb.ca.gov/toxics/Asbestos/2school.htm>

Note: Criminal and/or civil penalties may be imposed on any person who violates any rule, regulation, permit or Order of the State Air Resources Board or a district that is adopted to control and contain air emissions.

1.16 NOISE CONTROL

- A. San Francisco Noise Control Ordinance (Article 29 of the San Francisco Police Code, Ordinance # 274-72):
1. The Work of this contract is subject to requirements of City and County of San Francisco, Article 29 of the Police Code, Ordinance #274-72, and Regulation of Noise (herein after referred to as the "San Francisco Noise Ordinance").
 2. The San Francisco Noise Ordinance includes (but is not limited to) regulations on Ambient Noise, Non Stationary Sources, Fixed Source, Zoning Districts, Noise Level Measurements, Construction Equipment, Construction Work at Night, Enforcement and Violations.
 3. The maximum noise level from any powered construction equipment shall not be greater than 80dBA at 100 feet. This translates to 86dBA at 50 feet (dual units not applicable, as these are specific field and instrument measurements).
 4. Pay all fines for violations pertaining to the San Francisco Noise Ordinance, at no cost to the City.
- B. General: Conduct all operations, use appropriate construction methods and equipment in accordance with the San Francisco Noise Ordinance. Furnish and install acoustical barriers as necessary so that noise emanating from any equipment shall not exceed noise levels of the criteria specified in the San Francisco Noise Ordinance.
1. Provide equipment and trucks used for project construction equipped with the best available noise control techniques to minimize construction noise impacts. Prior to construction, the Contractor shall ensure that its equipment noise does not exceed the requirements of the San Francisco Noise Ordinance.
 2. Muffle and shield intakes and exhausts, shroud or shield impact tools, and use electric-powered rather than diesel-powered construction equipment, as feasible, so that noise will not exceed limits stated in the San Francisco Noise Ordinance.
 3. Enclose equipment such as large compressors, generators, and large de-watering pumps at a minimum in one-inch-thickness plywood sheds.
 4. Provide and use acoustically attenuating shields to limit the noise level created by Work performed between 8 p.m. and 7 a.m, if allowed See Special Provisions. to no more than the allowable ambient noise level plus 5 dba at the nearest property line.
 5. Impact tools must be equipped with intake and exhaust mufflers. Pavement breakers and jackhammers must be equipped with acoustically attenuating shield or shrouds.

6. Perform construction in a manner that maintains noise levels at noise sensitive land uses below specific limits. The City will monitor noise levels to evaluate the Contractors compliance with this section
7. Select haul routes that minimize intrusion to residential areas.
8. Select construction processes and techniques that create the lowest noise levels.
9. Minimize construction activities during evening, nighttime, weekend and holiday periods. A variance should be requested from the San Francisco Noise Ordinance if construction noise between 8 PM and 7 AM (See Special Provisions) is in excess of ambient plus 5 dba.
10. Apply for a City noise permit at least three (3) working days in advance of night (between 8:00 PM and 7:00 AM – See Special Provisions)), weekend and holiday Work. The requirements of the Contract documents, including safety requirements, shall apply for all night, weekend and holiday Work to be performed.

1.17 VIBRATION CONTROL

- A. Prior to starting Work at the Site, submit a Vibration Control Plan (VCP). The VCP shall include:
 1. A schedule indicating the dates that the Contractor anticipates sustained or intermittent vibration to occur
 2. How the Contractor plans to mitigate construction vibration impacts
 3. Methods of demolition and excavation
 4. Vibration processes that might cause potential for vibration concerns such as blasting, pile driving, demolition, use of jackhammers and hoe rams, and the use of tracked vehicles close to building.
- B. Construction vibration will be monitored at the construction Site and adjoining buildings by the City using equipment and methods as deemed appropriate by the City to measure potential building damage and effect on occupants, property, and sensitive equipment.
- C. Vibration Project Action (VPAL): Construction vibration impacts shall not exceed:
 - a. 0.03 inches per second, peak particle velocity (in/sec ppv) at all times for limited sustained (more than three hours aggregate occurrences in a workday) vibration, or
 - b. 0.10 in/sec ppv for infrequent (more than five seconds) vibration limits.
- D. City will require the Contractor to suspend operations that cause excessive vibrations or exceed the above Vibration Project Action Levels (VPAL). The

Contractor shall have to implement better engineering or mitigation controls when:

1. Vibration exceeds the above-specified VPAL limits
2. The Contractor fails to comply with vibration mitigation controls specified herein, or fails to follow his/her own Vibration Control Plan.
3. Damage or disturbance to adjoining property or occupants has been reported

The Contractor shall neither resume operations before correcting conditions that cause excessive vibration nor be entitled to additional compensation or extension of contract time for suspended operations because of its failure to perform vibration controls as specified.

- E. Implement the specific mitigation controls to reduce vibration from construction – related equipment to a less significant level by
1. Limiting the use of construction techniques that create high vibration levels especially near residential areas
 2. Using alternative procedures in vibration sensitive areas by using techniques with lower vibration levels. For example, use of a case-in-drill hole piling method instead of a non-restrictive pile driving method.
 3. Restricting the hours of vibration intensive activities such as pile driving, to weekdays during working hours (7am to 8pm).

1.18 FIRE PREVENTION

- A. Take all necessary precautions to prevent fires while performing the Work.
- B. Be responsible for all damage from fire caused directly or indirectly by his own activities or those of his employees or subcontractors.
- C. Provide spark arresters for all internal combustion engines employed at the Site.
- D. Maintain temporary fire protection equipment in accordance with Cal/OSHA Section 1910 and 1933, including but not limited to:
 1. Portable fire extinguishers within three (3) meters of welding and cutting operations.
 2. Portable fire extinguishers within three (3) meters of locations where flammable or combustible liquids are stored.
- E. Perform all Work in compliance with City and State fire safety laws and regulations.

1.19 PARKING RESTRICTIONS

Employees of the Contractor, sub-contractors, and suppliers shall not park their vehicles outside of the active construction area within when they are currently working and where public access is prohibited. The Contractor shall provide parking for their employees at a Site, which will not impact local public parking and transport employees between the parking area and the Work.

1.20 BRIDGING OVER TRENCHES AND EXCAVATIONS

Construct temporary bridges across excavations to provide, at all times, safe and adequate passage for vehicular and pedestrian traffic as specified in the General Provisions and where it is deemed necessary by the Engineer. In addition, provide and maintain sufficient number of lighted barricades to be used as determined by the Engineer in the field.

1.21 RESTORATION

- A. Completely remove temporary facilities when their use is no longer required.
- B. Clean and repair damage caused by temporary installation or the temporary use of facilities. Restore permanent facilities used temporarily to original condition unless otherwise specified.

1.22 ARCHAEOLOGICAL CONDITIONS

- A. Summary
 1. This Document includes procedures to provide for protection, removal, or investigation of archaeological findings, and to provide Contractor such compensation or relief as may be appropriate for unforeseen Work or for Work suspension directed by the City under the provisions of the Contract Documents.
 2. Pursuant to the National Historic Preservation Act of 1966, (16 U.S.C. 470) and PRM 75-27, the City intends to provide for the preservation and protection of such material of an archaeological nature as may be of scientific or historical value.
- B. Discovery of Archaeological Finds
 1. If potential historical, architectural, archaeological, or cultural resources are discovered at the Site, the following procedures are to be instituted:
 - a. Promptly report all subsurface archaeological finds to the Engineer. Prehistoric finds shall also be reported to local Native American organizations.
 - b. The Engineer will issue a written order to suspend Work in accordance with the General Provisions and Special Provisions directing Contractor to

cease all construction operations only at the location of such potential cultural resources find.

- c. The City's archaeologist will assess the significance of the find, and immediately report to the City Environmental Review Officer (ERO), and the President of the Landmarks Preservation Advisory Board (LPAB) who will recommend specific additional mitigation measures as necessary to minimize potential effects on cultural resources. Such mitigation measures may include additional Site security; on-Site investigations by an archaeologist; and documentation, preservation, and recovery of cultural materials. Following review and approval of the City archaeologist's report by the ERO, copies of the final report will be sent to the California Archaeological Site Survey Northwest Information Center and the President of the Landmarks Preservation Advisory Board.
2. Cost or time impacts as a result of a suspension under this Document shall be resolved as provided in the General Provisions and Special Provisions.
3. For Work suspensions, there shall be no compensation to Contractor for any delays up to a total of twenty (20) working days due to the City's order to suspend Work.
4. All historical, architectural, archaeological, or cultural resources discovered at the Site, shall be the property of the City and County of San Francisco.

1.23 SITE SPECIFIC EARTHQUAKE PREPAREDNESS AND EMERGENCY RESPONSE PLAN

The Contractor shall submit a Site-specific Earthquake Preparedness and Emergency Response Plan. This plan shall remain in effect for life of the Contract, and a copy of the plan must be on-Site at all times.

1. The Plan shall include earthquake, fire, spillage of hazardous/toxic wastes and liquids (with special emphasis to clean up of spillage due to fuel/oil from Contractor's equipment,), traffic accident, personal accident, power failure, or any event that may require modification or abridgment of Site control and decontamination procedures.
2. The Plan shall describe the responsibility of the Contractor's emergency coordinator/team who control each phase of the operations.
3. The Plan shall also include procedures to be followed in the event of a large-scale spill of contaminated materials on a public roadway in accordance with:

- The Hazardous Substance Highway Spill Containment and Abatement Act (California Vehicle Code, Section 2450 et seq.)
- The Emergency Service Act (California Government Code Section 8571.4 et seq.).
 4. The plan shall contain hazardous materials management spill procedures in the event of a lead and asbestos release, or any event that may require modification or abridgment of Site controls and decontamination procedures
 5. The plan shall contain provisions for emergency power and communication, evacuation procedures and post-earthquake safety inspection.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00823: SOFTWARE AND TECHNOLOGY PROCUREMENT**PART 1 – GENERAL****1.1 SOFTWARE LICENSES AND MAINTENANCE AGREEMENTS.**

- A. Except where the City instructs Contractor that City will provide required Software or Equipment, Contractor shall procure from third parties or shall itself provide for the benefit of the Project and the SFMTA all Software and all licensed Equipment containing embedded code that is necessary for the installation, testing, commissioning and operation of the Project. Contractor shall provide to the City valid licenses and current documentation (including but not limited to installation, configuration and operation manuals and instructions) for all Software and Equipment for which licenses are required. Where Contractor provides the City with open source or public code, Contractor shall include installation, configuration and operation instructions as part of the Project Record Documents.
- B. For each Software product Furnished by Contractor to the Project, Contractor shall provide itself or shall procure from and pay the license fee to the authorized licensor for a non-exclusive, perpetual license for the use of and for the number of users required by the SFMTA. The Software products required for the Project are listed below. The City and County of San Francisco shall be listed as the licensee on each such Software license. Contractor shall also procure from and pay to each licensor the maintenance fee for the Software products for the maintenance periods listed below. The City and County of San Francisco shall be listed in each maintenance agreement as the licensee and Product end-user that is to benefit from the maintenance agreement. Contractor may bill the SFMTA for the license for a Software product listed in Table 1 upon Contractor's receipt of documentation from the Software vendor granting the perpetual license to the City and execution of the maintenance agreement. The Contractor may bill the SFMTA for the maintenance agreements upon the SFMTA's Final Acceptance of the Project.
- C. Software to be provided by Contractor is listed in the following Contract Documents:
1. Harris Software License Agreement
 2. Harris Software Maintenance Agreement
 3. Harris Security Update Management Service (SUMS) Agreement
 4. ACS Hardware License Agreement

- C. All Software licenses, technology purchase agreements, and maintenance agreements Furnished by Contractor from third parties for the Project are subject to the City's approval as to terms and conditions. All license, technology purchase, and maintenance agreements for Software, Equipment and other technology provided by Contractor for the Project shall include at a minimum the following provisions:
1. Licensor shall be responsible at all times for compliance with applicable patents, copyrights, trademarks, and/or other intellectual property rights held by others encompassing, in whole or in part, any invention, design, process, product, Item, technology, Software, Equipment, device, material, article or arrangement provided by Licensor that is used, directly or indirectly, in the performance of the Work or incorporated into the Work.
 2. Contractor shall pay, and include in the Contract Sum, all royalties and license fees and assume all costs incident to the use in the performance of the Work or the incorporation into the Work of any invention, design, process, product, Item, technology, Software, Equipment, device, material, article or arrangement which is the subject of a patent right, copyright, trademark, and/or other intellectual property right held by others.
 3. As provided in the General Conditions, Section 3.22, Contractor shall defend, indemnify and hold harmless the City from any claim or action alleging infringement of copyright, patent or other intellectual property right arising out of the Project.
 4. All licenses for Software must include an additional included license for the relevant documentation of said Software products, including but not limited to user and maintenance manuals. Licenses for Software documentation shall be non-exclusive and perpetual, and shall grant the City license to use, copy and modify such documentation exclusively for the internal use of the SFMTA, which shall be license agreements separate from this Agreement.
 5. All licenses and maintenance agreements must include provision at no additional cost to the SFMTA during the warranty and maintenance periods all software updates, patches, code fixes and other software releases for the Software provided under said license agreements.
 6. All maintenance agreements must include provision for remote (telephone and email) support and emergency on-site support at rates acceptable to the SFMTA. Said support shall be available to the SFMTA 24 hours per day, seven days per week.

- D. Substitution of Data System Equipment. The SFMTA may in its sole discretion direct Contractor to substitute any of the computers, servers or other data processing hardware or other Equipment listed in Contractor's Proposal or in the Criteria Package herein with similar hardware from another manufacturer that is a functional equivalent. If the SFMTA directs Contractor to substitute Equipment at or prior to NTP, SFMTA shall bear the additional expense if it specifies substitute hardware that is more expensive than is listed in this Agreement, but SFMTA shall be credited the difference in price if the substituted hardware costs less than that specified in this Agreement. The SFMTA shall compensate Contractor for its actual additional direct costs, including delay, if any, caused by the SFMTA's direction issued after NTP to substitute listed hardware.
- E. Disabling Code Prohibited. No Software provided by Contractor shall contain any function or code that would allow Contractor or any third party, including but not limited to the vendor of the Software, to remotely disable or change the function of said Software (which shall include updates, upgrades, patches and Work arounds) without the SFMTA's prior written knowledge and actual concurrence at the time said Software is disabled or changed.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00824: QUALITY PROGRAM**PART 1 – GENERAL****1.1 INTRODUCTION**

This section specifies the Contractor Quality Control requirements for the Work that shall be performed on the project in conformance with the Contractor provided project Contractor Quality Control Plan (CQC Plan), the Contractor provided Quality Procedures and Instructions, the Federal Transit Administration (FTA) QA/QC Guidelines and the contract. It shall be the responsibility of the Contractor to follow and meet the requirements of the Quality Program for all Work performed and products provided under the contract, including the Work performed and products provided by subcontractors and suppliers. The Quality Program will consist of the CQC Plan and the Quality Procedures and Instructions, and the SFMTA furnished contributions for Quality Assurance (QA). The SFMTA and Consultants may conduct Quality Assurance activities. The Quality Control (QC) activities will be the Contractor's responsibility. Quality Program requirements are independent from acceptance inspection and testing performed by the SFMTA and/or testing and certification organizations.

Quality reports shall be included in the regular project reports, and shall be reported in the regular project progress meetings. In these reports, and at the project progress meetings, the Contractor's Quality Manager (CQC System Manager) shall review open issues relating to quality including but not limited to the status of Corrective Actions and quality trends, and provide an assessment of the suitability and effectiveness of the Quality Program in:

- Meeting the project requirements and statutory and regulatory requirements,
- Meeting SFMTA expectations,
- Meeting the requirements of the quality program
- Its compliance with the Federal Transit Administration's fifteen (15) quality elements.

Within ten (10) days after issuance of Notice to Proceed (NTP) for the Contract or as otherwise directed in the NTP, the Contractor shall submit the CQC Plan and Quality Procedures and Instructions to the SFMTA for acceptance by the SFMTA Project Engineer. Work shall not commence without review and acceptance of the CQC Plan and Quality Procedures and Instructions by the SFMTA.

Contractor shall submit prior to NTP qualifications and resumes of each design and construction team staff.

It is understood and expected that the Contractor has an institutionalized Quality Program that supports the CQC Plan and Quality Procedures and Instructions. The Contractor's Quality Program shall meet and align with the requirements of this contract and shall be designed and maintained such that the Contractor's Work, including, but not limited to, the design and the Work performed by the Contractor's suppliers and Sub-Contractors, complies with statutory and regulatory requirements such as the applicable codes, special provisions, technical specifications and with respect to materials, workmanship, construction, installation, finish, functional performance, testing, commissioning and identification. Further, the Contractor's Quality Program shall encompass all products and project Work.

Project personnel who have responsibility for ensuring or controlling quality shall be identified and interrelationships with project management defined. These relationships shall be shown on an organization chart. In particular, the personnel shall be identified who have responsibility to initiate and carry out actions to prevent quality problems, to identify and record quality problems, to implement solutions through appropriate channels, and to verify the effective implementation of these solutions to identified quality problems. Those personnel responsible for assuring quality must be independent of those having direct responsibility for the Work being performed.

During design, the Contractor Quality Manager shall report to the SFMTA Project Engineer. During construction, the Contractor Quality Manager shall report to the SFMTA Resident Engineer. The Contractor Quality Manager shall coordinate quality surveillances and audits with the SFMTA or Consultant auditors, as needed, throughout the duration of the project.

A reference Contractor Quality Control Plan (there named QA Plan) is located in Appendix Ten (10).

1.2 FTA QUALITY ELEMENTS

The Contractor's Quality Program, Quality Procedures and Instructions shall meet the requirements of the 15 FTA QA/QC quality elements as described in this section. The Quality Program shall encompass the actions involving, including but not limited to, the design, the construction, the selection of construction/installation material sources and suppliers, on-Site and off-Site fabrication of Contractor-furnished products and services to be included in the Work, on-Site and off-Site production of construction materials, inspection and acceptance of the SFMTA furnished materials, Work placement procedures, workmanship, inspection, testing and commissioning.

1.3 MANAGEMENT RESPONSIBILITY

Contractor shall provide evidence of the Contractor' team top management commitments to the development and implementation of the CQC Plan by [PRL 12-6-3 Top Management Commitment to Quality]:

- Communicating to the respective organizations the importance of meeting project as well as statutory and regulatory requirements
- Ensuring that quality objectives are established
- Conducting management reviews, which includes documented reviews of the CQC Plan quality policy at appropriate intervals to ensure that it remains suitable and effective, and
- Ensuring the availability of adequate resources to perform Work on the project in compliance with project requirements and industry practices.

The Contractor's top management shall ensure that the project requirements are determined and are met with the aim of enhancing the SFMTA's satisfaction.

1.4 QUALITY PROGRAM DOCUMENTATION

The Contractor shall establish and maintain a documented Quality Program to ensure project quality objectives are satisfied. The provisions of the Quality Program shall extend to the Contractor's suppliers and subcontractors, as appropriate.

Documented Quality Procedures and Instructions shall be developed and established for activities affecting quality in design, development, procurement, manufacturing, and construction as applicable to the Work performed. Quality Procedures and Instructions shall also be developed and documented for control of processes including inspection, testing, nondestructive examination, handling of nonconforming product, Corrective Action, maintenance of quality records, and training.

The Quality Procedures and Instructions shall contain statements of their purpose and scope, and shall contain any references to appropriate codes, standards, or specifications. In developing and documenting the Quality Procedures and Instructions, consideration shall be given to identifying and acquiring any inspection equipment, skills, or special quality processes needed to ensure quality performance. Inspection and testing techniques shall be kept current and effective. The Quality Procedures and Instructions shall contain formats for the quality records needed to ensure that the Quality Procedures and Instructions are followed and documentation requirements are understood by all personnel performing Work that affects the quality of the project products and services. Where new techniques are being used for construction, build or manufacturing, adequate time and resources shall be allocated for the development, verification and validation of appropriate Quality Procedures and Instructions for the application of new techniques.

1.5 DESIGN CONTROL

The CQC Plan shall establish, document and maintain Quality Procedures to control, verify and validate the design of the project deliverables in order to ensure that the design criteria, project requirements, and statutory and regulatory requirements are met. Design control includes but shall not be limited to:

- Ensuring that the design requirements are understood and fulfilled,
- The planning and maintenance of system interfaces,
- Design verification and validation,
- And controlling design changes through project completion.

The Contractor Design Manager shall prepare a plan for the design activities [CDRL 12-6-5 Design Management Plan], The Design Management Plan shall be part of the Project Management Plan, and meet the requirements of the Project Management Plan, including but not limited to the requirements for the development, submittal and review of the Project Management Plan. The Design Management Plan shall identify who has responsibility for the different design parts, and who has the responsibility for design oversight and design integration. It shall also identify the various organizational interfaces required between the groups producing and commenting on the design, and specify the information to be documented, transmitted, and regularly reviewed. Finally, the design plan shall specify how the operation and maintenance departments of the SFMTA will interact with the Contractor's designers, including subcontractors and suppliers.

Design input requirements shall be identified, documented, and reviewed by the Contractor Design Manager. Ambiguity in the design input requirements or inadequacies of the design inputs shall be resolved between the Contractor Design Manager and the SFMTA.

Design outputs shall be documented. Design outputs shall meet the design input requirements, the project requirements, include acceptance criteria, conform to statutory and regulatory requirements whether or not these have been stated in the design input requirements, and identify those aspects of the design that are crucial to the safe and proper function of the final product or system. It shall be the Contractor Design Managers responsibility to conduct and establish:

- Reviews of design requirements for adequacy and the identification of ambiguities
- Verification of design outputs for meeting the design and development input requirements
- Validation of design outputs for meeting project requirements as well as statutory and regulatory requirements
- The competence of design personnel are evident.

Signed color copies of check and back-check documents (i.e., drawings, calculations, spec's, reports) shall be submitted at all design submittal phases.

Appropriate procedures shall be established and documented for the identification, documentation, review, and approval of all changes and modifications to the design. This responsibility shall extend to those responsible for construction, build or manufacturing to ensure design outputs meet the design input requirements, and for the development of "as-built" documentation as part of the design documentation at the end of the project, including subcontractors and suppliers.

1.6 DOCUMENT CONTROL

The Contractor shall identify processes and document procedures of the Contractor's Document Control system. The handling of all documents related to project Work, including but not limited to final design documents, drawings, manuals and as-built documentation, shall be governed by a Document Control Procedure. Changes to documents and data are reviewed and approved by same functions/organizations that performed original review and approval, unless specifically designated otherwise.

The requirements of this procedure apply to all project documents of internal and external origin, including:

1. All project documents in electronic form (the preferred medium of storage)
2. All versions of hardcopy submittals by the Design/Build Contractor
3. Documents originating outside of the project (e.g. City and County of San Francisco, Federal Communications Commission, etc.).
4. A documented procedure shall be established to define the controls needed
5. To approve documents for adequacy prior to issue
6. To review and update as necessary and re-approve documents
7. To ensure that changes and the current revision status of documents are identified
8. To ensure that relevant versions of applicable documents are available at points of use
9. To ensure that documents are issued and remain legible and readily identifiable
10. To ensure that documents of external origin determined by the organization to be necessary for the project and the Quality Program are identified and their distribution controlled
11. To prevent the unintended use of obsolete documents, and to apply suitable identification to them if they are retained for any purpose

12. To ensure export controls and commitments to preserving the confidentiality of proprietary information and data are met, as agreed in the Contract and in accordance with statutory and regulatory requirements.

1.7 PURCHASING

The Contractor shall ensure that all purchased products and services conform to the project requirements and specifications of the Appendix Twelve (12). The Contractor shall qualify and select suppliers and subcontractors based on their capability to meet the requirements of the Quality Program, and establish warranty claim terms and conditions that conform to the requirements of the project. The Contractor shall be responsible for the conformance of supplier or subcontractor provided products and services with project requirements and statutory and regulatory requirements. The Contractor shall establish documented procedures that describe the processes used for the purchasing of products and services for this project.

1.8 PRODUCT IDENTIFICATION AND TRACEABILITY

The Contractor shall establish documented procedures that describe the processes for the proper identification and the traceability of products and materials, test equipments, tools, and equipment furnished by the SFMTA, throughout all stages of production, handling, storage, shipment, delivery, installation, segregation, correction, repair, exchange and testing. This identification and control shall also be extended to include spare parts. Products shall be identified, including but not limited to, the Contractor part number, the manufacturer's name, model number, serial number and name plate data.

Product identification and traceability is the primary responsibility of the Contractor.

1.9 PROCESS CONTROL

The Contractor shall establish documented procedures that describe Work processes executed by the Contractor, suppliers, and subcontractors that directly affect quality.

- F. This shall be conducted under controlled conditions through appropriate use of the following:
 1. Documented procedures defining the manner of production, installation, and servicing,
where the absence of such procedures could adversely affect quality
 2. Use of suitable production, installation, and servicing equipment and a suitable working environment
 3. Compliance with reference standards and codes, quality plans, and/or documented procedures

4. Monitoring and control of suitable process parameters and product characteristics
5. The approval of processes and equipment, as appropriate
6. Criteria for workmanship, which are stipulated in a clear and practical manner (e.g., documented standards, representative samples, or illustrations)
7. Suitable maintenance of equipment to provide continuing process control capability.

The Contractor Quality Manager shall be responsible that Work processes and product characteristics are monitored through the use of surveillances, hold-point inspections, report reviews and or audits. The Contractor Quality Manager shall perform planned and systematic reviews and audits of processes and procedural compliance where results of processes cannot be fully verified by subsequent inspection and testing of the product and where, for example, processing deficiencies may become apparent only after the product is in use.

1.10 INSPECTION AND TESTING

The Contractor, subcontractors and suppliers shall establish documented procedures that describe the processes used to monitor and verify quality conformance for all inspection and testing performed for material, equipment, software, and systems supplied for the project. This process shall include but not be limited to subcontractors, suppliers and testing organizations.

It shall be the responsibility of the Contractor Quality Manager to conduct inspection and testing to ensure conformance of inspection and testing performed by contractors, suppliers, subcontractors and testing organizations throughout the duration of the project. This applies to all activities related to supervision or performance of project inspections and tests including receiving, in-process, and final inspection and testing.

When products are delivered to the Contractor, it shall be the responsibility of the Contractor's Quality Manager to ensure the verification of these products and their conformance with all project requirements of Document 00900, Design Criteria, Appendix Twelve (12), as well as statutory and regulatory requirements. Verification shall be in accordance with the Quality Program and the procedures and processes established for that purpose. The extent of receiving inspection can vary with the amount of inspection at the source, the safety criticality of the product, and the confidence in the quality procedures of the supplier.

In-process testing and inspection of the Work to verify conformance of an item or Work activity to specified requirements shall be in accordance with the Quality Program and documented procedures. Both inspection and process monitoring methods shall be performed, as necessary, to ensure that the specified requirements for the control of Work processes and the quality of the item are being achieved throughout the duration of the Work.

Final inspection and testing shall ensure that all specified inspections and tests, including those specified for receipt of product or in-process Work, have been carried out and the resulting data

meet specifications. Final inspection and testing shall be carried out and properly documented to ensure conformance of the finished product to the specifications. The Contractor shall identify all points of inspection and testing, including but not limited to First Article, receiving, assembly, acceptance, construction, installation and commissioning.

Records shall be maintained of the various inspections and tests to provide evidence that the products have passed inspection and that the products have been tested with the defined acceptance criteria.

The Contractor shall permit the SFMTA staff or its representative's access to the Contractor's facilities while system manufacturing and testing are taking place, and to any facility where hardware or software is being produced for the project.

The SFMTA will perform inspections that include visual examination of hardware, cables, and equipment. The documentation and quality records produced by the Contractor may also be examined to verify that it adequately identifies and describes all hardware and software.

Inspection rights shall expand to subcontractors that are developing new hardware or software for inclusion in the project.

1.11 INSPECTION, MEASURING, AND TEST EQUIPMENT

The Contractor's, subcontractors' and suppliers' inspection, measuring, and test equipment required to carry out inspection and testing shall be identified, controlled, calibrated, and maintained in order to demonstrate the conformance of products to the specified requirements of the Appendix Twelve (12).. Provisions shall be made for recalibration of such equipment in a timely manner.

Inspection, measuring, and test equipment used shall meet the standards of accuracy for the measurements which are required. The equipment shall be calibrated according to national standards as applicable, and to documented standards where no national standards exist. The equipment shall be recalibrated at regular intervals, and the recalibration properly documented. A record of the equipment calibration status shall be maintained.

The equipment shall be properly maintained to ensure its fitness for use. When in use, the Contractor shall ensure that the environmental conditions are suitable for the use of the equipment. When inspection, measuring, or test equipment is found to be out of calibration, the validity of previous inspection and test results shall be assessed and documented by the Contractor Quality Manager.

The Quality Program shall include the documented procedures to provide and maintain measuring devices, inspection and test equipment that is calibrated in accordance with the statutory and regulatory requirements. These statutory and regulatory requirements shall be in accordance with national standards and calibration certificates, and shall be maintained current and be submitted to the SFMTA. Any equipment exceeding its re-calibration date, or that is damaged or otherwise deemed unreliable, shall be handled through the procedure for non-confirming product.

1.12 INSPECTION AND TEST STATUS

The Contractor, subcontractors and suppliers shall establish documented procedures that describe the processes for identifying and controlling the inspection and test status of items during production and installation. The Contractor shall also establish document procedures that describe the process of identifying and controlling non-conforming Work product and material items by physical segregation and status indicators such as tags, markings, serialization, stamps, and/or inspection records.

The identification system used shall ensure that only those Work items that have passed inspection shall be used, shipped, or installed, the nonconforming Work product and material items shall be removed from the project Site and storage areas.

Work products, materials and/or equipment manufactured or assembled under this contract shall be accepted for use or released for shipment, as appropriate, when the following conditions(s) have been met:

1. After inspection and/or release by the SFMTA and/or certification by the Contractor that the Work product or material item is complete and in compliance with the contract specifications.
2. Upon request for acceptance or a release for shipment submitted by the Contractor and supported by a satisfactory inspection report or certification of compliance accompanied by certified copies of test data. The certificate of compliance shall clearly identify the Work product or material item covered by the certificate and shall also contain the test date and the name and address of the organization performing the require tests, as applicable.

After testing in accordance with Appendix Twelve (12) Section Seven (7).

Supplies, services, materials, and products procured from suppliers and subcontractors shall conform to the contract requirements and the Inspection Plan. Inspect all supplies, materials, services, and products upon receipt.

1.13 NON-CONFORMANCES

The Contractor shall establish documented procedures that describe the processes used to identify, segregate, correct and disposition non-conforming items that are found during the execution of the project.

The identification of non-conforming products or services shall be performed by any personnel of the project team. Reports of non-conforming products or services shall be verified by Contractor engineering staff, who issue a corresponding Corrective Action Request (CAR). It shall be the Contract Quality Manager's responsibility that non-conforming products or services are precluded from further use without proper authorization. Most commonly a method of

"tagging" and/or segregating shall be used if applicable. Segregation may not always be feasible due to size, configuration or installation location. In any regard, the process for identification of non-conforming products or services shall preclude its further use without proper authorization.

Non-conformances occurring inside a subcontractor's or supplier's plant shall also be accountable to the requirements and processes of the CQC Plan and in accordance with the subcontractor's or supplier's quality plan. Tracking and closure of non-conformances initiated in the subcontractor's or supplier's plant shall be accomplished by that plant's quality team, but shall be auditable by the SFMTA and the SFMTA Quality Assurance Manager.

At a minimum, a nonconformance report, issued by the designated quality representative(s), shall document the following:

1. Description of the condition adverse to quality,
2. Approved disposition/instructions (i.e. reject, rework, repair, or accept as is),
3. Corrections made or Corrective Actions taken, and
4. Results of re-inspection after corrective Work (if any) has been completed.

The decision to scrap, rework, reassign to alternative applications, or accept with or without repair

(waiver to specified requirements) is made by the appropriate SFMTA designated authority, e.g. the Resident Engineer, with the approval of the appropriate manager. A repaired or reworked product

is re-inspected in accordance with documented procedures that are part of the Quality Program and subject to acceptance by the SFMTA.

All non-conformances shall remain in an open status until satisfactory Corrective Action has been implemented.

The Contractor Quality Manager shall monitor the Contractor's, subcontractor's and suppliers' QC procedures for control, processing, and correct content of non-conformance reports and CARs. Additionally, the Contractor Quality Manager shall capture system wide defects and their defect rates, and prepare trend reports identifying patterns of non-conforming products or services, with association to design consultants, suppliers, Contractors, and subcontractors for the Contractor's Quality Management Review Meeting.

Work products or materials represented by installations or samples taken and tested in accordance with the specified test that are failing to meet required values shall be considered to be defective regardless of prior tests or approvals.

Unless otherwise accepted by the SFMTA, defective Work products or material items shall be removed from the Site. Where defects can be corrected, the Contractor may propose Corrective Action in accordance with the manufacturer's recommendation or by other means as is deemed

appropriate by the SFMTA. If the Contractor's Work does not conform to the requirements of the contract, the SFMTA may issue a "Corrective Action" or "Non-conformance Report" to the Contractor. The Contractor shall correct all deficiencies or otherwise respond to the report within ten (10) days of issuance of report by the SFMTA. The Contractor shall not build or conceal any feature of the Work containing uncorrected defects.

1.14 CORRECTIVE ACTION

The Contractor shall establish documented procedures for the investigation and identification of the root cause of nonconforming Work or products, and the Corrective Action needed to prevent recurrence, and procedures for analysis to detect and eliminate potential causes of nonconforming Work and products. This element also includes implementing and recording changes in procedures resulting from Corrective Action. The Contractor Quality Manager shall be responsible for the effective implementation of Corrective Actions.

The Contractor shall demonstrate the effective implementation of the Corrective Action. Corrective Action Requests shall only be dispositioned after acceptance by SFMTA. The SFMTA may accept the corrective action, but does not assume responsibility for the success thereof. Re-inspection and/or re-test may be made to determine acceptability of the material after corrective measures have been taken.

1.15 QUALITY RECORDS

The Contractor shall establish documented procedures that identify, collect, index, access, file, store, maintain, and disposition quality records that provide evidence of the execution of the Contractor Quality Program against the requirements of this section. The procedure shall be consistent with the SFMTA criteria for the handling of quality records. Quality records shall be maintained to provide evidence for the achievement of quality objectives and the performance of the Quality Program. Supplier, Contractor, and subcontractor quality records shall be included. Quality records shall be legible and shall specify the Work involved. They shall be kept in an environment to minimize deterioration, loss and damage. Retention times and final disposition shall be established and recorded. Quality records shall be made available to the SFMTA for the purpose of audits and surveillances.

1.16 QUALITY AUDITS AND SURVEILLANCE

Quality surveillances and audits will be conducted by SFMTA or SFMTA's consultants, to ensure that the elements of the Quality Program are functioning as required and intended, throughout the duration of the project.

Audits and surveillances will be coordinated with the Contractor, taking into consideration the status and importance of the processes and areas to be audited as they relate to the project schedule and the progress of project execution, as well as the results of previous audits and surveillances and the management reviews. The audit criteria, scope, frequency and methods

shall be defined prior to an audit or surveillance and depend on the nature and importance of activity. Audited entities will be notified of audits and surveillance in advance.

The management responsible for the audited area shall ensure that any necessary corrections and Corrective Actions are taken without undue delay to eliminate detected non-conformances and their root causes. Follow-up activities shall include verification of the effectiveness of the actions taken, and the reporting of verification results.

1.17 TRAINING

The Contractor shall establish, document and maintain procedures for identifying the training needs and provide for the training of all personnel performing activities affecting the quality of products and services. All personnel performing activities affecting quality shall be qualified and evidence shall be provided that show the competence of personnel on the basis of appropriate education, training, and/or experience, as required. Appropriate training and qualification records shall be maintained.

1.18 INSPECTIONS

A. Standards

It shall be the responsibility of the Contractor to provide and maintain an Inspection Plan for all Work performed under the contract. This requirement is independent of any acceptance inspection and testing performed by the SFMTA and/or testing and certification organizations. Within sixty (60) days after the issuance of the NTP, the Contractor shall submit an Inspection Plan to the SFMTA for acceptance [CDRL 12-6-3 Inspection Plan]. The plan shall cover all Work to be performed under the contract. Acceptance of the Contractor's Inspection Plan shall not relieve the Contractor of the responsibility to comply with the contract requirements as well as statutory and regulatory requirements.

The Inspection Plan shall be designed and administered to assure that the Contractor's Work, including Work performed by the Contractor's suppliers and Subcontractors, shall be in compliance with the latest version of applicable codes, special provisions, technical specifications and plans under the contract with respect to materials, workmanship, construction, installation, finish, functional performance, testing, commissioning and identification. The Inspection Plan shall encompass all actions involving selection of production, configuration, installation material sources and suppliers, on-Site and off-Site fabrication of Contractor-furnished items to be included in the Work, on-Site and off-Site production of construction materials, inspection and acceptance of the SFMTA furnished materials, Work placement procedures, workmanship, inspection, testing, and commissioning.

The Contractor's Inspection Plan shall include, but not be limited to a detailed schedule/matrix of control testing and inspection keyed to the individual Special

Provisions and Technical Provisions of the Contract, covering each item of the Work the SFMTA shall accept. The inspection schedule shall cover all Work to be performed under the contract, including both on-Site and off-Site fabrication. Inspection and test records shall include, but shall not be limited to, the factual evidence that inspections have been conducted, nature and number of observations made, the number and type of deficiencies found and proposed Corrective Actions to be taken. All records shall provide identification and signature of the individual in charge of the inspection. These records shall be certified by the Contractor's Quality Manager and include, as a minimum, the results of:

1. Inspection results, observations, conclusions and recommendations
2. Fabrication procedures and controls
3. Identity of the personnel present and description of their competence and certifications
4. Discrepant material details (including disposition records). The legible copies of these records must be furnished to the SFMTA Project Engineer on a daily basis. The records shall cover all Work performed subsequent to the previously furnished records and shall be verified by the Contractor Quality Manager.

A minimum of three (3) phases of inspection to be performed by the Contractor's staff for all definable items of Work. The phases are:

1. Preparatory inspections shall be performed prior to beginning of each item of Work and shall include a review of contract requirements and the Inspection Plan test and inspection schedule as defined in Appendix Twelve (12) Section Seven (7): "Testing and System Acceptance". Preparatory inspections shall include a physical examination of materials and equipment to verify the conformance to approved shop drawings or submittal data and that materials and equipment are present in the required quantities to proceed with the Work.
2. **Initial inspections** shall be performed as soon as a representative portion of the Work has been accomplished. Initial inspections shall verify the conformance with contract requirements and statutory and regulatory requirements, establish acceptable levels of quality and workmanship, review quality control testing and confirm that defective, damaged or unapproved materials are not incorporated into the Work.
3. Follow-up inspections shall be performed regularly by the Contractor's staff to ensure continued conformance with the contract requirements and statutory and regulatory requirements at established levels of quality and workmanship.
4. The SFMTA shall be notified at least forty-eight (48) hours in advance of each preparatory and initial phase inspection. Additionally, the Contractor Quality Manager shall ensure that all phases of inspection are made a matter of record in the Inspection Plan documentation.

B. Manufacturing Control

The Inspection Plan shall include methods for ensuring that all machining, wiring, shaping, and all other basic processing, fabrication and production operations of any type are accomplished under controlled conditions, including documented Work instructions, qualified personnel, adequate production equipment, and any special working environment.

C. Non-Conforming Items

The Contractor Quality Manager shall take prompt action to correct conditions that have resulted or may result in non-conforming products, parts, components, installations, or functions/operations. The Contractor Quality Manager shall document the non-conforming Work and efforts to correct the deficiencies and prevent its occurrence in the future. The Inspection Plan shall provide for:

Maintaining an effective and positive system for controlling non-conforming Work product and material item(s) including procedures for identification, segregation, removal and disposition. The Contractors shall document the Corrective Actions and submit to the SFMTA for acceptance.

Ensuring that all non-conforming items(s) shall be positively identified to prevent unauthorized use, shipment, or intermingling with conforming items. Disposition for the use or repair of non-conforming items shall require the SFMTA's acceptance.

1.19 SOURCE OF MATERIALS

Contractor shall identify sources of all products and services from which the Contractor proposes to obtain material requiring approval, certification, or testing indicating details and characteristics. These shall not be changed without written approval by the SFMTA.

1.20 HANDLING AND STORAGE

The Inspection Plan shall ensure that proper instructions are provided and followed for handling, storage, preservation, packaging, and shipping to protect the quality of products and to prevent damage, loss, deterioration, degradation, or substitution of products. Documented procedures shall be established that describe the processes used to protect against deterioration or damage to products/equipment in storage and handling.

1.21 CQC PLAN REQUIREMENTS

The CQC Plan and Quality Procedures shall include, at a minimum:

1. An organization chart showing the Contractor's project organization that shows personnel that are involved with the project in a function that affects product or service quality [CDRL 12-6-4 Quality Organizational Chart]. This shall include a description of the roles and responsibilities of the project staff. When it is necessary

to make changes to the CQC staff, the Contractor shall revise the CQC Plan to reflect the changes and submit the changes to the relevant Engineer (Project or Resident Engineer, depending on whether design or construction is affected) for acceptance.

2. The Contractor's on-Site organization chart including the proposed Contractor Quality Manager and QC Staff.
3. The SFMTA's and the Contractor's commitment to the development and implementation to the Quality Program.
4. Documented procedures that describe the processes for accomplishing and reviewing Work, supervision, inspection, tests, certifications, documentation of QC activities, including those of subcontractors for all on-Site and off-Site Work under the Contract.
5. Documented procedures and instructions for Quality Control personnel, construction supervisors, managers, subcontractors and suppliers.
6. The coordinating procedures and authorities concerning the Work activities performed off-Site and not under the direct supervision of the Contractor Quality Manager.
7. Evidence of the competence of QC personnel in meeting the requirements of the CQC Plan.
8. Separate payment, apart from bid item on Independent Inspection and Testing Agencies, will not be made for providing and maintaining an effective Quality Control program, and all costs associated therewith shall be included in the applicable unit prices or lump-sum prices contained in Appendix Twenty Eight (28) Cost Proposal Form.

1.22 REQUIREMENTS FOR CONSTRUCTION WORK

A. Control

Contractor Quality Control is the means by which the Contractor ensures that the design and construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. The CQC System Manager for each definable feature of Work shall conduct at least three phases of control as follows:

B. Preparatory Phase

This phase shall be performed prior to beginning Work on each definable feature of construction Work, after all required plans/documents/materials are approved/accepted, and after copies are at the Work Site. This phase shall include:

1. A review of each paragraph of applicable specifications, reference codes, and standards. The Contractor at the preparatory inspection shall make a copy of

those sections of referenced codes and standards applicable to that portion of the Work to be accomplished in the field available. These copies shall be maintained in the field and available for use by City personnel until final acceptance of the Work.

2. A review of the drawings.
3. A check to assure that all materials and/or equipment have been tested, submitted, and approved.
4. Review of provisions that have been made by the Contractor to provide required control inspection and testing.
5. Examination of the Work area to assure that all required preliminary Work has been completed and is in compliance with the contract.
6. A physical examination of required materials, equipment, and sample Work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.
7. A review of the activity hazard analysis to assure safety requirements is met.
8. Discussion of procedures for controlling quality of the Work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of Work.
9. A check to ensure that the Engineer (Resident Engineer or Project Engineer) has accepted the portion of the plan for the Work to be performed.
10. Confirm that the previous definable features of Work have been correctly implemented and all deficiencies have been corrected before this definable feature of Work can begin by providing organized and compiled documents and records, including but not limited to QC reports, test results and special inspection reports.
11. Discussion of the Initial Phase (see below).
12. The Engineer (Resident Engineer or Project Engineer) shall be notified at least 72 hours in advance of beginning the preparatory control phase. This phase shall include a meeting conducted by the CQC System Manager and attended by the Engineer (Resident Engineer or Project Engineer), the Contractor's Construction Manager, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The results of the preparatory phase actions shall be documented by separate minutes prepared by the CQC System Manager and attached to the daily CQC report. The Contractor shall instruct applicable workers as to the acceptable level of workmanship required in order to meet Contract Specifications.

C. Initial Phase:

This phase shall be accomplished at the beginning of a definable feature of construction Work. The following shall be accomplished:

1. A check of Work to ensure that it is in full compliance with Contract requirements. Review minutes of the preparatory meeting.
2. Verify adequacy of controls to ensure full Contract compliance. Verify required control inspection and testing.
3. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.
4. Resolve all differences.
5. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
6. The Engineer (Resident Engineer or Project Engineer) shall be notified at least 48 hours in advance of beginning the initial phase. Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the daily CQC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
7. The initial phase should be repeated for each new crew to Work onsite, or any time acceptable specified quality standards are not being met.

D. Follow-up Phase:

Daily checks shall be performed to assure control activities, including control testing, are providing continued compliance with Contract requirements, until completion of the particular feature of Work. The checks shall be made a matter of record in the CQC documentation. Final follow-up checks shall be conducted and all deficiencies corrected prior to the start of additional features of Work that may be affected by the deficient Work. The Contractor shall not build upon nor conceal non-conforming Work.

E. Additional Preparatory and Initial Phases

Additional preparatory and initial phases shall be conducted on the same definable features of Work if: the quality of on-going Work is unacceptable; if there are changes in the applicable CQC staff, onsite production supervision or Work crew; if Work on a definable feature is resumed after a substantial period of inactivity; or if other problems develop.

1.23 COORDINATION OF INSPECTIONS AND TESTINGS

- A. The Contractor shall perform specified or required tests to verify that control measures are adequate to provide a product, which conforms to Contract requirements. Upon request, the Contractor shall furnish to the Engineer (Resident Engineer or Project Engineer) duplicate samples of test specimens for possible testing by the City. Testing includes operation and/or acceptance tests when specified. The Contractor shall procure the services of a City approved testing laboratory. The Contractor shall perform the following activities and record and provide the following data:
1. Verify that testing procedures comply with contract requirements.
 2. Verify that facilities and testing equipment are available and comply with testing standards.
 3. Check test instrument calibration data against certified standards.
 4. Verify that recording forms and test identification control number systems, identified in Contractor's CQC plan, including all of the test documentation requirements, have been prepared.
 5. Results of all tests taken, both passing and failing tests, shall be recorded on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test shall be given. If approved by the Engineer (Resident Engineer or Project Engineer), actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility shall be provided directly to the Engineer (Resident Engineer or Project Engineer). Failure to submit timely test reports as stated may result in nonpayment for related Work performed and disapproval of the test facility for this contract.
- B. The Contractor shall hire different independent inspection and testing agencies/laboratories to cover all construction Work. This may include, but not be limited to the following:
1. Independent Certified Testing Laboratory for soil testings, e.g. Compaction testing for soil, evaluation of soil for landscaping, imported fill.
 2. Independent Certified Testing Laboratory analyzing chemical contents, etc. of the soil to determine whether the soil is hazardous or not.
 3. Independent Testing and Inspection for lightweight/cellular, cast-in-place, Site concrete test requirements including but not limited to plant batch certification, slump and shrinkage tests, cylinder tests, materials testing and other tests required in accordance with the project technical specifications.
 4. Independent Testing and Inspection for asphalt concrete paving.
 5. Independent Monitoring of vibration and settlement of existing structures.

6. Independent Testing and Inspection for other items of Work not listed above but, is specified in the Contract Documents.
7. Special/continuous inspections and testing services shall be performed by a qualified Independent Certified Inspection and Testing Agency. These are special inspections and testing as specified in the contract documents and as required by the building official and building codes and are not to be confused with other types of inspections and testings. The Independent Inspection and Testing Agency shall investigate thoroughly the scope of all the special inspections and testings required by the building codes prior to submitting bid. Below is a sample, incomplete list of areas requiring special/continuous inspections and testing services:
 - a. Concrete
 - b. Bolts installed in concrete
 - c. Epoxy Anchors
 - d. Reinforcing Steel
 - e. Structural Welding
 - f. General Welding
 - g. Special Moment Resisting Frames
 - h. Welding of reinforcing steel, if applicable
 - i. High-strength Bolting
 - j. Structural Masonry
 - k. Piling
 - l. Special Grading, Excavation and Grading

Where there is a dispute between whether a special inspection or testing is to be performed or any disputes on the frequency of these testings, inspections or on the timing and the manner by which these testings and inspections are to be performed, such disputes shall be resolved between the Engineer (Resident Engineer or Project Engineer) and the Construction Manager within two working days or else brought before the City's Building Permit Agency (the agency issuing the Building Permit) immediately for resolution. The Building Permit Agency's interpretation/ruling on the dispute shall be final.

Independent Certified Inspection and Testing Agencies for conducting specialized inspections and testings related to architectural, mechanical and electrical Work as required in the various sections of the Specifications.

Note: None of the Independent Inspection and Testing Agencies/Laboratories proposed and retained by the Contractor shall be associated with the Contractor or any of its subcontractors,

i.e. associated by way of being a past or current affiliated company, subsidiary company, partnering company of the Contractor or one of the subcontractors.

- C. Where the required inspections and testing vary from the approved inspections and testing schedule, the Independent Inspection and Testing Agencies/Laboratories shall provide a minimum of five (5) working day advance notice to the Contractor and to the Engineer (Resident Engineer or Project Engineer) prior to the date of the inspection and testing so that both the Contractor and the Engineer (Resident Engineer or Project Engineer) can witness the inspections and the tests
- D. Within five (5) working days after the completion of the inspections or tests performed, the Independent Inspection and Testing Agencies/Laboratories shall submit to the Engineer (Resident Engineer or Project Engineer), in duplicate copies, the results of the inspections and tests with a copy to the Contractor Quality Control System Manager, indicating observations and the results of tests and indicating compliance or non-compliance with the Contract.
- E. In addition, the City's Construction Management Team may choose to verify the CQC testings and inspections with its own CQA testing. The Contractor shall cooperate fully with the City's own inspection and testing agencies/laboratories and shall furnish samples of materials, design mix, equipment, tools, storage, and assistance as requested.
- F. Re-testing or re-inspection required (including re-inspections by building officials) because of non-conformance to specified requirements shall be performed by the same independent agency/laboratory on instructions by the Engineer (Resident Engineer or Project Engineer). All expenses related to re-testing and re-inspections shall be borne solely by the Contractor.
- G. Contractor is responsible to coordinate all required inspections, tests, including any re-tests, by all independent inspection and testing laboratories/agencies so as to avoid unnecessary delays to the construction schedule.

1.24 COMPLETION INSPECTION

A. CQC Preliminary Punch-Out Inspection

Near the end of the Work, or any increment of the Work, the CQC Manager shall conduct an inspection of the Work. A preliminary punch list of items, which do not conform to the approved drawings and specifications, shall be prepared and included in the CQC documentation. The list of deficiencies shall include the estimated date by which the deficiencies will be corrected. The CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected. Once this is accomplished, the Contractor shall notify the Engineer (Resident Engineer or Project Engineer) that the facility is ready for the CQA Pre-Final Inspection.

B. City Pre-Final Inspection

The City will perform the pre-final inspection to verify that the facility is complete and ready to be used. A City Pre-Final Punch List will be developed as a result of this inspection. The Contractor's CQC System Manager shall ensure that all items on this list have been corrected before notifying the City, so that a Final Inspection with Muni Operations and Maintenance and other City Departments can be scheduled. Any items noted on the Pre-Final Inspection shall be corrected in a timely manner. These inspections and any deficiency corrections required by this paragraph shall be accomplished within the time slated for completion of the entire Work or any particular increment of the Work if the project is divided into increments by separate completion dates.

C. Final Acceptance Inspection

The Contractor's Quality Control Inspection personnel, plus the Contractor's Construction Manager or other primary management person, and the Engineer's Representative shall be in attendance at the Final Acceptance Inspection. Additional City personnel including, but not limited to, those from Muni Operations and Maintenance or other City Departments may also be in attendance. The Engineer (Resident Engineer or Project Engineer) based upon results of the Pre-Final Inspection will formally schedule the Final Acceptance Inspection. Notice shall be given to the Engineer (Resident Engineer or Project Engineer) at least 14 calendar days prior to the Final Acceptance Inspection and shall include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining Work performed under the contract, will be complete and acceptable by the date scheduled for the Final Acceptance Inspection. Failure of the Contractor to have all contract Work acceptably complete for this inspection will be cause for the City to bill the Contractor for the City's additional inspection cost

1.25 DOCUMENTATION

- A. The Contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the Work of subcontractors and suppliers and shall be on an acceptable form that includes, as a minimum, the following information:
1. Contractor/subcontractor and their area of responsibility.
 2. Operating plant and equipment with hours worked, idle, or down for repair.
 3. Work performed each day, giving location, description, and by whom. When CPM Network Analysis is used, identify each phase of Work performed each day by CPM activity number.
 4. Test and/or control activities performed with results and references to specifications/drawings requirements. The control phase shall be identified

(Preparatory, Initial, Follow-up). List of deficiencies noted, along with corrective action.

5. Quantity of materials received at the Site with statement as to acceptability, storage, and reference to specifications/drawings requirements.
6. Submittals and deliverables reviewed, with contract reference, by whom, and action taken.
7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. Instructions given/received and conflicts in plans and/or specifications.
10. Contractor's verification statement.

These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the Work and workmanship comply with the contract. The original and one copy of these records in report form shall be furnished to the Engineer (Resident Engineer or Project Engineer) daily within twenty-four (24) hours after the date covered by the report, except that reports need not be submitted for days on which no Work is performed. As a minimum, one report shall be prepared and submitted for every seven (7) days of no Work and on the last day of a no Work period. All calendar days shall be accounted for throughout the Construction phases. The first report following a day of no Work shall be for that day only. Reports shall be signed and dated by the CQC System Manager. The report from the CQC System Manager shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

1.26 NOTIFICATION OF NON-COMPLIANCE

The Engineer (Resident Engineer or Project Engineer) will issue a Non-Compliance Notice to the Contractor for any detected non-compliance in the Work or portion thereof that has not been performed in accordance with the Contract Documents. Such Notice, when delivered to the Contractor at the Work Site, shall be deemed sufficient for the purpose of notification.

The Contractor and Contractor's CQC System Manager shall take immediate corrective action after receipt of such Notice. The Contractor shall provide a written Response to Non-Compliance within five (5) working days after receipt of the Notice. The Contractor's response shall detail either (a) why they believe that the Work was performed in accordance with the Contract Documents or (b) what corrective action they intend to take, at their sole expense, to correct the non-complying Work.

If the Contractor disputes issuance of the Notice, the Engineer (Resident Engineer or Project Engineer) will respond within five (5) working days after receipt of dispute by either (a) withdrawing the Non-Compliance Notice or (b) directing the Contractor to correct the Work. Such determination from the Engineer (Resident Engineer or Project Engineer) shall be final and conclusive of the matter. If the Engineer (Resident Engineer or Project Engineer) directs the Contractor to correct the Work, the Contractor shall do so within five (5) working days after receipt of such direction from the Engineer (Resident Engineer or Project Engineer), or such other time as may be agreed to with the Engineer (Resident Engineer or Project Engineer).

Payment shall not be made on any portion of the Work for which a Non-Compliance Notice has been issued and the Work not corrected to the satisfaction of the Engineer (Resident Engineer or Project Engineer).

If the Contractor fails or refuses to comply promptly, the Engineer (Resident Engineer or Project Engineer) may issue an order stopping all or part of the Work until satisfactory corrective action has been taken. The Contractor shall make no part of the time lost due to such stop orders the subject of a claim for extension of time or for excess costs or damages.

1.27 UNCOVERING OF WORK

- A. No Work shall be covered until inspected by the City or other public authorities having jurisdiction.
- B. If any part of the Work is covered prior to inspection by the City or other public authorities having jurisdiction, Contractor shall, upon written request by the City, uncover it for inspection by the City or other public authorities having jurisdiction and subsequently replace it with no increase in the Contract Sum and without change in the Contract Time.
- C. Should the City or other public authorities having jurisdiction wish to re-inspect a portion of the Work that has been covered, Contractor shall uncover it upon written request. If the Work conforms to the requirements of the Contract Documents, the City will pay the costs of uncovering and replacement; if the Work does not conform to the requirements of the Contract Documents, the City at its option will reduce the Contract Sum by an amount sufficient to cover such costs, including related disruptions and delays.

1.28 TESTS AND INSPECTIONS

- A. If the Contract Documents require any part of the Work specifically to be inspected, tested or approved by the City or other public authorities having jurisdiction, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests or approvals. Contractor shall give the Engineer, special inspectors, and pertinent representatives from other public authorities having jurisdiction a minimum of two (2) working days notice, excluding weekends and City holidays for local inspections and four (4) calendar weeks for out of area testing and

inspections, of when and where tests and inspections are required so the City and other public authorities having jurisdiction may arrange for the appropriate Engineers and inspectors be present to perform the necessary inspections or tests. The cost or expense associated with the attendance by City employees at special inspections required by the Contract Documents shall be paid by the City. The City reserves the right to modify the scope of, or to reassign, any of the testing and inspection services specified in the various sections of the Contract Documents to be performed by a testing agency or Contractor retained by the City in connection with the Work.

- B. If the City or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection or approval not included in subsection 8.02A, the City will order the performance of such services by qualified independent testing agencies, or Contractors as may reasonably be required. The City shall bear such costs except as otherwise provided in this section.
- C. If the procedures for testing, inspection or approval reveal failure of the portion of the Work to comply with requirements of the Contract Documents, Contractor shall bear all costs made necessary by such failure, including costs of repeated procedures and compensation for the City's additional testing and inspection services and expenses.
 - 1. If the City's observation of any inspection or testing undertaken reveals a failure in any one of a number of identical or similar items or elements incorporated in the Work to comply: (i) with the requirements of the Contract Documents or (ii) with Laws of any public authority having jurisdiction with respect to the performance of the Work, then the City will have the authority to order inspection and testing of all such items or elements of the Work, or of a representative number of such items or elements of the Work, as it may consider necessary or advisable.
 - 2. Contractor shall be responsible for all costs for the City's additional testing and inspection services, and the Contract Sum shall be reduced by such amounts. The City may perform such additional testing and inspection services if Contractor fails to do so, or the City at its option may reduce the Contract Sum by an amount to cover the costs. Neither the City's authority to act nor any decision made by the Engineer in good faith either to exercise or not to exercise such authority shall relieve Contractor of any liability for the Work or give rise to any duty or responsibility of the City to Contractor, any Subconsultant or Subcontractor, or any of their agents or employees, or any other person performing any of the Work.
- D. Neither observation by the City nor inspections, tests, or approvals by the City's inspectors or testing agencies and Contractors, or other public authorities having jurisdiction, shall relieve Contractor from Contractor's obligation to perform the Work

- in accordance with Contract Documents and provide quality control services to assure that the Work conforms to the requirements of the Contract Documents.
- E. Unless otherwise required by the Contract Documents, required certificates of testing, inspection or approval shall be secured by Contractor and furnished to the City in accordance with the Contract Documents.
 - F. If observation or testing is required outside the nine Bay Area counties and does not take place at a Site, Contractor shall bear the travel-related costs, including transportation, lodging, meals, long-distance telephone calls and facsimile transmittals, and associated expenses of the City without adjustment to the Contract Sum.
 - G. Contractor shall provide promptly all facilities, labor, and material reasonably needed for performing such safe and convenient inspection and tests as may be required by the City. Tests or inspections conducted pursuant to the Contract Documents will be made promptly to avoid unreasonable delay in the Work. The City reserves the right to charge to Contractor any additional cost of inspection or test when the Work, material or workmanship is not ready for inspection or testing at the specified time.
 - H. So that the SFMTA may determine whether the Contractor has complied or is complying with the requirements of the Contract not readily enforceable through inspection and tests of the Work and materials, the Contractor shall at any time when requested submit to the SFMTA properly authenticated documents or other satisfactory proofs of its compliance with such requirements.

1.29 LINES AND GRADES, MEASUREMENTS.

The Contractor shall keep the SFMTA informed a reasonable time in advance of the times and places at which it wishes to perform Work, in order that necessary measurements for record and payment may be made with the minimum of inconvenience to the Engineer and of delay to the Contractor. At the request of the SFMTA, the Contractor shall, without charge, provide workers from its force, and tools and materials, to assist the SFMTA temporarily in making measurements and surveys and in establishing temporary or permanent reference marks. The marks shall be carefully preserved.

It may be necessary at times that portions of the Contractor's Work be discontinued, in order that the SFMTA may make measurements or surveys without interruptions or other interference that might impair the accuracy of the results. At any time, on request of the SFMTA, the Contractor shall discontinue its Work to such extent as may be necessary for the purposes of the SFMTA.

No direct payment will be made for the cost to the Contractor of any Work or delay occasioned by making measurements, or by inspection, and no extension of time will be allowed for such delays.

The location, alignment, position, and grade or dimensions of any portion of the Work may be changed upon notice by the SFMTA from those shown in the Criteria Package, at any time before or after the commencement of Work under this Contract.

1.30 CORRECTION OF NON-CONFORMING WORK

- A. The City will have the sole and unfettered authority to disapprove or reject Non-conforming Work. If required in writing by the City, Contractor shall remove Non-conforming Work from a Site and replace it promptly with Work that conforms to the Contract Documents, regardless of when the Non-conformance is discovered. Contractor shall pay all claims, costs, losses, and direct, indirect and consequential damages of removal and replacement, including, but not limited to, all costs of inspections, fees and charges of architects, engineers and other professionals, and repair or replacement of Work of others to correct the Nonconforming Works. This subsection, however, shall not be interpreted to provide for recovery of attorney's fees.
- B. Failure or neglect on the part of the City or any of its authorized agents or representatives to condemn or reject Non-conforming Work or defective materials shall not be construed:
 - 1. To imply acceptance of such Non-conforming Work or materials; or
 - 2. As waiver or otherwise barring the City at any subsequent time from the recovery of money needed to build anew all portions of such Non-conforming Work; or
 - 3. To relieve Contractor from the responsibility of correcting Non-conforming Work or materials.
- C. If Contractor fails to correct Non-conforming Work or proceed with corrections within a reasonable time as stated in the written notification from the City, the City may correct the Non-conforming Work, or may remove it and store the salvageable materials or equipment at Contractor's expense. If Contractor does not pay the costs of such removal and storage within 7 days after written notice, the City may sell, auction, or discard such materials and equipment and, after deducting said costs and damages to the Work and the City's expenses in rectifying same, credit Contractor's account. If the proceeds fail to cover said costs and damages, the City at its option will reduce the Contract Sum by the deficit. Such corrective action by the City shall not entitle Contractor to any extension of the Contract Time.

1.31 CORRECTION OF DEFECTIVE WORK

- A. Contractor shall repair or replace Non-conforming Work or damage resulting from such Non-conforming Work promptly at no additional cost to the City or extension of Contract Time, whether due to: (i) faulty materials or workmanship; or (ii) defective installation by Contractor of materials or equipment manufactured by others but

Furnished by Contractor; or (iii) disturbance of, or damage to, City improvements by Contractor's operations contrary to the Contract Documents; (iv) System-Wide Defect (see section RFQ/RFP Appendix 12 Section 1.2.1); or (v) other failure to conform to the requirements of the Contract Documents. Such repair or replacement shall be in accordance with the City's written notification of occurrence and such correction period specified as follows:

1. In any part of the surface Work, or in surface improvements of the City such as building superstructures, pavements, curbs, walks, tracks, walls, stairways, poles antennas, foundations, mechanical and electrical equipment, materials, appurtenances and accessories, or other surface structures, provided that such Non-conforming Work or damage resulting there from be detected within Two Years following the date of the date that the City accepts the Project, or within such longer period of time as may be prescribed by Law or by the terms of any applicable guarantees required elsewhere in the Contract Documents; or
 2. In any part of subsurface Work, or in subsurface improvements of the City not included in the Work, such as building foundations, sewers, side sewers, culverts, other drainage structures, pipes, valves, conduits, conductors, or other subsurface structures, provided that such Non-conforming Work or damage resulting therefrom be detected within two years following the date that the City finally accepts the Project, or within such longer period of time as may be prescribed by Law or by the terms of any applicable guarantees required elsewhere in the Contract Documents.
- B. This agreement to correct Non-Conforming Work shall continue for corrected or replaced Equipment, or corrected/replaced parts thereof, until two (2) years after the date the City finally accepts the Project.
- C. This agreement to correct Non-conforming Work, and all similar agreements applicable to equipment of Subcontractors, Subconsultants of any tier or Suppliers used in or as a part of the Work (whether on Equipment of the nature above specified or otherwise) shall inure to the benefit of the City without necessity of separate transfer or assignment thereof.
- D. The remedies provided for in this section shall not be restrictive but shall be cumulative and shall be in addition to all other legal remedies the City may possess with respect to latent defects or frauds. Nothing in these provisions obligating Contractor to replace or repair Non-Conforming Work shall be constitute a period of limitations for any other rights or remedies the City may have concerning this Contract. Nothing in this Contract shall be construed as limiting the City's remedies as to latent defects.

1.32 SYSTEM-WIDE DEFECTS

The Contractor shall comply with the requirements set forth in Appendix 12, section 1.2.1 (System-Wide Defects), and shall redesign as necessary and replace Equipment and Items that the City determines to be System-Wide Defects.

1.33 ACCEPTANCE OF NON-CONFORMING WORK

If, in the sole and unfettered judgment of the City, it is undesirable or impractical to replace any defective or Non-conforming Work, the City at its option may reduce the Contract Sum by such amount as the City and its authorized representatives deem equitable in light of the reduced value to the City of the Non-Conforming Work as compared to the value of the Work that conform to the Contract Documents. Contractor shall pay all fees and charges for architects, engineers and testing agencies attributable to the City's evaluation of and determination to accept such Non-conforming Work.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF DOCUMENT

DOCUMENT 00825: CADD DOCUMENT LIABILITY WAIVER AND RELEASE**PART 1 – GENERAL****1.1 SUMMARY**

The City may issue to Contractor computer-aided design document (CADD) files of the Conceptual and Preliminary Designs, which were prepared for the City for the Work of the Project, in electronic format for the limited purpose of facilitating Contractor's final design of the Work.

1.2 PROJECT CONDITIONS

- A. The City's issuance of Project CADD files to Contractor is not a representation of the completeness or accuracy of the information contained in the files.
- B. Because Contractor is required to perform all Work in accordance with the requirements of only the printed versions of the Criteria Package for Project as originally issued or modified in accordance with the Contract Documents, Contractor shall review the CADD files for the same accuracy and completeness as the original printed versions prior to Contractor's use and shall certify that all information contained in said Project CADD files accurately conforms to said Contract Documents.
- C. Contractor agrees not to transmit to third parties or otherwise reuse Project CADD files without prior written consent of the City. Unauthorized use of Project CADD files shall be at the sole liability of the user.
- D. Contractor hereby agrees to release the City from inaccuracies, incompleteness, or discrepancies between Project CADD files and said printed versions of the Contract Documents.
- E. Contractor shall be responsible for all damages resulting in whole or in part from inaccuracies, incompleteness, or discrepancies between said Project CADD files and said printed versions of the Contract Documents.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

Not Used.

END OF DOCUMENT

DOCUMENT 00826: EXISTING UTILITY FACILITIES**PART 1 - GENERAL****1.1 SUMMARY**

This Document includes special requirements for existing utilities and underground facilities owned or controlled by any person or entity, private or governmental, referred to herein as "Utility Owners," which may be encountered by Contractor performing the Work.

1.2 EXISTING UTILITIES INDICATED

- A. The Contract Documents may identify or include utility occupancy drawings or utility reference drawings, hereinafter called "reference drawings," showing the approximate locations and other details, of pipes, conduits, structures and other utility facilities which are based on information and data furnished the City by the Utility Owners.
1. In the absence of such reference drawings, Contractor may inspect in the offices of the Bureau of Engineering, Department of Public Works, and the City Distribution Division, San Francisco Water Department, such drawings and other information relative to Sewer, Auxiliary Water Supply System for Fire Protection facilities, and Water facilities, and information regarding other facilities which may have been made available to the City by the Utility Owners.
 2. It is understood that the City makes no representation as to the completeness or accuracy of said reference drawings or other information available to Contractor and assumes no responsibility therefore.
- B. The cost of all of the following with respect to existing pipes, wires, conduits, and other utility facilities shall be included in the Contract Sum, and Contractor shall assume full responsibility for the following:
- Reviewing and checking all such reference drawings or information.
 - Locating all underground facilities indicated in the Contract Documents, reference drawings or other information available to Contractor.
 - Coordinating the Work with the Utility Owners including the City. The safety and protection of all such utility facilities as provided in Article 12 of Document 00700 and repairing damage thereto which may result from the Work.
 - Removing and adjusting utility facilities located in, over or around the location of the Work as necessary to allow the prosecution of the Work.

1.3 EXISTING UTILITIES NOT INDICATED

- A. Consistent with the provisions of Section 4215 of the California Government Code, the City will assume the responsibility for the timely removal, relocation, or protection of existing main or trunk line utilities located on the Site of the Work, if such utilities are not identified in the Contract Documents, reference drawings or other information available to Contractor.
- B. Contractor shall notify promptly the City and the public utility in writing, and before further disturbing conditions affected thereby, of such utility facilities it discovers while performing the Work which are not indicated in the Contract Documents, reference drawings or other information available to Contractor.
- Contractor shall negotiate with the Utility Owner, who shall have the sole discretion to perform repairs or relocation Work or permit Contractor to do such repairs or relocation Work at a reasonable price.
- C. Contractor will be granted a non-compensable time extension and shall not be assessed liquidated damages for delay in completion of the Work if the delay was caused by such existing main or trunk line utilities in direct conflict with the Work and not indicated in the Contract Documents, reference drawings or other information available to Contractor.
- D. Contractor will be compensated under the provisions of Article 6 of Document 00700 for its direct costs associated with the extra Work involving existing City-owned utilities not indicated on the Contract Documents, reference drawings or other information available to Contractor but in direct physical conflict with the Work.
- This extra Work shall be limited to the following:
- a. Removing and relocating as directed by the City such existing main or trunk line utility facilities.
 - b. Equipment on the project necessarily idled during such Work.
- E. Contractor shall not be entitled to any adjustment in the Contract Sum or Time if the existence of such condition:
1. Could have been reasonably discovered or revealed as a result of examination, investigation, exploration, test or study of the Site and contiguous areas required by the Contract Documents to be conducted by or for Contractor prior to commencing the Work; or
 2. Could have been inferred from the presence of other visible facilities, such as buildings, meter and junction boxes, on or adjacent to the Site.

1.4 GOVERNMENTAL FACILITIES

1. Contractor shall satisfactorily support, Work around, and protect, as approved by the City, all facilities, whether shown on the Drawings or not, which exist within any excavation and which are owned or controlled, and maintained, by a City department or other authority in the exercise of a governmental function, including, but not limited to, traffic control, lighting, police communication and fire alarm systems, and all conduits, wiring and related appurtenances for such systems; sewers and sewer structures; San Francisco Water Department facilities; pipes and facilities of the Auxiliary Water Supply System for Fire Protection; and the Municipal Railway and Hetch Hetchy Water and Power overhead lines and power feeder systems serving the Municipal Railway.
2. Municipal Railway facilities and Hetch Hetchy Water and Power facilities serving the Municipal Railway, if encountered, shall be supported in a manner satisfactory to the SFMTA of the Public Utilities Commission of the City and County of San Francisco.
3. Auxiliary Water Supply for Fire Protection facilities, if encountered, shall be supported by a minimum of one cable with turnbuckle, a strongback, and a beam spanning the trench; however, where a joint falls within the trench area, a cable with turnbuckle shall be placed on each side of the joint. All such support Work shall be subject to the approval of the City before commencement thereof. After supports are removed and the pipe is sufficiently supported by partial backfill, but with the joints exposed, the pipe shall be subjected to a hydrostatic field test of 450 psi pressure in accordance with section 908.22 of the DPW Standard Specifications (refer to Division 1 for reference standards) before final backfill is placed. If a joint is visibly wet, Contractor shall repair the joint in accordance with section 910 of the DPW Standard Specifications.
4. If vitrified clay pipe side sewers or culverts are encountered, Contractor may elect, in lieu of supporting such side sewers and culverts, to cut and restore those portions of the side sewers and culverts which obstruct the prosecution of the Work, provided that it complies with the provision of section 301 of the DPW Standard Specifications regarding the handling and disposal of seepage, storm water and sewage.
5. San Francisco Water Department facilities, if encountered, shall be supported as follows:

- a. Push-on joint pipes: Pipes shall be supported by a minimum of one cable with turnbuckle, a pipe clamp and a beam spanning the trench; however, where a joint falls within a trench area, a cable with turnbuckle and pipe clamp shall be placed on each side of the joint.
 - b. Copper tubing and plastic pipes (service pipes 2 inches or smaller in diameter): If the trench is less than 8-foot wide, no support is required. For trenches wider than 8 feet, one support is required for every additional 8 feet or part thereof.
 - c. Steel welded pipes: Pipes shall be supported in a manner satisfactory to the SFMTA.
 - d. Contractor shall submit support designs for approval and start Work only with approved support designs.
6. The adjustment of manhole castings and other castings of governmental facilities, and the paving adjacent thereto, shall be done in accordance with the requirements of section 217 of the DPW Standard Specifications.
- F. Supporting, working around, and protecting existing governmental facilities indicated in the Contract Documents, reference drawings or other information available to Contractor shall be considered incidental Work and no direct or additional payment will be made therefor.
- G. Governmental facilities not shown on the Contract Documents, reference drawings or other information available to Contractor that require removal, adjustment or relocation to avoid direct physical conflict with the facilities to be constructed under the Contract shall:
1. be removed or adjusted by Contractor in accordance with the provisions of the Contract Documents; or
 2. in the absence of such provisions, be removed or adjusted by Contractor on a force account basis as set forth in Article 6 of Document 00700; or
 3. be removed or adjusted by other suitable procedure at the City's expense.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF DOCUMENT

DOCUMENT 00827: ARCHAEOLOGICAL CONDITIONS**PART 1 - GENERAL****1.1 SUMMARY**

- A. This Document includes procedures to provide for protection, removal, or investigation of archaeological findings, and to provide Contractor such compensation or relief as may be appropriate for unforeseen Work or for Work suspension directed by the City under the provisions of the Contract Documents.
- B. Pursuant to the National Historic Preservation Act of 1966, (16 U.S.C. 470) and PRM 75-27, the City intends to provide for the preservation and protection of such material of an archaeological nature as may be of scientific or historical value.

1.2 DISCOVERY OF ARCHAEOLOGICAL FINDS

- A. If potential historical, architectural, archaeological, or cultural resources are discovered at a Site, the following procedures are to be instituted:
 - 1. Promptly report all subsurface archaeological finds to the City. Prehistoric finds shall also be reported to local Native American organizations.
 - 2. The City will issue a written order to suspend Work in accordance with Paragraph 14.2 of Document 00700 directing Contractor to cease all construction operations only at the location of such potential cultural resources find.
 - 3. The City's archaeologist will assess the significance of the find, and immediately report to the City Environmental Review Officer (ERO), who will recommend specific additional mitigation measures as necessary to minimize potential effects on cultural resources. Such mitigation measures may include additional Site security; on-Site investigations by an archaeologist; and documentation, preservation, and recovery of cultural materials. Following review and approval of the City archaeologist's report by the ERO, copies of the final report will be sent to the California Archaeological Site Survey Northwest Information Center and the President of the Landmarks Preservation Advisory Board.
- B. Cost or time impacts as a result of a suspension under this Document shall be resolved as provided in Document 00700.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF DOCUMENT

DOCUMENT 00828: HEALTH & SAFETY**PART 1 - GENERAL****1.1 INTRODUCTION**

- A. This Document sets forth general health and safety requirements for the Contract. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Contractor shall be solely and fully responsible for compliance with all laws, rules and regulations applicable to health and safety of Contractor Personnel and other persons affected by the Work of Contractor's Personnel during the performance of the Project, and shall fully assume the defense of, indemnify, and hold harmless those entities and persons as required by this Agreement. Contractor shall be solely and fully responsible for all construction means, methods, techniques, sequences, and procedures, including all safety precautions and programs taken in connection with the Work, as well as coordinating all portions of the Work. Contractor, not the City, is responsible and liable for the health and safety of Contractor's employees and Subcontractors as set forth in applicable statutes, laws, and regulations. Contractor shall be solely responsible for any and all fines, penalties or damages which result from its failure to so comply.
- B. The health and safety requirements specified in this Agreement are not all-inclusive. It is Contractor's sole responsibility to identify and comply with all applicable health and safety requirements for the Work. The City will neither assume administration nor direct control and responsibility for maintaining Contractor's health and safety program.
- C. The City will provide instruction to Contractor as to known hazards existing in certain Job Sites, including but not limited to maintenance facilities, tunnels, stations, boarding platforms, bus stops, traction power systems, and roadways and shared rights of way. But it shall be Contractor's responsibility at all times to ensure the safety of Contractor's Personnel and the safety of Contractor's performance of the Work. Contractor was prequalified to compete for this Contract and was selected in part based on the qualifications of its experience performing radio communications installation and construction Work in dangerous Work environments similar to those of the Project Job Sites. As such, the City may reasonably rely on Contractor's experience in working in active transit facilities and shall tailor its orientation and training of Contractor's Personnel accordingly, unless Contractor specifically identifies particular Contractor's Personnel as needing more in depth orientation and training.

- D. Contractor has an immediate and continuing obligation under this Agreement that when first entering and whenever and for however long present at a Job Site on SFMTA property to inquire of the Engineer as to conditions and dangers present at the Job Site that may not be readily known by reasonable observation or that Contractor could not discern by Contractor's reasonable investigation and experience and familiarity with active public transit operations.
- E. Nothing contained in the Agreement shall relieve Contractor, or any Subcontractor or Supplier, from the obligations set forth herein and obligations as required by applicable laws, rules, or regulations pertaining to Work place safety. If a provision of this Document 00814 conflicts with any applicable provision of the Agreement or any federal, state, or local safety regulations, the more stringent requirements that maintain a greater level of safety shall apply.
- F. By entering into this Agreement, Contractor acknowledges and understands that it will perform a significant amount of the Work under this Contract that is:
1. in active transit vehicle maintenance facilities at night in which vehicles will be under power and moving;
 2. at transit vehicle fuel and wash facilities where petroleum products and high humidity conditions are common;
 3. in underground rail tunnels;
 4. in roadways open to the public and shared rail right of ways open to the public;
 5. under and around overhead high voltage traction power lines;
 6. in and around subway stations, boarding platforms, and bus stops;
 7. at heights on new and existing antennae installations and on rooftops of tall buildings
- G. Contractor shall not allow any of Contractor's Personnel to enter any Job Site unless and until said Contractor's Personnel have received orientation and training applicable to that Job Site from either the SFMTA or Contractor's designated safety personnel assigned to perform such orientation and training. Where Contractor is assigned certain areas as a Job Site within an SFMTA facility, Contractor shall ensure that Contractor's Personnel remain in that area unless authorized by the SFMTA to go elsewhere. Contractor shall be extremely vigilant in Job Sites located in the rail tunnels or active vehicle maintenance facilities. Contractor shall ensure that all transit vehicles in which it works are braked, wheels chocked or otherwise immobilized, and electric vehicles disengaged from the traction power system with lockout/tag out measures in place.

1.2 DEFINITIONS

The following definitions are in addition to the definitions set out in the General Conditions and in other provisions of this Agreement that define terms, which are incorporated here by reference.

1. **Activity Hazard Analysis (AHA)/Job Hazard Analysis (JHA)** – a form used to identify the task and break it down into steps, identify the hazards associated with each step, and identify the control measures used for each step to protect the worker, environment or public. This form is also commonly referred to as Job Safety Analysis (JSA).
2. **Engineer** - the SFMTA Project Manager or his designated representative.
3. **Competent Person** – one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
4. **Hot Work** – any activity using tools or equipment resulting in the generation of sparks or open flame. This includes, but is not limited to, cutting or burning with torches, welding, grinding, and the use of reciprocating saws.
5. **Incident** – any unplanned or unexpected event that results in personal injury, property damage, or environmental release.
6. **Near-Miss Incident** - any unplanned or unexpected event that could have resulted in serious personal injury, property damage or environmental release, but did not due to luck, chance, or other circumstances.
7. **Project PPE** – ANSI Z87.1 safety glasses/shields, hard hat, Work boots or protective footwear, gloves, hearing protection, and high visibility vest.
8. **Qualified Person** – one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his/her ability to solve or resolve problems related to the subject matter, the Work, or the Project.

9. **Site Safety Representative** – a Contractor’s employee(s) assigned to the Project based on the contract requirements for the entire duration of construction activities.
10. **Work Areas** – Refers to the portion of a Job Site not wholly occupied by Contractor where Contractor performs Work.

1.3 DELEGATION OF CONTROL OF THE JOB SITES

Notwithstanding the requirements set out in this Document and any other requirement(s) of this Agreement, the City delegates to the Contractor control of each Job Site or Work Area for the Project and responsibility for the safety of the persons and property on a Site or Work Area. Contractor understands and agrees that nothing in this Agreement, including but not limited to the requirements set out in this Section, shall amend said delegation or otherwise relieve Contractor of its responsibility for the safety of persons and property within the perimeter of the Job Site. Where Contractor is performing Work at a Job Site that is an active SFMTA facility in operation, such as a transit vehicle maintenance facility, Contractor shall be responsible for the safety of all persons within its assigned Work Area and shall be responsible for the safety of other persons at the facility to the extent that a safety issue arises out of Contractor's activities. Where Contractor is performing Work at a Job Site at which SFMTA personnel are not performing active operations, such as antenna sites, Contractor shall be wholly responsible for the safety of all persons at that Job Site without limitation.

1.4 PERSONS AND PROPERTY

- A. Contractor shall take all necessary precautions for safety of, and shall provide the necessary protection to prevent damage, injury or loss to the following:
 1. All persons on a Site or others who may be affected by the Work;
 2. The Work and the materials and equipment to be incorporated therein, whether in storage on or off a Site; and
 3. Other property at a Site or adjacent thereto including, but not limited to, trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not indicated to be removed, relocated or replaced on the Contract Documents.
- B. Contractor shall give notices pursuant to California Civil Code section 832 and shall comply with all applicable Laws of public authorities bearing on safety of persons or property or their protection from damage, injury or loss.
- C. Prior to performing any excavation, Contractor shall notify owners of adjacent property, underground facilities and utilities, such as PG&E, AT&T, San Francisco Department of Public Works, and the San Francisco Public Utilities Commission, of

Contractor's operations a reasonable time in advance thereof so as to permit the owners to make suitable markings on the street surface of the locations of such facilities. After such markings have been satisfactorily made, Contractor shall maintain them as long as necessary for the proper conduct of the Work.

- D. Contractor shall not hinder or interfere with an owner or agency having underground facilities and utilities when removing, relocating, or otherwise protecting such facilities.
- E. Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, safeguards for safety and protection, such as posting danger signs and other warnings against hazards; promulgating safety regulations; and notifying owners and users of adjacent sites, underground facilities and utilities of Contractor's operations.
- F. Contractor shall perform all Work in such manner as to avoid damage to existing underground facilities and other utilities in the process of their removal or adjustment and to avoid damage to such facilities lying outside of or below a required excavation or trench area which are intended to remain in place.
- G. Contractor shall be responsible for coordinating the exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at a Site in accordance with applicable Laws.
- H. In the event of damage or loss to property referred to in the previous subparagraphs, whether caused by Contractor, its Subcontractors or Lower-Tier Subcontractors, or its Subcontractors or Lower-Tier Subcontractors, Contractor shall promptly remedy such damage or loss, except such damage or loss attributable to the sole negligent acts or omissions of the City. The foregoing obligations of Contractor are in addition to Contractor's obligations under Paragraph 3.18 of these General Conditions (Warranty and Maintenance).
- I. Pursuant to section 6705 of the California Labor Code, excavation for trenches 5 feet or more in depth shall not begin until Contractor has received acceptance from the City of Contractor's detailed plan for worker protection from the hazards of caving ground during excavation of such trenches. Contractor's shoring plan shall be submitted in accordance with the requirements of the Contract Documents and shall show the details and supporting calculations of the design of shoring, bracing, sloping, or other provisions to be made for worker protection during such excavation. No plan shall allow the use of shoring, sloping or other protective system less effective than that required by the Construction Safety Orders of the Division of Occupational Safety and Health. If Contractor's shoring plan varies from the shoring system standards established by the Construction Safety Orders, the plan shall be prepared and sealed by an engineer retained by Contractor who is

registered as a civil or structural engineer in the State of California. The City's acceptance of Contractor's shoring plan shall not be construed to relieve Contractor of its sole responsibility for damage or injuries related to the excavation resulting from unsafe shoring.

- J. Contractor shall be responsible for for the performance of the Work, including any temporary installation or temporary facilities necessary for the Work. In performing the Work, Contractor shall protect the Work, Equipment and materials and fully or partially completed work of the City or separate contractors from damage due to Contractor's operations, the action of the elements (to the extent the Work exposes material, Equipment or City property to the elements), and the carelessness of Contractor's Subconsultants or Subcontractors until Final Completion of the Work. Should improper Work of any trade be covered by another contractor and damage or defects result, Contractor shall make the whole Work affected good to the satisfaction of the City and without an increase in the Contract Sum.

1.5 SAFETY PERMITS

- A. A California industrial safety permit shall be obtained and paid for by Contractor if the following occurs:
1. The construction of a building, structure, false Work or scaffolding more than 3 stories or the equivalent of 35 feet height; or
 2. The demolition of a building, structure, false Work or scaffolding more than 3 stories or the equivalent of 35 feet height; or
 3. The excavation of a trench 5 feet deep or deeper into which a person must descend.
- B. Contractor shall obtain and pay for all other required safety permits.

1.6 EMERGENCIES

In emergencies affecting the safety or protection of persons or property at a Site, Contractor shall take all action necessary to prevent threatened damage, injury or loss. Contractor shall give prompt written notice to the City if Contractor believes that, due to the nature of the emergency or circumstances related thereto, any significant changes in the Work or variations in the Contract Documents have been caused thereby or are required as a result thereof. If the City determines that a change in the Contract Documents is required because of action taken by Contractor in response to such an emergency, a Change Order or Unilateral Change Order will be issued as provided in Article 6.

1.7 RELATED DOCUMENTS

Additional Documents related to the health and safety requirements for the Project set forth in this Document include, but are not necessarily limited to the following, which are incorporated here by reference:

1. Contractor Health and Safety Plan (HASP) Template
2. General and Supplementary Provisions of this Agreement
3. SFMTA safety directives and standard operating procedure documents, as provided to Contractor during Job Site orientation and training

1.8 REFERENCES

Work performed shall be consistent with the following guidelines and references and in compliance with all applicable regulations and standards, including those listed below. In the case that these requirements are conflicting, the one which offers the greatest level of safety shall be followed.

- A. CAL/OSHA Occupational Safety and Health Administration (OSHA) Regulations
 1. CCR Title 8 Standards (All)
 2. CCR Title 8 Tunnel Safety Orders (8400-8568).
- B. National Institute for Occupational Safety and Health (NIOSH) Publications
- C. U.S. Environmental Protection Agency (USEPA) Publications
- D. American Conference of Governmental Industrial Hygienists (ACGIH) Publications.

1.9 SUBMITTALS

This Article summarizes required safety-related Submittals. This Article is not intended to be all-inclusive. In addition, some Submittal requirements specified below may not apply depending on the specific Work performed at a particular time or Job Site. Contractor is solely responsible for identifying and submitting to the City and/or appropriate authorities having jurisdiction all Submittals required by applicable laws, rules and regulations.

1. Site-Specific Contractor Health and Safety Plan (HASP) – Submitted to the Engineer 10 working days prior to commencement of Site Work activities. Note: Contractor's HASP will include plan for the Contractor's Substance Abuse Policy.
2. Resume for the Contractor's designated a Site Safety Representative (SSR).

3. Completed Activity Hazard Analysis (AHA) or Job Hazard Analysis (JHA) submitted with the HASP using the AHA/JHA template for all significant activities and tasks with a high-risk potential, describing the job steps, hazards associated with each job step and the controls used to remove or minimize the associated hazards.
4. Project Specific Contractor Hazardous Communications Plan – Submitted to the Engineer 10 working days prior to commencement of Site Work activities.
5. Daily Health and Safety inspections performed by the Contractor's Site Safety Representative (SSR) will be submitted to the Engineer in a weekly report.
6. Safety Meeting Attendance sheet ("Toolbox Meetings") – Submitted to the Engineer on request.
7. Air Monitoring Results/Reports – Submitted to the Engineer on request (if requested by City).
8. Monthly Field Project Report – Including man-hours, incident/injury and property damage reports – Submitted to the Engineer on a monthly basis within 5 days of the last working day of the month.
9. Heavy Equipment Inspection Forms – Submitted to the Engineer on request (if applicable).
10. Incident Investigation Reports – Submitted to the Engineer within 24 hours of the Project Incident.
11. HASP modification requests, and approved modifications to the appended HASP – Submitted to the Engineer for review (where applicable).
12. Documentation for all individuals applicable to Regulatory Medical Surveillance guidelines and HAZWOPER training per CAL/OSHA requirements – Submitted to the Engineer for review prior to beginning any Work associated with these requirements (where applicable).
13. Critical Lift Plans – Submitted to the Engineer on request (where applicable).
14. Crane Inspection Certifications – (Daily, Annual, Quad crane inspections conducted by qualified individuals submitted to the Engineer on request (where applicable).
15. Crane Operators certification – Submitted to the Engineer on request (where applicable).
16. Detailed two/three week Look-Ahead Schedule addressing specific scheduled activities, the associated hazards and their mitigation – Submitted to the Engineer on request (where applicable).
17. Applicable employee training and required medical approval documentation in compliance with CAL/OSHA standards

18. A final report, submitted within 20 working days following completion of the Project and prior to final acceptance by the City. The following minimum information shall be included in the final report:
- a. Summary of the overall performance of safety and health (including accidents or incidents including near misses, unusual events, lessons learned, and issues to be addressed).
 - b. Final decontamination documentation including procedures and techniques used to decontaminate equipment, vehicles, and on-Site facilities.
 - c. Complete summary of personnel monitoring.
 - d. Complete summary of air monitoring accomplished during the Project (if applicable)

1.10 GENERAL HEALTH AND SAFETY REQUIREMENTS

The list of general health and safety requirements set forth in this Document 00828 is not a comprehensive list of all requirements that may apply to Contractor's Work under this Contract. In addition, some of the specified requirements may not apply to the Work under this Contract, depending on the type and scope of the particular portion of the Work being performed. Contractor is solely responsible for determining and complying with all applicable health and safety requirements in accordance with applicable laws, rules, and regulations.

1. Contractor shall implement a zero Incident philosophy on the Project and establish a goal of zero accidents and zero injuries with Work tasks designed to minimize or eliminate hazards to Contractor's Personnel, SFMTA operations and employees, the Work, equipment, environment and the general public.
2. Contractor shall develop and use Activity Safety Analyses (AHAs)/JSAs that address all elements of Work required by CAL/OSHA to be undertaken by the Contractor.
3. Contractor shall have a written Lockout/Tagout Procedure that complies with CCR Title 8, Section 3314. The written program will also be coordinated with and submitted to SFMTA personnel when applicable based on scope and location of Work performed at a particular Job Site.
4. Contractor shall have a written Permit-Required Confined Space Program that complies with CCR Title 8, Section 5156-5158. Contractor will provide Engineer with documentation of confined space entrant/attendant/supervisor/rescue training. Retrieval equipment and qualified rescue team shall be provided by each Contractor for all permit-required confined space entries.
5. Contractor shall have a written Fall Protection Program to address Work activities that occur at heights greater than six (6) feet (1.8 meters), which is communicated to all affected employees.

6. Hoisting of personnel on a personnel platform by a crane or derrick is prohibited, except when the erection, use, and dismantling of conventional means of reaching the worksite, such as a personnel hoist, ladder, stairway, aerial lift, elevating Work platform or scaffold, would be more hazardous or is not possible because of structural design or worksite conditions. This type of operation must meet the requirements of CAL/OSHA regulatory requirements.
7. Raising a load over people or occupied buildings is prohibited. Tag lines must be used to control every load. All materials shall be rigged to prevent unintentional displacement. Hooks with self-closing safety latches shall be used to prevent components from slipping out of the hook. Defective rigging equipment shall be tagged and removed from service.
8. Only qualified operators may operate power equipment. Seat belts must be worn per manufacturer and CAL/OSHA standards.
9. Safe lifting procedures for cranes and hoists must be developed and documented. Crane and hoist operators and qualified riggers must conduct rigging equipment inspections prior to each use on each shift and as necessary during its use.
10. Preventative maintenance must be conducted on cranes and hoists in accordance with manufacturer's guidance and CAL/OSHA standards.
11. Riding on hooks, headache balls, or slings of hoisting equipment is strictly prohibited.
12. Scaffolds shall be built per CAL/OSHA standards.
13. All scaffolds must be inspected by a Qualified Person before use and must be designed for the safe working load. Guardrails and toe-boards shall be used on all scaffolds and secured per CAL/OSHA standards. Rolling tower scaffolds must be locked while the scaffold is in use.
14. Scaffold platforms more than 6 feet (1.8m) above any working surface must be equipped with a guardrail system – Top rails (42 inches (1.1m) plus or minus 3 inches, mid rails (midway between the top rail and the scaffold platform) and toe boards or personal fall arrest systems must be utilized.
15. No scaffold shall be erected, moved, dismantled, or altered except by trained and personnel under the authority of the Qualified Person.
16. The Scaffold Tag System shall be implemented using red, yellow, and green tags.
17. Outriggers and platforms below the working/walking level shall be fully planked.
18. Electrical equipment shall not be installed, repaired, or removed except by trained qualified electricians.
19. Temporary lighting must be guarded.

20. All 120-volt, single phase 15 and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and are in use by employees, shall have approved Ground Fault Circuit Interruption (GFCI) for personnel protection.
21. Extension cords must be at least 16-gauge heavy duty 3-wire with a UL approved three prong grounded plug.
22. Gasoline and similar flammable liquids must be stored only in approved safety containers and in areas free of burning hazards.
23. Open fires are strictly prohibited on any Job Site.
24. Every Hot Work operation must have a properly trained and equipped fire watch with appropriate fire extinguishers for the specific hazard in the Work area. The fire watch must remain in the Work area for at least 30 minutes after the Hot Work activity is completed.
25. The Contractor will utilize a Hot Work permit system when working in/around a combustible environment.
26. Defective tools and equipment must be taken out of service and shall be properly repaired before reuse.
27. Compressed gas cylinders shall remain standing and securely tied off, whether empty or full. Valves shall be closed on all empty cylinders. Protection caps shall remain on cylinders when not in use. The valve shall be closed on all empty cylinders.
28. When moving cylinders by crane or derrick, a cradle, boat or suitable platform shall be used. Slings or hooks shall not be used.
29. When cylinders are not in use, they must be secured and capped. If cylinders are not used within a 24-hour period, they are considered to be in storage, and must be secured, capped and separated. Separate oxygen and fuel gas cylinders by a minimum distance of 20 feet or by a noncombustible barrier that is at least 5 feet high, and has a fire-resistance rating of a ½ hour.
30. A motor vehicle engine shall not be left running if the vehicle/equipment is unattended unless it is necessary in the normal operational requirement of the unit. Unattended means that the operator has left the normal control position of the vehicle.
31. All moving equipment must be equipped with back-up alarms per manufacturer and CAL\OSHA standards.
32. All protruding nails in form lumber, boards, etc., must be withdrawn or bent into the wood before the wood is stacked or piled.
33. Job-made wooden ladders can be utilized on the Job Site if they meet CAL/OSHA requirements.

34. Stepladders (A-Frame) must be fully open and cannot be used as straight/extension ladders.
35. Properly secure. and ensure compliance with all ladder safety requirements per manufacturer and CAL\OSHA standards
36. Contractor is responsible for cleaning up and removing hazardous and non-hazardous waste generated on the Job Site.
37. Each Contractor shall be responsible to maintain areas where he is performing Work that is free of waste materials, debris, and rubbish.
38. Provide a proper collection container and floor protection when using cutting oil, solder flux, hydraulic oil, and other fluids. In the event of a large spill, immediately install acceptable containment barriers and notify the Engineer.
39. Follow all safety standards for Tunnel Work as specified in CAL/OSHA Title 8, Section 8400-8568 regulations.(If applicable)
40. Alcoholic beverages, recreational drugs, and people under the influence of these substances are not permitted on any Job Site.
41. Weapons and firearms are strictly prohibited on the Job Site.
42. Heavy equipment operators are prohibited from utilizing music radios/headsets and cellular phones while operating equipment on the Job Site.
43. No cameras or video equipment are permitted on any Job Site except as necessary to document the progress of the Work, as may be allowed under a Site Security Guidelines or approved by the Engineer.
44. Smoking is allowed in designated Project areas based on the Engineer's approval.
45. Horseplay and fighting is prohibited on any Job Site.
46. Contractor shall protect floor and roof openings by providing adequate barricades and secured covers. All covers must be painted with high visibility paint and shall be properly per CAL\OSHA standards.
47. All Contractor's Personnel , including vendors and visitors must comply with the Project's security and access program as outlined in the Contract Documents.
48. All liquid hazardous materials must be properly contained in accordance with the Contract Documents, environmental and CAL\OSHA regulations.
49. Contractor shall ensure that the Job Site(s) are properly illuminated at all times. When any Work is performed at night or where daylight is shut off or obscured, the Contractor shall provide artificial light sufficient to prosecute the Work properly and safely and to permit safe performance and thorough inspection of the Work.

50. Contractor shall not use Work or drop lights that have an exterior made of a conductive material in any SFMTA facility or location in which an overhead traction power line is present (that is, in areas where electric trolley bus, LRV, and historic car (PCC and Milano) vehicles are operated or maintained).
51. Contractor shall not use aluminum (or other metal) ladders at any Job Site.
52. Contractor's Personnel must park in designated Contractor- Project authorized areas only. The driver of any motor vehicle on a Job Site is responsible for its safe condition and use. The driver is required to have a valid driver's license and the vehicle must have a valid license plate. All Job Site traffic rules must be obeyed.

1.11 HAZARDOUS MATERIALS

- A. In the event Contractor encounters on a Site Hazardous Materials, or other material or Site conditions that Contractor believes to be hazardous that may present a substantial danger to persons or property exposed thereto in connection with the Work, Contractor shall stop Work in the area affected promptly and before disturbing the conditions believed to be hazardous, notify the City in writing. The Work in the affected area shall not be resumed thereafter except by written notification of the City.
- B. Contractor shall perform all Work relating to Hazardous Materials as required by the Contract Documents. Should Hazardous Materials be encountered that were not indicated in the Contract Documents and not contemplated to be part of the Work at the time that the Contract was executed, Contractor shall be given an adjustment in the Contract Sum and Contract Time.

1.12 STAFF ORGANIZATION

1. The Contractor shall develop an organizational structure that sets forth lines of authority, responsibility, and communication. The Contractor shall include a description of this organization and responsibilities of Contractor's Personnel.
2. The Contractor shall designate in writing, subject to contract requirements, at least one individual trained in the OSHA Certified 30-Hour Construction Training Course, to be the Project Site Safety Representative (SSR). If more than one Project Site working shift is initiated, the Contractor will have to ensure that provisions are made to have a qualified SSR for all Work shifts.
3. The SSR shall be readily available to consult with the Engineer at a Site during all Projects working hours and shall be available 24 hours a day, 7 days a week by telephone or other approved means.

If determined necessary by the SFMTA, the SSR shall be present at a Site during all working hours.

4. The SSR shall possess at a minimum, the following qualifications:
 - a. 5 years of Construction Project Safety Management experience on similar Projects with OSHA 30- Hour Certified Construction Training
 - b. Or CSP with experience in construction related Projects.
5. The SSR should also have formal documented safety training as required by CAL/OSHA or other state regulations, including but not limited to the following:
 - Fall Protection
 - Material Handling
 - Confined Space
 - OSHA 500 (30 hour construction training)
 - Excavation
 - Scaffolding.
6. Contractor shall provide at least two (2) individuals on the Job Site that have current CPR/First Aid training. Where Contractor provides Automatic External Defibrillators (AEDs), at least two individuals must be trained in its use.
7. Contractor must identify and certify Competent Persons as defined by CAL/OSHA for Work or tasks requiring this level of qualification or supervision. The personnel identified must be present on the Project when Work requiring the Competent Person is taking place. The names of these Competent Persons will be provided by the Contractor to the Engineer in writing prior to start of Work activities.
8. All Contractor employees, City and Project Representatives shall have “Stop Work Authority” – the ability to stop Work without any adverse consequences when unsafe conditions are present.

1.13 CONTROLLED SUBSTANCE ABUSE AND ALCOHOL POLICY

1. Contractor acknowledges that pursuant to the Federal Drug-Free Workplace Act of 1989, the unlawful manufacture, distribution, dispensation, possession, or use of a controlled substance is prohibited on City premises. Contractor agrees that any violation of

this prohibition by Contractor, its employees, agents or assigns will be deemed a material breach of this Agreement.

2. Contractor acknowledges and agrees that the safety of the public, as well as the safety of fellow employees, dictates that it shall not permit its employees to perform their duties while under the influence of drugs or alcohol. Contractor shall have in effect at times during the Contract: (1) a substance abuse policy that prohibits persons assigned to the Project from performing their duties under the influence of drugs or alcohol; and (2) effective procedures to ensure said policy is enforced.

1.14 TRAINING

1. Contractor must comply with all applicable CAL/OSHA training requirements.
2. Contractor Managers, Supervisors, and Site Safety Representatives must attend a Site-Specific Safety Orientation training conducted by the City that will include Site-specific hazards and controls.
3. The Contractor shall provide a Project Orientation session that includes Site hazards, procedures, and all requirements. This Orientation will be provided to all Contractor employees and all employees of Subcontractors' working on the Project Site.
4. Prior to working on a Site, Contractor's Site Safety Representative (SSR) must have completed a 30-hour OSHA Certified Construction Safety training session and must submit documentation of such training to Engineer.
5. Crane operators shall meet the CAL/OSHA requirements for certification. Proof of current certification shall be provided to the Engineer prior to commencement of crane activities on the Job Site.

1.15 MEETINGS

1. The Contractor (at a minimum) shall conduct "toolbox" safety meetings per CAL/OSHA standards. The meeting must be documented using the Safety Meeting Attendance sheet and submitted to the Engineer.

2. The Contractor's Project Manager, Construction Manager, and SSR shall attend Engineer meetings as required to review Project Immediately Dangerous to Life and Health (IDLH), stop Work activities, incidents, and incident investigations.

1.16 PROJECT ACTIVITY HAZARD ANALYSIS/JOB HAZARD ANALYSIS PROGRAM

1. Contractor shall develop AHA/JHA for Job Site hazardous Work activities based on their two or three-week look-ahead Project schedule.
2. The Contractor will submit the completed AHAs/JHAs to the Engineer prior to conducting Work activities. The submission of AHAs/JHAs to the City shall not be construed as approval of the adequacy of the Contractor's SSR, the AHAs/JHAs, the Contractor's HASP, or any safety measures taken in or near the construction Site.
3. Contractor's supervision will monitor workers which includes observing a worker's behaviors and comparing them against the written AHA/JHA.
4. Observations by supervision indicating non-compliance with AHAs/JHAs should be corrected immediately and documented.

1.17 SITE-SPECIFIC CONTRACTOR HEALTH AND SAFETY PLAN (HASP)

1. Contractor shall be responsible for developing, implementing, and enforcing a Site-specific Contractor HASP consistent with all CCR Title 8 or other applicable regulations.
2. The Contractor shall prepare a Site-specific Contractor Health and Safety Plan (HASP). Contractor HASP shall establish, in detail, the protocols necessary for the recognition, evaluation, and control of all hazards associated with each task performed by Contractor's Personnel. The Contractor HASP shall be Site specific and cover all Work to be performed under this Contract.
3. The Contractor HASP must be reviewed, and approved by signature, by the Contractor's Project Manager and the SSR, and a file copy submitted to the Engineer for recordkeeping. Submission of the HASP to the City, or any review of the HASP by the City, shall not be construed as approval of the adequacy of the Contractor's SSR, the Contractor's HASP or any safety measures taken in or near a Job Site.

4. The Contractor HASP shall address Job Site-specific safety and health requirements and procedures based upon Job Site-specific hazards and conditions.
5. Contractor will develop a HASP that complies with requirements as set forth in this Document.
6. The Contractor's HASP shall describe the emergency and first aid equipment to be provided by Contractor and Contractor's Personnel to be utilized for the Project.
7. Contractor shall include in its HASP an Example Project Safety Inspection form and shall include date, Work area checked, employees present in the Work area, PPE, Work equipment being used in each area, safety and health issues, notes, and signature of inspector.
8. Contractor shall include in its HASP a sample Hot-Work Permit, which shall be made available to the Engineer when requested.
9. The formats for all safety forms and reports shall be developed by the Contractor and submitted as part of the Contractor HASP.
10. The Contractor shall include an organizational structure in the HASP that sets forth lines of authority, responsibility, and communication, including a description of this organization and responsibilities of each key personnel.
11. Contractor shall include in the HASP the names and qualifications (resumes including education, training, experience, and certifications) of all Site safety and health personnel designated to perform Work on the Project and shall be submitted to the Engineer. Submissions will include the designated Site Safety Representative and other competent and qualified personnel to be used on the Project in support of Job Site safety requirements.
12. Contractor shall develop Emergency Response and Contingency Planning procedures that will be included in the Contractor HASP to address potential Incidents and emergencies that may occur during the Work.
13. Contractor will include the following information in the HASP, as applicable:
 - a. Confined Space Entry Plan
 - b. Crane Critical Lift Plan

- c. Fall Protection and Prevention (FP&P) Plan Activity Hazard Analysis (AHA) /Job Hazard Analysis (JHA)
- d. Written Hazard Communication Plan for Work place chemicals brought to a Site must be established. Contractor shall also maintain a Material Safety Data Sheet (MSDS) for all products/chemicals brought to the Project Site.
- e. Emergency Response Plan.
 - 14. Any changes or modifications to the Contractor's HASP must be signed by the Contractor's Project Manager and SSR and submitted to the Engineer. The modification shall be appended to the Contractor HASP. All on-Site personnel shall be fully informed of the modifications, changes and required actions prior to conducting any additional Work activities.
 - 15. The Contractor's HASP shall describe the Contractor's plan for compliance with the Substance Abuse Policy. The Contractor's plan for compliance with the Substance Abuse Policy will include but not be limited to the following:
 - a. Contractor's method for ensuring that all employees working on the Project comply with the Drug and alcohol restrictions on the Job Site
 - b. The name and telephone number of the Contractor's Designated Employer Representative for the Substance Abuse Policy.

1.18 INSPECTIONS

- 1. Contractor SSR shall perform daily inspections of their active field Work area(s) covering workplace conditions, physical facility safety, and employee Work practices. Any deficiencies and corrective actions shall be documented. The daily inspection shall be documented in the Contractor's Monthly Health and Safety Report submitted to the Engineer.
- 2. Each piece of heavy equipment shall be inspected upon delivery to a Site and at the beginning of each Work shift. Heavy equipment inspection documentation shall be submitted to the Engineer upon request.
- 3. Crane inspection documentation shall be submitted to the Engineer prior to use. The Contractor shall provide current inspection documentation and Certification per OSHA that the crane operator is qualified and trained in the operation of the crane to be used.

4. Cranes shall be visually inspected prior to each shift by the Contractor's competent person. The inspection must include observation for deficiencies during operation. The inspection must be written and a copy submitted to Engineer if requested.

1.19 INCIDENT REPORTING AND INVESTIGATION

1. Contractor's Personnel involved in or witnessing an Incident must immediately report it to the responsible supervisor or foreman, who in turn immediately notifies the Engineer.
2. Contractor will allow Engineers to participate and review all Project incident or near-miss investigations.
3. Contractor employees involved in or witnessing a Near-Miss Incident must report it to the responsible supervisor or foreman in a reasonable time frame, not to exceed 24 hours, who in turn must immediately notify the Engineer.
4. No supervisor may decline to accept or relay a report of injury or significant Near-Miss Incident from a subordinate.
5. Contractor shall immediately investigate all incidents and significant Near-Miss Incidents.
6. Contractor must investigate incidents and submit an initial investigation report to the City Representative using a Contractor Incident Investigation Report within 24 hours of learning about an Incident or significant Near Miss Incident. Contractor shall submit a Final Report to the City Representative within 48 hours of the Incident or significant Near Miss Incident.
7. Contractor shall submit to the City a Corrective Actions Report for every Incident and Near-Miss Incident. Contractor shall not proceed with Work in the area of the Incident until Contractor corrects Job Site hazards and behaviors that caused the Incident or significant Near-Miss Incident.
8. Contractor must investigate near-miss incidents and submit an investigation report to the Engineer using the Contractor Incident Investigation Report within one Working Day of learning about the near-miss incident.

1.20 PERSONAL PROTECTIVE EQUIPMENT

1. Contractor shall define task specific Personal Protection Equipment (PPE) requirements for all personnel in compliance with applicable laws, rules, and regulations.
2. PPE shall be worn at all times on a Site, including travel within a Site when starting or ending shifts. Minimum requirements include:
 - a. Hard hats are required at all times in the Project Work areas.
 - b. Appropriate eye and face protection that complies with ANSI Z87 shall be worn at all times.
 - c. Safety glasses with side shields are required in the Project Work areas
 - d. Sensible and safe Work clothing/shoes must be worn in the Project Work areas.
 - e. No canvas /leather sneakers or sandals will be worn in the Project Work areas.
 - f. Appropriate hearing protection shall be worn in Work areas where levels exceed established standards per CAL\OSHA standards.
 - g. Suitable gloves must be worn to protect the hands from injury per CAL\OSHA standards.
 - h. High visibility warning vests or other suitable garments marked with or made of reflection or high-visibility material must be worn at all times on the Project.
3. The Contractor's SSR shall establish additional appropriate levels of protection for each Work task per CAL\OSHA standards.
4. If respiratory protection is utilized, the Contractor will have a Respiratory Protection Program in compliance with CAL/OSHA requirements. The Contractor will also provide the following to the Engineer prior to beginning Work utilizing respiratory protections:
 - a. Copies of the Respiratory Program
 - b. Respirator training records
 - c. Fit-testing and medical approval documentation
 - d. Annual documentation for training, fit testing and medial evaluations
5. All respiratory equipment will be provided to the employees by the Contractor and properly inspected and maintained by the employees per CAL/OSHA regulations.

6. Where Hot Work is involved, a Hot Work permit must be submitted to the Engineer prior to Work. Protective clothing that provides thermal protection shall be required. Welding screens must be used when welding operations have the ability to expose other employees or the general public per CAL\OSHA standards
7. Safety harnesses must be worn per manufacturers and OSHA requirements in man lifts.
8. Workers must wear a safety harness with their safety lanyard secured to a separate lifeline while working from swing scaffolds, boatswain's chairs, or other suspended Work platforms where a fall hazard is present.
9. Proper PPE must be worn for welding and burning. Welding screens must be used when welding operations may expose other employees or the general public.

1.21 EMERGENCY EQUIPMENT

1. The Contractor shall provide the required emergency and first aid equipment to be utilized for the Project. The following items, at a minimum, shall be maintained at each Job Site in cabinet(s) close to all points where persons are at Work and available for immediate use. Contractor shall keep such cabinets stocked :
 - a. First aid equipment and supplies, including first aid kits with the proper dressings, antiseptics, and other necessary medical provisions and eyewash station per CAL\OSHA standards.
 - b. Spill control materials and equipment, including multi-purpose absorbent materials, poly bags, brooms and shovels and drums. (If applicable)
 - c. Fire extinguishers with a minimum rating of 2A-10B:C and as required by CAL\OSHA standards for scope of Work requirements.
 - d. Emergency rescue equipment including SCBA and tripod/extraction equipment for confined space rescue; backboard/basket for transport of injured personnel, air horns/bull horns for emergency signaling and communications. (If applicable),
 - e. All Contractor's boats and vessels used on the Project shall comply with the U.S. Coast Guard and CAL\OSHA and all applicable regulations for working in/around water and waterways.
 - f. Two-way radios shall be immediately available to key-line supervisors, and forepersons for emergency signaling and communications.

Contractor shall promptly transport sick or injured Contractor Personnel from the Job Site to points, including industrial injury medical facility as appropriate, at which they may receive proper care.

1.22 LOGS, REPORTS AND RECORDKEEPING

1. Contractor shall maintain Project safety audits, equipment safety inspection logs, Incident reports, and all reports covering the implementation of Contractor HASP on the Project Site for review upon request by the Engineer.
2. Contractor shall submit Monthly Project safety statistical report to Engineer that includes Project safety inspections, hours worked by Contractor, OSHA Recordable Incidents, Incident Rates, Near Miss Incidents, Lost Work Day Cases, Total Project Lost Work Days, Days Away from Work Rate, First Aid Cases, and Property Damage Incidents.
3. Contractor shall submit Weekly Safety Inspection Reports to the Engineer which shall include corrective actions.
4. Contractor shall allow Engineers access to all Contractor operations and records. The City's review of Contractor's logs and records documenting safety performance shall not be construed as approval of the adequacy of any safety measures taken in, on or near the construction Site, nor shall it relieve the Contractor of its responsibilities of performing and enforcing health and safety inspections/audits, monitoring or any other components of the Project safety requirements and Site-specific Contractor HASP.

1.23 REMEDIAL ACTION

1. The Engineer will issue a notice of non-compliance to ensure that observed immediately dangerous to life and health situation(s) and repeated failure to comply with health and safety requirements violations are corrected by the Contractor in a timely manner. The notice will document non-compliance and requires an immediate action to remedy and correct the non-compliance with a written response from Contractor's Project Manager within 24 hours of receipt of this notice.
2. If Contractor repeatedly fails to comply with applicable health and safety laws, rules, regulations, and orders, the City reserves the authority to have the necessary Work performed by others and

deduct corresponding costs from Contractor's progress payment(s), suspend progress payments, and/or terminate the contract for cause.

3. The Contractor's non-compliance with applicable health and safety laws, rules, regulations, orders and contract safety requirements shall be considered failure by the Contractor to perform a provision of the Contract, and may be cause for the suspension of the Work and/or the discharge from the Work of Contractor Personnel, Subcontractor or Supplier as set forth in the General Conditions. The Contractor shall be responsible for all costs arising from stoppage of Work and/or replacement of Contractor Personnel caused by Contractor's failure to Project safety requirements.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION

DOCUMENT 00829: TRAFFIC ROUTING AND TEMPORARY PAVEMENT MARKING

PART 1 – GENERAL

This Section sets forth the minimum requirements for traffic routing and traffic control under Contract Documents. Contractor should comply with the Blue Book for construction Work on San Francisco streets. This can be found at: <http://www.sfmta.com/cms/vcons/bluebook.htm>
Streets of major importance.

No Work is allowed on the following streets during the specified hours.

Contractor is not allowed to leave holes, debris, any material/equipment in the traffic lanes, including tow-away lanes, during these hours.

- Broadway (tunnel) Powell – Larkin 7AM - 7PM, 7AM - 7PM Mon-Sat
- Stockton St. Market - Broadway 7AM - 7PM, Everyday 7AM - 7PM Everyday
- Geary Blvd. Gough - Presidio 3PM - 7PM, 7AM - 9AM Mon - Fri
- Geary Blvd. Presidio - 25th Ave. 7AM - 6PM, 7AM - 6PM Mon-Fri

The MacArthur Tunnel and the Yerba Buena Tunnel are under Caltrans Jurisdiction. The Contractor would need permits from Caltrans to do any Work in these locations.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF DOCUMENT

DOCUMENT 00830: PROJECT SECURITY AND SITE ACCESS**PART 1 – GENERAL****1.1 DESCRIPTION**

A. Responsibilities include:

1. Contractor shall comply with the SFMTA's protocol for personnel identification, Job Site access control, and Contractor deliveries.
2. Where Contractor has sole possession of a Job Site, the security of that Job Site shall be the Contractor's responsibility from commencement of Work at that Job Site through Final Completion. Where Contractor is present on a Job Site that is a SFMTA operational facility, Contractor shall comply with such requirements as imposed by the SFMTA to ensure the security of that Job Site, which will vary with the conditions present and activities conducted at each Job Site. Where Contractor is performing Work on a Job Site not owned by the City, Contractor shall comply with the Site security requirements of the owner of that Job Site.
3. Contractor's Site Security Monitor shall be present at each Job Site and available at all times while Work is being performed, ensuring that requirements of the City and third party property owner's security requirements are met.
 - a. The Site Security Monitor (SSM) may have collateral duties but shall attend to security matters as a top priority.
 - b. The SFMTA reserves the right to require the SSM be provided solely for security matters if the duties as prescribed in the Specifications are not fulfilled and/or any lapses occur in the enforcement of the SSM's primary duties. Any additional costs realized by the Contractor as a result of the SFMTA requiring the SSM to be devoted solely to security matters shall be borne fully by the Contractor and no additional compensation shall be paid.

1.2 SUBMITTALS

- A. Provide daily sign-in log to the Engineer at the start of the workday identifying all personnel with all forms of badges as specified in Article 1. 3.B., below. Log shall include the following information:
 - Individual's full name
 - Company name
 - Responsibilities

- Company phone number.
- B. Submit name and cell phone contact number of individual(s) designated as a Site Security Monitor(s) to the Engineer.

1.3 PERSONNEL IDENTIFICATION AND BADGING

- A. Contractor's personnel and all others directly associated with the Work will be issued individual SFMTA Photo-Identification Badges that will be valid either for the duration of the Project, or for a maximum period of one (1) year from the date of the Notice to Proceed. If the Project duration exceeds one year, the Contractor shall submit a written request to the Engineer for an extension of the validity of the badges.
- B. Project badges will be issued by the SFMTA for use by Contractor's staff, subcontractor's staff, and all persons associated with the Work. There will be three types of identification badges required: (1) Photo-Identification Badges with an orange colored background for personnel who will Work at the Site regularly; (2) Temporary Contractor Badges with a yellow colored background for those personnel awaiting their permanent Photo-Identification Badges, or those who will only Work at the Site on an infrequent basis or for less than a total of 10 days, and (3) Visitor Badges with a white background and black lettering for those personnel who will be at the Site for the day only.
- C. Contractor shall make arrangements with the Engineer to have its personnel's photographs and those of its subcontractors taken at such location as the SFMTA may direct. Alternatively, the Contractor shall provide proof of identification (e.g. copy of driver's license), an electronic photograph in jpeg format, and a completed Photo ID/Access Card Request Form (Appendix A) to the Engineer for each individual for issuance of a Photo-Identification Badge. The jpeg photograph must be in color and conform to the following parameters: full-face frontal view from the top of the sternum to several inches above the top of the head taken from a range of 3 feet to 4 feet from subject, with an orange-colored background, clear, and in focus with a minimum resolution of 640 by 480. The Contractor shall repeat this procedure on an as-needed basis when additional Photo-Identification Badges are required.
- D. Contractor shall keep a written record of the name, employer, and Work telephone number of each person issued a Photo-Identification Badge or a Temporary Contractor Badge. Lost or missing badges shall be reported within 24 hours to the Engineer and Site Security Monitor. A Temporary Contractor Badge will be issued by the Contractor until a replacement Photo-Identification Badge or Temporary Contractor Badge is obtained from the SFMTA. A monthly report detailing any and all lost or missing badges shall be forwarded to the Engineer, who will then forward it to the SFMTA Director of Homeland Security. Upon receipt of the report

documenting a lost or missing badge, the SFMTA will replace that badge within 10 business days.

- E. All project Photo-Identification Badges and Temporary Contractor Badges shall be surrendered to the Engineer no later than at the completion of the Contract . The Contractor will identify which badges have not been surrendered and provide documentation that the Contractor is working on another SFMTA project. Failure to return or properly account for badges will delay Final Payment. Contractor will pay a fee of \$100 for each unreturned badge, which shall be deducted from the Final Payment. The Site Security Monitor shall immediately surrender to the Engineer the badges of any Contractor's employees that are reassigned to other non- SFMTA sites or terminated during the construction. The Site Security Monitor shall be responsible for collecting and returning badges on a continuing basis when they are no longer required.
- F. The SFMTA will also issue twenty (20) Temporary Contractor Badges to the Contractor for Contractor's temporary workers, delivery personnel, and other temporary workers. Upon verification by the Contractor's Site Security Monitor, and compliance with Article 1.3 of this Document, a Temporary Contractor Badge or Visitor Badge will be issued to the temporary worker. The Contractor shall supply the Visitor Badges unless otherwise noted in the Specifications. If additional Temporary Contractor Badges are needed, the Contractor shall submit a request in writing to the Engineer for approval.
- G. All personnel associated with the Work shall be required to wear a Photo-Identification Badge, Temporary Contractor Badge, or Visitor Badge as described in Article 1.03 of this document at all times while working at a Job Site. All forms of identification badges shall be attached above the waist on outer garments and shall be visible at all times. Any Contractor employee or worker who does not display a Photo-Identification Badge, Temporary Contractor Badge, or Visitor Badge while on Site shall be required to leave the Site or will be denied access until such time as they have an approved badge.
- H. Upon request, badges shall be shown to SFMTA's staff or Security Officers. Persons without badges shall be required to immediately leave the Site unless the Contractor's Site Security Monitor can verify that the person is required on Site. Upon verification by a Site Security Monitor and compliance with Article 1.03 of this Document, a Temporary Contractor Badge (or a Visitor Badge) will be issued as provided for in Article 1.03 of this Document.
- I. If emergency Site access (for emergency access as determined by the Contractor and approved by the Engineer) is needed, the Contractor's Site Security Monitor shall verify the identity of the visitor to the Engineer. After sign-in with a Site Security Monitor, the visitor will be issued a Visitor Badge as provided for in Article 1.03 of Specification Section 01501. The visitor shall return his/her badge to the

designated location as identified in Article 1.03 of this Document by the end of the day.

- J. The Contractor will be assessed \$100 for each unreturned Photo-Identification Badge, Temporary Contractor Badge, or each replacement Photo-Identification or Temporary Contractor Badge, which shall be withheld from the Monthly Progress Payment.
- K. Contractor and all other people associated with the Work that enter a Job Site are required to possess and carry a Photo-Identification Badge, Temporary Contractor Badge, or Visitor Badge in addition to a valid and current California Driver's License, California Identification Card (issued by the California Department of Motor Vehicles), valid and current Passport, or current driver's license or photo-identification card issued by another state. This identification shall include a photograph and signature of the holder. Personnel without such identification shall be removed from the Site by the Contractor.

1.4 BACKGROUND CHECKS

- A. Upon the request of the SFMTA and at no additional cost to the SFMTA, the Contractor shall provide such information as necessary and as allowed by law for a Department of Justice (DOJ) background check on any person that enters a Job Site. The SFMTA shall bear the costs of conducting a DOJ background check.

1.5 SITE ACCESS CONTROL

- A. At the end of each workday the Contractor shall secure all equipment, hazardous materials, tools, materials, and flammable fluids. The Contractor shall take all necessary precautions to ensure that only authorized personnel have access to equipment, hazardous materials, tools, materials, and flammable fluids.
- B. The Contractor shall prepare a Key Control Plan outlining the lock system to be used along with the list of personnel who will be issued keys and are authorized to use said keys. Upon loss of critical keys, the Contractor shall replace all corresponding locks and re-issue keys to prevent unauthorized access.
- C. Unless otherwise indicated on the Drawings, existing fences and gates at Job Sites shall remain intact and in use throughout construction. The existing perimeter security of Job Sites shall be maintained at all times. Fences and gates that are breached due to construction (e.g., construction of a utility crossing under a fence) shall be restored by the end of working hours each day. The SFMTA reserves the right to request additional fencing or other separation barriers around any areas of Job Site or Work Area. Additional fencing or barriers shall be paid for as extra Work. Fencing or gates installed by the Contractor that are breached and/or damaged shall be immediately restored/replaced at Contractor's expense.

- D. Contractor-requested modifications to existing fences and gates are subject to Engineer's approval. Additional fencing or modifications requested by the Contractor shall be at Contractor's expense.
- E. The Contractor is advised that all persons seeking entry to a Job Site will be required to show proof of identification (e.g. driver's license). All Contractor's trucks and drivers are subject to the same search requirements as described in above.

1.6 VEHICLE AND EQUIPMENT SEARCH

- A. All vehicles and packages on SFMTA property are subject to search by SFMTA security personnel or by SFMTA staff.
- B. If the driver/owner of a vehicle will not allow the search, access to the Site will be denied. All vehicles on SFMTA property may be searched for items that may pose a threat to the facility or to personnel.

1.7 PHOTO CONTROL

- A. Contractor and its subcontractors shall restrict photographs, video, film, or any other images or image formats to the Limit of Work, unless otherwise required in the Specifications. The Contractor and its subcontractors shall seek the prior written approval of the Engineer before taking any photographs, video, film, or any other images or image formats and shall specifically identify the intended object(s) being captured.
- B. Photographs, video, film, negatives, backup copies, archived copies, any electronic hardcopies and electronic or digital files, and any other images or image formats of the Project are considered confidential, protected information. The Contractor and its subcontractors agree to hold the above-described confidential, protected information in trust and confidence and agree that it shall be used only for documenting the Work performed and shall not be used for any other purpose or be disclosed in any form to any person, entity, or third party without the prior written approval of the SFMTA.
- C. The Contractor shall provide to the Engineer at Project completion a detailed list of photographs, video, film, negatives, backup copies, archived copies, any electronic hardcopies and electronic or digital files, and any other images or image formats of the Project to be retained by the Contractor and its subcontractors.
- D. The SFMTA reserves the right to disallow photography at any Site, of any SFMTA facilities, equipment, or processes which are deemed to be security sensitive in nature.

1.8 CONFIDENTIALITY, PRIVACY AND SECURITY OF INFORMATION.

A. Proprietary, Confidential and Security Sensitive Information.

Consultant understands and agrees that, in the performance of the Work or services under this Agreement or in contemplation thereof, Consultant may have access to private or confidential information which may be owned, controlled by, or licensed to the City and that such information may contain proprietary or confidential details, or it may constitute Sensitive Security Information (as that term is defined and applied under federal law and other applicable regulation and authority), the disclosure of which to third parties may contrary to law, harmful to public safety, and/or damaging to City. Consultant agrees that all information disclosed by City to Consultant shall be held in the strictest confidence and used only in performance of the Agreement. Consultant agrees that all Work Product, reports, studies, analyses, specifications, Work schedules and recommendations prepared by the Consultant for use in connection with the Work under this Agreement or furnished to the Consultant by the City are confidential, and that Consultant will not publish, circulate or use any of the foregoing except in the performance of this Agreement without first obtaining the SFMTA's written approval to do so.

B. Project Security.

Consultant shall consider and treat all Work Product as Sensitive Security Information as defined by FTA Circular 42.20.1(f) and other applicable regulation and authority. Consultant shall at all times guard and keep secure and confidential all such information and documents. Consultant's failure to guard and keep safe and confidential said documents shall be a material breach of this Agreement. In such an event, in addition to any other remedies available to it under equity or law, the City may terminate the Contract, bring a false claim action against the Consultant pursuant to Chapter 6 or Chapter 21 of the Administrative Code, or debar the Consultant.

C. Protection of Private Information.

Consultant has read and agrees to the terms set forth in San Francisco Administrative Code Sections 12M.2, "Nondisclosure of Private Information," and 12M.3, "Enforcement" of Administrative Code Chapter 12M, "Protection of Private Information," which are incorporated herein as if fully set forth. Consultant agrees that any failure of Contractor to comply with the requirements of Section 12M.2 of this Chapter shall be a material breach of the Contract. In such an event, in addition to any other remedies available to it under equity or law, the City may terminate the Contract, bring a false claim action against the Consultant pursuant to Chapter 6 or Chapter 21 of the San Francisco Administrative Code, or debar the Consultant.

D. Survival of Obligations.

The provisions of this Section 1.8 shall survive termination or expiration of the Contract.

1.9 PRODUCTIVITY LOST AND COST DUE TO SECURITY REQUIREMENTS

- A. Time lost and/or costs incurred due to compliance with SFMTA security measures (e.g., deliveries or personnel held at the gate without badges or identification, refusal of package deliveries, etc.) shall be deemed an inexcusable delay, and will not be reimbursed for any delay costs. Contractor shall allow additional time to accommodate Site security measures.

Failure to comply with these security measures may lead to suspension or termination of the Contract, in accordance with Article 14 of the General Conditions [Document 00700].

1.10 CONSTRUCTION SCHEDULE COORDINATION REQUIREMENTS

- A. The Contractor is advised that some of the Job Sites are located on active SFMTA transit maintenance facilities. Additionally, it is anticipated that there may be other contractors and private enterprises working within these areas. Therefore, access to Work areas must be shared and coordinated with other entities.
- B. If access to a particular Job Site is not provided to the Contractor, then for each day of delay, the completion date of the aforementioned Work in the area shall be extended accordingly if Contractor is unable to avoid said delay by scheduling Work at another Job Site or Work Area. No monetary compensation will be made for these delays.

1.11 SFMTA OPERATIONS SHUTDOWN HOURS

- A. All Work in and about the Market Street Subway, Twin Peaks Tunnel and Sunset Tunnel, including Contractor mobilization on-Site and demobilization from Site each evening, and testing, shall be performed within the durations and hours specified herein.
- B. Current Subway shutdown hours, except on the days and at the locations specified in paragraphs D, E, and F below:
 - a. Monday 1:45 a.m. to 3:45 a.m.
 - b. Tuesday 1:45 a.m. to 3:45 a.m.
 - c. Wednesday 1:45 a.m. to 3:45 a.m.
 - d. Thursday 1:45 a.m. to 3:45 a.m.
 - e. Friday 1:45 a.m. to 3:45 a.m.
 - f. Saturday 1:45 a.m. to 5:00 a.m., Sunday 1:45 a.m. to 6:00 a.m.

Contract access time will depend on MME pull out/pull in times and other projects. Any early shutdowns will be subject to approval by SFMTA Management

- C. Contractor will not be allowed, at any time, to gain access to the Work Site using active tracks, crossovers, or turnouts when revenue vehicles are in operation.
- D. The Contractor will not be allowed to access the Market Street Subway, Twin Peaks Tunnel and Sunset Tunnel on Bay to Breakers, Halloween night, Christmas Eve, New Year's Eve, Gay Pride Parade weekend, and July 4th.
- E. The Contractor's Work activities shall have no impact to SFMTA transit operations and passenger services. The station platforms must remain safe and fully accessible to enable passengers boarding and alighting the trains. The Contractor shall Work in a station only when it is closed to the public.
- F. The Site access restrictions described out in this Document are known Site constraints, and the Contractor shall include in its bid all costs for Work performed on nights and weekends and the City shall not pay any additional compensation for such Work

1.12 SITE CONSTRAINTS AND EXISTING SITE CONDITIONS

- A. The Contractor shall have exercised diligent efforts in studying all Site conditions and constraints and the Drawings and Specifications prior to submitting its bid. By submitting its bid, the Contractor acknowledges that there are unique constraints and conditions (both subsurface and above surface) at the Job Sites related to the WORK and accepts such constraints and conditions as part of the WORK and as part of its bid price where these Site conditions and constraints are known or for which information was available and could be reasonably discovered prior to the time of the bid.
- B. The Contractor also acknowledges and recognizes that SFMTA LRV vehicles are entering and leaving the Geneva Yard during the morning rush hours from 6:00 AM to 9:00 AM and the evening rush hours from 5:00 PM to 8:00 PM Monday thru Friday. San Jose Avenue is also a very busy route for trucks and other motor vehicles. Therefore, the Contractor agrees to minimize entering and leaving the Geneva Yard during rush hours.
- C. It is incumbent upon the Contractor to develop the means and methods to perform the Work per the requirements and conditions specified in the Contract, including construction of temporary facilities to maintain SFMTA operations in the subway. Any associated Work shall be considered as incidental Work and is included in the bid price submitted by the Contractor. The Contractor shall anticipate and be responsible for all construction difficulties and constraints in performing the Work.
- D. The ingress and egress for the rail vehicles may be at the West Portal Station, Eureka Portal, Duboce Portal, and the Folsom Portal, and will be subject to the

Engineer's approval. The Contractor is advised that during wet weather season, the SFMTA may not allow its hi-rail vehicle to use the Duboce and/or Eureka Portals for ingress and egress to the Subway and Tunnel.

- E. The Contractor is alerted to the presence of exposed asbestos-containing fireproofing material at the unfinished sections of Powell and Montgomery Stations. The Contractor shall ensure that its employees, agents and subcontractors comply with all applicable health and safety standards, requirements, rules, regulations and orders established by the State of California at all time.

1.13 WORK HOURS, NIGHT WORK AND WEEKEND WORK

- A. Because of SFMTA operations and Project schedule requirements, the SFMTA will permit Contractor to perform Work seven (7) days per week, except as restricted by other requirements of this Contract.
- B. Night Work shall be subject to the requirements of Article 29, San Francisco Police Code, and Regulation of Noise. If night Work is permitted, the Contractor shall notify all residences and businesses located within two hundred (200) feet of the Work seventy-two (72) hours in advance of the scheduled Work.
- C. Weekend Work shall be restricted to the hours of 8:00 a.m. to 9:00 p.m., unless otherwise noted.

1.14 PAYMENT

- A. Full compensation for any and all costs, including labor, equipment, and materials, required to comply with Site security requirements as specified in these Specifications shall be included in the Contractor's Cost Proposal.
- B. Adjustments will be made to the Monthly Progress Payment for each lost or replacement Photo-Identification Badge or Temporary Contractor Badge at \$100 each.
- C. Adjustments will be made to the Final Payment for each unreturned Photo-Identification Badge or Temporary Contractor Badge at \$100 each.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00830-A: Photo ID/Access Card Request Form
PHOTO ID/ACCESS CARD REQUEST FORM

Employee: _____ **Phone:** _____

Employee's CDL No.: _____ **Phone:** _____

Company Name: _____ **Phone:** _____

Site Supervisor: _____ **Phone:** _____

Site Security Monitor: _____ **Phone:** _____

F/T Employee: **Time Period From** _____ **AM to** _____ **PM**

Temporary Employee: **Dates Needed From** ___/___/___ **to** ___/___/___

Time Period From _____ **AM to** _____ **PM**

Other:

Visitor: **Dates Needed From** ___/___/___ **to** ___/___/___

Contractor:

Contractor: **Time Period From** _____ **AM to** _____ **PM**

Other: _____

Building: _____

No Building Access

Room: _____

Room: _____

Room: _____

- All Building Access**

Building: _____

- No Building Access**
- Room:** _____
- Room:** _____
- Room:** _____
- All Building Access**

Other Buildings/Rooms: (*name location*)

- _____
- _____
- _____
- _____
- _____
- _____

Site Security Monitor (*signature*): _____

Date: _____

Employee (*signature*): _____

Date: _____

END OF DOCUMENT

DOCUMENT 00831: GEOTECHNICAL DATA

PART 1 - GENERAL

1.1 SUMMARY

This Document 00831 describes Reference Documents, including existing geotechnical data and soils engineering reports, and the use of data resulting from the various investigations.

1.2 GEOTECHNICAL REPORTS

A. Contractor's attention is directed to geotechnical reports that were prepared for the sites as follows:

1. Forest Hill Geotechnical Report
2. South Hill Geotechnical Report
3. Twin Peaks Geotechnical Report, December 1997

These reports are contained in Appendix 40.

B. Copies of the above referenced reports are included in the Design Criteria for SFMTA Radio Replacement Project.

1.3 USE OF DATA

- A. Geotechnical consultation was obtained only for the use of the City and its consultants for the planning and design of the Project and is provided for reference only.
- B. All statements, findings, and interpretations in said report are those of the geotechnical consultant and the City makes no representations, either express or implied, as to the completeness or adequacy of said report.
- C. Contractors shall visit a Site and familiarize themselves with existing conditions.

1.4 PRE-PROPOSAL SITE VISIT TO WORK SITE

Contractor has conducted Site visits hosted by the SFMTA to inspect and to satisfy itself as to Site conditions.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00832: ENVIRONMENTAL ASSESSMENT INFORMATION**PART 1 - GENERAL****1.1 SUMMARY**

This Document 00832 summarizes Reference Documents prepared for the City and to be made available to Proposers in preparing their Proposals. The City will amend this Document via an Addendum to the RFP if the Categorical Exemptions (CE) for this Project are published prior to the due date for Proposals. The CE is for the antennae sites. Contractor can assume the Project will receive Categorical Exemptions for the existing antennae sites.

1.2 ENVIRONMENTAL REPORTS

- A. The SFMTA has applied for a Categorical Exemption from environmental review for the Project under the California Environmental Quality Act ("CEQA"). The SFMTA estimates that the a final decision on that application will be issued in August 2010. If the exemption is not granted, the SFMTA may suspend Work on the Project until such exemption is received or until a formal environmental impact report is prepared and accepted. In the alternative, the City may amend the scope of this Contract to include providing assistance to the City in completing any necessary environmental impact report.
- B. The City will make available to Contractor copies of the Categorical Exemptions as they are available.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00833: PROJECT MANAGEMENT & SCHEDULE REQUIREMENTS

In the monthly report, the Contractor will address status of the Work and completion of Milestones in a mutually agreed format. That report should accompany each monthly invoice. If there are major delays, the Contractor will explain the delay and recommend a course of action to maintain schedule.

The Contractor Project Manager shall use Project Management Processes and Procedures as described by Project Management Institute (PMI) standards. This includes incorporation of any and all processes and procedures as described in the "Project Management Body of Knowledge (PMBOK)" Guide (ANSI/PMI 99-001-2008) as required by the SFMTA at the beginning and throughout the life of the Project.

This section specifies the requirements for project planning, scheduling and progress reporting to be performed by the Contractor.

Within ten (10) days of approval of the Contract, a satisfactory baseline Project Schedule shall be submitted by the Contractor. Additional cost and delays associated with the failure to provide a satisfactory schedule shall be the responsibility of the Contractor.

The Contractor shall employ Critical Path Method scheduling (CPM) or planning, scheduling and reporting the Work required by the Contract Documents. The approved CPM project schedule will be the baseline schedule. The schedule must be updated on a monthly basis.

1.1 TERMS:

- **Baseline Schedule:** A detailed CPM schedule, prepared by the Contractor, indicating the Contractor's plan for executing the Work. This schedule shall include the Contractor's logic network diagrams, all schedule network reports and all schedule resource reports. The Baseline Schedule shall conform to all requirements of the Contract Documents.
- **Revised Baseline Schedule:** The Baseline Schedule shall be revised as necessary to incorporate Contract changes. The Contractor's field performance or other avoidable delays shall not be considered justification for Baseline Schedule revision.
- **Current Schedule:** The updated logic network and supporting reports indicating actual progress to date and forecasted logic and estimated progress for the remaining Work. The update will be, at a minimum, to the same level of detail as the Baseline Schedule.
- **Supplemental Schedule:** Detailed schedules prepared by the Contractor to substantiate changes that may have a schedule impact.
- **Summary Level Bar Chart:** A summary level bar chart schedule encompassing the entire Contract and indicating all Contract required Milestones.

- **Weekly Plan:** A detailed bar chart plan of the Work to be accomplished in the coming three (3) weeks. All activities and sub-task activities in the Weekly Plan shall be referenced with the activity numbers in the Current Schedule or schedule in effect.
- **As-Built Schedule:** The resulting schedule incorporating all actual activity durations, actual start and finish dates of all activities as accomplished or incurred during the Contract. The Contractor shall submit this As-Built Schedule to the City at the completion of the Work.
- **Work Day or Working:** Any day scheduled for Work including Saturdays, Sundays and holidays. Separate activities shall be used in the schedule to identify other than a normal Work schedule such as weekends, holidays and multiple shifts per day or extended hours (more than a normally scheduled Work shift).
- **Float:** Float is the amount of time that a schedule activity can be delayed without delaying the early start of any immediately following schedule activities. Any float identified in the Baseline or Current Schedule is jointly owned by the City and the Contractor. The Contractor shall notify the City of any use of float.
- **City-Owned Float:** Float is the amount of time that a schedule activity can be delayed without delaying the early start of any immediately following schedule activities. City-owned float shall be considered a resource for the exclusive use of the City. The City may accrue City-owned float by the early completion of review of any type of required submittal when it saves time on the critical path. The City may use City-owned float to mitigate past, present or future State delays by offsetting potential time extensions for contract change orders.
- **Calculation of Liquidated Damages:** Liquidated damages shall be calculated based on the Project Schedule agreed by the Parties. Absent modification of the Project Schedule by executed modification of the Contract, liquidated damages shall be calculated based on 1110 Days for Substantial Completion and 1200 Days for Final Completion, measured from NTP.
- **Schedule Constraints:** A schedule constraint is any limitation or restraint placed on the project schedule that affects when a schedule activity can be scheduled and is usually in the form of fixed imposed dates. Any scheduling constraints such as start-on dates, finish-on dates, and sequencing other than finish-to-start such as start-to-start, start-to-start with lag time, finish-to-finish, etc. shall be clearly identified and shown in the applicable CPM Schedule Submittal required in Attachment 2.

Dedicated full-time scheduling staff shall perform all the planning and scheduling Work required by this Contract. Scheduling staff shall have a minimum of three (3) years experience in scheduling similar design/build construction projects using Primavera CPM software. The Contractor shall submit the qualifications and experience of the Scheduler for approval by the City. The Scheduler's sole

responsibility is scheduling and shall not perform other design, construction management, or other functions.

Contractor Computer Software Consultant shall consider and treat all Work Product as Sensitive Security Information as defined by FTA Circular 42.20.1(f) and other applicable regulation and authority. Consultant shall at all times guard and keep secure and confidential all such information and documents. Consultant's failure to guard and keep safe and confidential said documents shall be a material breach of this Agreement. In such an event, in addition to any other remedies available to it under equity or law, the City may terminate the Contract, bring a false claim action against the Consultant pursuant to Chapter 6 or Chapter 21 of the Administrative Code, or debar the Consultant.

The Contractor shall use the latest version of Primavera (P3) software, or equivalent, for all computer generated tabular reports and logic network graphics. The Contractor shall furnish schedule software and all original software instruction manuals to the City for the City's exclusive possession and use with submittal of the baseline schedule. The Contractor shall also furnish the latest schedule-comparing software, which is compatible for use with the schedule software to the City.

The Contractor shall instruct the City in the use of the software and provide software support until the acceptance of contract. Within twenty (20) days of Notice to Proceed, the Contractor shall provide a commercial eight (8) - hour training session for two (2) City employees in the use of the software at a location acceptable to the City.

1.2 PROJECT MANAGEMENT TASKS

The Contractor shall appoint a full-time Project Manager who will be the single point of contact to the SFMTA for the project. The Project Manager will Work out of the local project office, as defined to follow.

The Project Manager shall coordinate resources and Work so that Milestones are met in an efficient manner. Tasks shall be scheduled to minimize implementation time, while taking into consideration resource and time constraints (such as the City's staff availability).

The Project Manager shall ensure that employees performing tasks have appropriate skill levels and credentials. The SFMTA reserves the right to require the Contractor to remove or reassign any individual on the Contractor's Project team if the SFMTA is unsatisfied with that person's performance or that person fails to demonstrate the required qualifications or expertise. The SFMTA reserves the right to review and approve replacement team members.

The Contractor shall submit a Project Management Plan within ten (10) Days of NTP or as otherwise directed in the NTP.

1.3 SCHEDULE SUBMITTAL PROCEDURE FOR DESIGN AND CONSTRUCTION

The procedure and timing for schedule submittal is shown in “Attachment 1 - Contractor's Schedule Submittal, Monitoring, Review and Revision Procedure”, and “Attachment 2 - CPM Schedule Submittal”.

The Baseline Schedule is submitted by the Contractor in two (2) successive parts (when applicable), both of which are to be reviewed and approved by the SFMTA:

1. The design and construction logic and durations, which the Contractor proposes with the costs attributable to each of the schedule activities.
2. Upon acceptance of the design and construction logic, the resources attributable to each of the scheduled activities. Resources must include number and size of crews, equipment and materials assigned to each activity and the schedule must contain a resource dictionary defining all resources, their units of measure, and cost per unit of measure.
3. The Bid Items (schedule of values) must be assigned to each resource in each activity. Cost Accounts on the Schedule of Values and all resources on each activity shall be tied to a cost account. The total cost of all activities must equal the total contract amount.
4. The Current Schedule shall be submitted by the Contractor in two (2) successive parts:
5. A preliminary “Current Schedule”, which is an update of the previous month's “Current Schedule”, is submitted prior to schedule and progress review meeting. The update shall be made by handwriting, to clearly show what is being changed from the previous month's schedule.
6. The “Current Schedule”, which incorporates the comments from the schedule and progress review meeting, is submitted as the schedule in effect.

1.4 PROJECT SCHEDULE

In their response to this RFP, the Proposer shall include a draft project schedule, showing how the Schedule requirements set out below can be met. A Proposer who proposes a different schedule must explain why the City's Schedule cannot be met.

The Project shall be scheduled to meet the following requirements:

Milestone	Weeks after NTP
Submit project schedule	1
Submit Quality Assurance Plan	2
Establish local project office	6
Complete Intermediate (65%) Design Review	16
Complete Final (100%) Design Review	47
Completion of fixed Site construction	82
Completion of on-Site integration testing including radio coverage acceptance test	92
Production vehicle installations and cutover completed	118
Successful completion of Reliability Demonstration Test (base system)	134
Completion of advanced features and options	156

1.5 PRE-CONSTRUCTION SCHEDULING MEETING

The Contractor shall schedule a pre-construction scheduling meeting within ten (10) days of NTP for construction. At this meeting, the Contractor shall submit a general time-scaled logic diagram displaying the major activities and sequence of planned operations and shall be prepared to discuss the proposed Work Plan and schedule methodology. The Contractor shall also submit the alphanumeric coding structure and the activity identification system for labeling the Work activities. The City will review the logic diagram, coding structure, and activity identification system, and provide any required baseline changes to the Contractor for implementation.

A. Baseline Schedule Meeting

Beginning the week following the pre-construction scheduling meeting, the Contractor shall meet with the City weekly until the baseline schedule is accepted by the City to discuss the Contractor's design and construction logic, durations and cost loading, and to resolve any questions or disagreements. After the meeting, all agreed upon corrections, changes or comments will be incorporated and the Baseline schedule shall be resubmitted for acceptance. If

necessary, a meeting may be required for the resource loading of the accepted construction logic.

B. Current Schedule Meeting

The Contractor shall submit a current schedule and meet with the City to review Contract progress, on or before the first day of each month, beginning one month after the baseline schedule is accepted. At monthly intervals, and at other times at the request of the Engineer, the Contractor shall update the prior month's Current Schedule, which is also called the Preliminary Current Schedule. On a date mutually agreed upon by the City and the Contractor, a monthly schedule and progress review meeting will be held. Appropriate Sub-Contractors, suppliers, utilities representatives and other City agencies may be asked to attend.

During the schedule and progress review meeting, the Preliminary Current Schedule including any required Supplemental Schedules and all relevant events affecting the schedule will be discussed in detail. The City may request the Contractor to revise or correct the data for the Current Schedule due to any inaccuracies or conflicts with the Contract Documents, and also suggest ways to modify the schedule because of behind schedule activities. City's participation in the schedule review process shall not relieve the Contractor from the approved Contract completion dates in effect.

C. Baseline Schedule

The Baseline Project Schedule submitted by the Contractor shall represent the Contractor's plan of operation performed within the specified Contract completion time and within the Contract bid price. It shall represent a practical plan to complete the Work. A schedule extending beyond the Contract completion date will not be accepted.

The Contractor is required to involve all Sub-Contractors in the development, implementation, and updating process of its schedule. When completed with the proper format and content, the Contractor shall submit its Baseline schedule and analysis to SFMTA for review and approval. The Contractor shall revise the network diagram as required and resubmit the network diagram and the tabulated schedule produced there from. The resubmitted network diagram and the tabulated schedule shall be approved or rejected and resubmitted for further modification as required.

Failure by the Contractor to include any element of Work required for the performance of this Contract shall not excuse him/her from completing all Work required within any applicable completion date, notwithstanding SFMTA's approval of the CPM diagrams. Items missing from the schedule are assumed to be incidental Work and not critical activities. If activities are found to be missing from the schedule after the SFMTA's approval, the Contractor shall submit a revised schedule to include these items. The revised schedule shall be subject to

review and approval by SFMTA as described in "Revised Schedule" clause in Section 9.5.5. No extension of time will be granted because of errors or omissions on the schedule. The Contractor shall be responsible to incorporate all necessary activities to cover the Work required by the Plans and Specifications.

The CPM schedule and analysis when approved by SFMTA shall constitute the official Contract Work schedule throughout the design and construction phases. No alteration of the logic, duration of activities, etc. will be allowed without the approval of the SFMTA.

The Work of this Contract may affect neighboring businesses, resident and other agencies. Therefore, it is imperative that a schedule be submitted as soon as possible in order for the SFMTA to have enough time to inform other parties affected by the construction operations. If the Contractor delays submitting the required schedule, the Contractor will be restricted from doing any Work until a schedule is submitted. Delay and any associated delay cost shall be borne by the Contractor.

The Baseline schedule shall comply with the following:

1. The time scaled schedule shall be cost loaded.
2. A maximum of fifteen (15) Work days duration shall be given to each CPM construction activity. Any activity in excess of the fifteen (15) days shall be broken down in detail so that each detail activity will not exceed the fifteen (15) days maximum.
3. All constraints, dates, and lags will require the SFMTA's approval. All activities shall have succeeding activities except project completion. The Contractor shall demonstrate the necessity of having any dummy activities.
4. The schedule shall include separate non-construction activities indicating:
 - a. Preparation and submittal of shop drawings, by specific item.
 - b. City review and approval of shop drawings.
 - c. Procurement and delivery of major material and equipments.
 - d. Installation and testing (minimum two (2) weeks) of major equipment.
 - e. Curing
 - f. Inspections by agencies and authorities have jurisdiction
 - g. Training of City personnel
 - h. Final cleaning
 - i. Final inspection (minimum two (2) weeks).

j. Punch list.

The Contractor shall be responsible for all impacts resulting from resubmitted of shop drawing and submittals.

1. Each activity shall be assigned a responsibility code corresponding to Contractor or Sub-Contractor responsible for performing the Work. For the Activities, where the responsibility party is the City, the Contractor shall discuss the preceding activities, succeeding activities, duration, and constraints of these activities with the City during the Pre-Construction meeting prior to incorporating them into the Baseline Schedule
2. Negative float will not be allowed on the CPM schedule on the initial submittal. Initial CPM schedule with negative floats shall be rejected immediately. The Contractor shall provide sufficient staff (multiple crews) and maximize hours (extended hours) to perform the required Work within the specified completion time and Contract bid price.
3. The CPM schedule's critical activities shall not exceed fifteen percent (15%) of the number of activities. Critical activities are those that have less than five (5) days float.

Along with the Baseline schedule, a written narrative shall be submitted. The narrative shall discuss basic assumptions, historic project comparisons, productivity and installation rates, construction staging plans, maintenance of traffic, quantities, staff and crew development, construction equipment planned, and other element related to developing the schedule.

A. Early Completion Schedule

The Contractor may submit a schedule, which contains completion dates earlier than the dates specified in the Contract or earlier than the dates subsequently approved by Contract modification. The Contractor agrees that the City has the right in its sole discretion, to take any one of the following actions:

1. Reject the early completion schedule and require the Contractor to furnish a schedule that indicates completion by (i) the completion dates in the Contract as awarded if the early completion schedule is submitted as the Baseline Schedule, or by (ii) the latest Contract completion dates if the early completion schedule is submitted as a Revised Baseline Schedule; or
2. Approve the early completion schedule but not modify the Contract to incorporate the Contractor's proposed early completion date. By City's action under this subparagraph 2, the City and the Contractor hereby agree that the time difference between the Contractor's proposed early completion date and the existing approved Contract completion date shall be considered to be Contract float. No request for a time extension shall be considered nor granted by the City as long as Contract float remains in the Contract. The

Contractor further agrees that if Contract completion occurs after the Contractor's proposed early completion schedule, but no later than the prior Contract completion date, the Contractor shall not be entitled to any damages or costs arising out of that late completion, loss of profit, or any additional compensation because of the City's approval to the Contractor's proposed early completion schedule. Similarly liquidated damages for Contract completion will not be assessed for completion under the same said condition, but will be assessed if completion occurs after the latest Contract completion date; or

3. Approve the early completion schedule and modify the Contract to incorporate the Contractor's proposed early completion dates. Until the Contract modification is fully executed, the early completion schedule shall be as if it were approved under subparagraph 2 above. Following execution of the Contract modification, the early completion schedule shall have the same force and effect as if the Contract had originally contained the early completion schedule. Liquidated damages for Contract completion will be assessed based upon the modified Contract completion date. Other liquidated damages, if any, will be assessed based upon any other modified contractual Milestone dates.

The Contractor further agrees to waive any and all claims or right of action against the City for damages, loss of profit or any additional compensation as a result of any of the above actions taken by the City in rejecting or approving the Contractor's submittal of an early completion schedule.

1.6 REVISED BASELINE SCHEDULE

The Revised Baseline Schedule is an update of the latest approved Baseline Schedule. Any revision to the latest approved Baseline Schedule requires the SFMTA's approval. Revisions shall reflect only changes that are approved or that are unavoidable. The Revised Baseline Schedule submittal shall meet the following minimum conditions:

1. Critical path(s) shall be clearly identified.
2. Durations, sequence and logic of activities shall not be changed except as a result of changes or changes in unit price quantities that directly affect the durations, sequence and logic of activities in the latest approved Baseline Schedule.
3. New activities added to the Revised Baseline Schedule shall include, as applicable, the cost, manpower, and quantities associated with these new activities.
4. The Revised Baseline Schedule is not to be progressed.

5. Time Extensions to the Contract will be considered only through a revised Baseline Schedule submittal. If requested, Supplemental schedules shall be submitted to justify changes in logic and sequence.
6. Revised completion date shall be shown in the Revised Baseline Schedule submittal. The latest approved Contract completion date shall also be shown. If there is any time difference between the two (2) completion dates, positive, or negative floats shall be shown.
7. Written narratives are required to explain the reasons for any change that is incorporated into the Revised Baseline Schedule.

Upon approval of the Revised Baseline Schedule, the Contractor shall submit the required reports and number of copies in accordance with Attachment 2.

1.7 CURRENT SCHEDULE OR PRELIMINARY CURRENT SCHEDULE

A Current Schedule is the Contractor's periodic report of actual progress, estimated progress to completion, and any problems that may cause the Work to be delayed. The Current Schedule is to be submitted for SFMTA's review and to resolve behind schedule activities. The SFMTA does not approve a Current Schedule submittal. The SFMTA may however reject a Current Schedule when it finds that the Current Schedule does not abide by or meet the overall contract requirements. If the SFMTA rejects such Current Schedule submittal, the City will inform the Contractor the reasons for such rejection and request a resubmittal. If the Contractor disagrees with the City's reasons for rejection, the Contractor shall resubmit the Current Schedule, revised as requested by the City, and explain the disagreements in written narratives. If the Contractor refuses to resubmit, the Contractor is deemed not in compliance.

A satisfactory updated current schedule shall meet the following minimum conditions:

1. Current schedule shall consist of the updated overall CPM Logic Network and supporting reports for the total project.

All activities started prior to the update date must show actual start dates. If an activity is uncompleted as of the update date, a percent completion and remaining duration shall be indicated for that activity. All completed activities shall indicate the actual completion dates and 100% completion.
2. The approved Contract completion date shall be shown.
 - If the Current Schedule shows an earlier completion date than the approved Contract completion date, the time difference is considered project float. The Contractor agrees that if all Contract Work is accomplished on or prior to the

approved Contract completion date, the Contractor is not entitled to any damages, loss of profit or any additional compensation because of City's action or inaction in maintaining the Current Schedule.

- If the Current Schedule shows a later completion date than the approved Contract completion date, the Contractor will propose ways to overcome the delay at the schedule and progress review meeting. If, after the meeting and updating of the Current Schedule, the completion date is still later than the approved Contract completion date, the Contract is considered behind schedule and estimated liquidated damages may be assessed.

3. Include a written narrative documenting the following:

- Work completed during the period.
- Identification of unusual conditions or restrictions regarding labor, equipment or material.
- Description of the current critical path.
- Changes to the critical path and scheduled completion date since the last schedule submittal.
- Description of problem areas.
- Current and anticipated delays: cause of delays; impact of delay on other activities, Milestones and completion dates; corrective action and schedule adjustments to correct the delay.

4. Supplemental schedule submittal is required if the requested changes include new activities, delays, approved changes, logic changes, duration changes, or changes to staffing, cost, and quantities.

5. New activities that are included in the Current Schedule shall be cost, staffing , and quantity loaded (when applicable).

6. After the schedule and progress review meeting and Contractor's incorporation of the changes, if any, the Contractor shall submit the required reports and number of copies in accordance with Attachment 2.

1.8 SUPPLEMENTAL SCHEDULES

The Supplemental schedule shall be a detailed diagram prepared by the Contractor to:

1. Substantiate schedule impact of change orders. Submittal of schedule impact is required at the time of the submittal proposal for the pricing of the change order.

2. Substantiate schedule impacts of unforeseen conditions or delays.
3. Demonstrate how any delay is proposed to be overcome by the Contractor.

After the SFMTA's review of the Supplemental schedule, it shall be incorporated into the Current Schedule or Revised Baseline Schedule submittal.

1.9 SUMMARY LEVEL BAR CHART

Upon approval of the Baseline Schedule or any subsequent Revised Baseline Schedule including its resource loading (when applicable), a Baseline or Revised Baseline Schedule Summary Level Bar Chart showing the planned summary bars by base and area shall be produced. In addition, a planned early and late schedules S-curves derived from the cost loading of the activities in the Baseline or Revised Baseline Schedule shall be superimposed onto the Baseline or Revised Baseline Schedule Summary Level Bar Chart. All required contract Milestones including the approved Contract completion date shall be shown.

Upon each update of the Current Schedule, the Summary Level Bar Chart shall also be updated showing the planned and actual progress on each summary bar. An actual progress S-curve up to the Current Schedule update date shall be shown; a planned S-curve derived from the Current Schedule early schedule shall be shown from the update date to completion. The planned early and late schedules S-curves described in the previous paragraph shall also be shown.

1.10 WEEKLY PLAN

1. The Contractor shall prepare and deliver to the SFMTA at the progress meetings, a weekly plan.
2. The weekly plan shall cover the period from the last progress meeting through the next three (3) weeks after the meeting.
3. The weekly plan shall be prepared in the form of a bar chart breaking down activities on the Contractor schedule into detailed subtasks.
 - Subtasks shall identify related activity on the construction schedule with actuality code.
 - Subtask shall identify responsibility for completion.
4. The weekly plan shall be prepared on 8½ inch by 11 inch white paper and printed in dark blue or black ink.
5. The Contractor shall notify the SFMTA in writing of any deviation from the plan, no less than twenty-four (24) hours prior to said deviation. Deviations from the plan may be disapproved by the SFMTA.

1.11 DAILY CONSTRUCTION WORK PLAN

The Contractor shall provide to the City in advance daily Work plans for each day. The daily Work plan shall provide:

- Project name
- Project number
- Contractor's name
- Contractor's address
- Names of each employee in each Work crew and sub-Contractor
- Activity codes for the Work
- Description of the Work to be performed
- A list of the equipment other hand tools to be utilized by the Contractor and sub-Contractor(s)
- A list any force account or change order number that will be worked on.

The Contractor shall send via electronic mail to SFMTA the Daily Work Plan for each subsequent Work day by 7:00 pm of the previous Work day.

1.12 DAILY CONSTRUCTION WORK REPORT

The Contractor shall provide to the City daily construction Work reports for each day. The daily Work reports shall include:

- Project name
- Project number
- Contractor's name
- Contractor's address
- Names of each employee in each Work crew and sub-Contractor
- Activity code for the Work
- Weather, temperature and any unusual conditions
- Description of the Work performed
- A list of any equipment other than hand tools utilized by the Contractor or Sub Contractor(s)
- A list of any force account or change order number that was worked on.

The Contractor shall send via electronic mail to SFMTA the Daily Construction Work Report for each subsequent Work day by 7:00 pm of the previous Work day.

1.13 COMPLIANCE

Failure of the Contractor to comply with the requirements of this Section shall be grounds for the City to withhold 25 percent of the estimated value of each progress payment until when the Contractor is in compliance. In addition, liquidated damages will be assessed as per Section 0802 Contract Time and Liquidated Damages.

1.14 PROJECT MANAGEMENT REPORTING

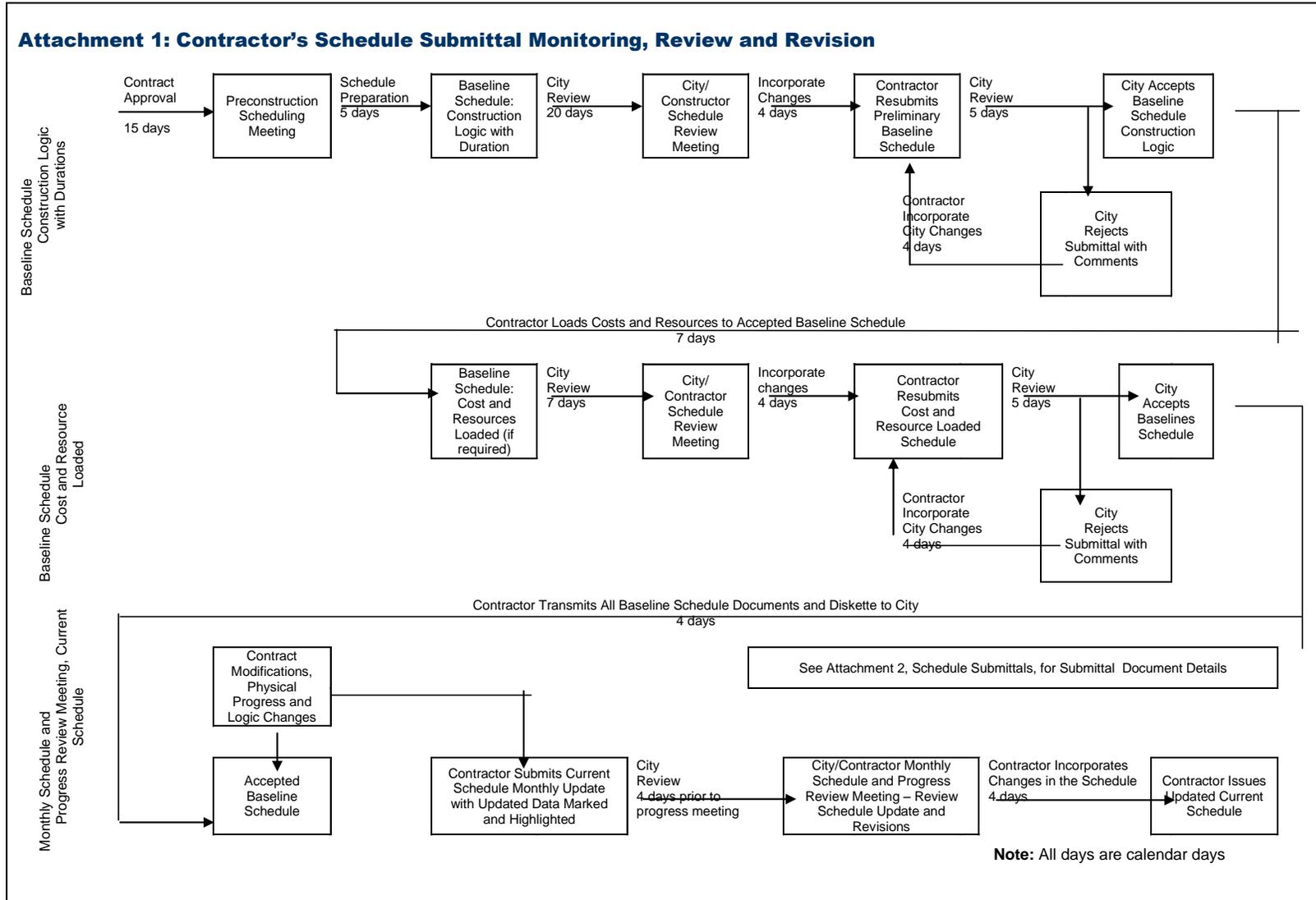
As part of the Contractor's regular project management activities, the Project Manager shall:

- Participate in and conduct weekly project progress review meetings and other related meetings as appropriate. Weekly progress review meetings will be jointly scheduled by the SFMTA's and the Contractor's Project Manager, and must be attended by both managers, other necessary personnel, as well as additional personnel requested by the SFMTA. Progress review meetings will be conducted at a SFMTA facility or other agreed upon location, and shall be used to review, at a minimum, the progress, schedule, written correspondence exchanged since the last meeting, and open action items, to obtain clarifications, request information, and discuss future activities. The Contractor Project Manager will prepare a meeting agenda for and record the minutes of each meeting and forward a copy to MTA for review and approval.
- The Contractor will participate in meetings as requested by the SFMTA to discuss technical aspects of the project, and to review comments on the Contractor's submittals. When appropriate, these meetings may be conducted as extensions to the progress meetings.
- Prepare monthly project progress/status reports in both electronic and hard-copy to the SFMTA within five (5) days after the end of the preceding month. The progress report must include the following items:

1. An updated project schedule including Milestone and Work plan updates with explanations of any deviations from the planned delivery schedule. Each explanation should include the anticipated impact of any delays and a plan for returning to the target schedule. All delays must be factored into the project schedule as soon as the Contractor's Project Manager has knowledge of them. In addition, all changes to the schedule since the last progress report and items on critical path must be identified. Any changes to the project schedule or Work plan shall be reviewed and approved by the SFMTA.
 2. An update to the Project Management Web Portal (described below), of all correspondence transmitted and received during the month. Additional hard copy listings will be provided at the SFMTA's request.
 3. An updated documentation schedule, highlighting the documents to be transmitted for review during the next two reporting periods.
 4. An update to the Project Management Web Portal, of open action items, uniquely numbered, with status and required resolution dates. Additional hard copy listings of action items will be provided at the SFMTA's request.
 5. The status of open change requests and change orders.
 6. A description of current and anticipated project problem areas or risks and steps to be taken to resolve each problem.
- Participate in and conduct project presentations and briefings, as requested by the SFMTA.
 - Participate in as-needed conference calls to review any technical, schedule, action item, deliverable, coordination, or project management issues that need to be discussed in order to help keep the project on schedule. These conference calls shall be scheduled for a mutually agreeable time, preferably at the same day and time each week. These conference calls shall be conducted informally, and both the Contractor and the SFMTA may propose topics to be discussed. A scheduled conference call may be canceled anytime at the SFMTA's discretion.
 - Manage project transmittals, using the Project Management Web Portal described herein.

- Participate in community meetings and assist in community outreach and regulatory processes.

The Contractor shall provide a Project Management Web Portal for storage and retrieval of design documents, design drawings, correspondence, and other supporting documents. The web portal shall be accessible using a standard web browser (e.g. Internet Explorer or Mozilla Firefox) and secure connection, and not rely on any specialized client software.



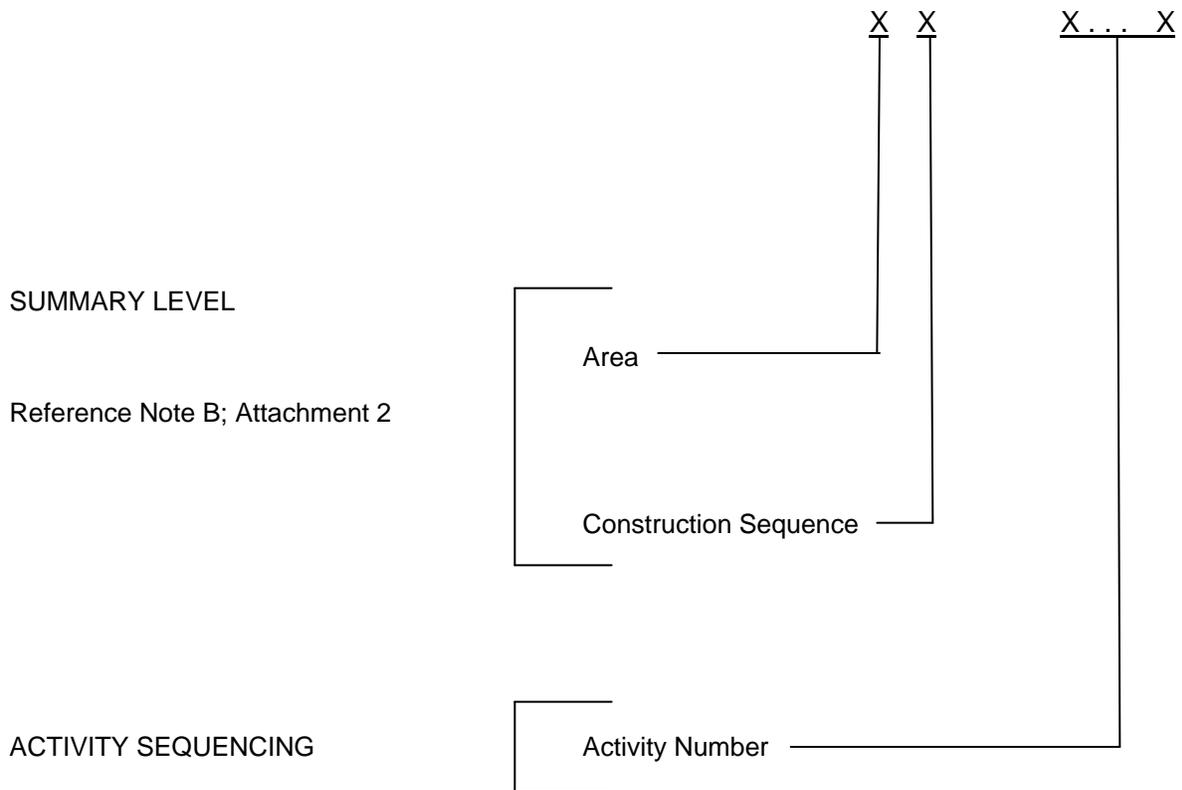
Attachment 2. CPM Schedule Submittal

Submittal Requirements	Construction Logic with Durations and Cost— Within 14 Days of Notice to Proceed	Schedule with Resources Loaded (if required)— Within 7 Days of Baseline Construction Logic	Monthly Update Submittal— 4 Days Prior to Progress Meeting	Updated Current Schedule— 5 Days After Progress Meeting	Notes
	Baseline Schedule	Current Schedule			
Type I					
Critical path network					1,5,6
Reproducible tracings	1	1	1*	1	
Blue line prints	4	4	2*	4	
Summary level bar chart (indicating milestones)					8
Reproducible tracings	1	1	-	1	
Blue line prints	4	4	-	4	
Activities log		4	4	4	9
Descriptive narrative	4	4	4	4	7
Schedule network reports					2,3
1. Activity sort—activities sorted in ascending order	4	4	4	4	
2. Chronological sort—sorted chronologically	4	4	4	4	
3. Critical path sort—sorted by float; least to greatest	4	4	4	4	
4. Predecessor/ successor sort	4	4	4	4	
Schedule cost and resource reports—resources by month and totaled; activities sorted chronologically		4		4	2,4
1. Cost sort	4	4	-	4	
2. Manhour cost	-	4	-	4	
3. Quantities sort—major construction materials only	-	4	-	4	
List of major construction equipment	4	4	-	-	
Most current computer software working disk (electronic file)	1	1	1	1	

1. *THE CURRENT SCHEDULE UPDATE SUBMITTAL SHALL BE MARKED UP AND HIGHLIGHTED TO INDICATE PROGRESS, PROPOSED LOGIC CHANGES AND FORECASTS.
2. EACH REPORT SHALL BE PREFACED WITH THE FOLLOWING:
 - PROJECT NAME
 - RUN DATE AND SCHEDULE DATE
 - CONTRACTOR
 - COMPUTER RUN NUMBER
 - TYPE OF SORT
 - SCHEDULE NUMBER
3. THE SCHEDULE NETWORK REPORTS SHALL INCLUDE THE FOLLOWING FOR EACH ACTIVITY:
 - ACTIVITY NUMBER
 - EARLY FINISH DATE
 - SCHEDULED DURATION
 - LATE START DATE
 - DESCRIPTION
 - LATE FINISH DATE
 - EARLY START DATE
 - TOTAL FLOAT
4. THE SCHEDULE RESOURCE AND COST REPORTS SHALL INCLUDE THE FOLLOWING FOR EACH ACTIVITY:
 - ACTIVITY NUMBER
 - DESCRIPTION
 - TOTAL COST
 - EXPENDED COST
 - REMAINING COST
5. IN ADDITION TO CONSTRUCTION LOGIC, THE CRITICAL PATH NETWORKS SHALL INCLUDE SEPARATE ACTIVITIES INDICATING:

- SHOP DRAWING SUBMITTAL, BY ITEM
 - SFMTA'S APPROVAL OF SHOP DRAWINGS
 - DELIVERY OF MAJOR MATERIAL AND EQUIPMENT, BY ITEM
 - REQUIRED DELIVERY OF CITY-FURNISHED, CONTRACTOR INSTALLED MATERIAL AND EQUIPMENT
 - SUMMER SEASON AND HOLIDAY SEASON MORATORIA
 - MAJOR TESTING ACTIVITIES (MINIMUM 2 WEEKS)
 - FINAL CLEANING
 - FINAL INSPECTION (MINIMUM 2 WEEKS)
 - PUNCH LIST
6. THE LOGIC NETWORKS MAY BE ON A NUMBER OF SHEETS, WITH SUITABLE ACTIVITY INTERFACE NOTATION. INDIVIDUAL SHEETS SHALL NOT EXCEED 1m x 1.5m (36" X 60"). THE LOGIC NETWORK SHALL BE TIME SCALED. THE NOTATION ON EACH ACTIVITY SHALL INCLUDE:
- A BRIEF WORK DESCRIPTION
 - ESTIMATED DURATION
7. THE DESCRIPTIVE NARRATIVE SHALL SUPPORT THE LOGIC NETWORK AND SHALL INCLUDE:
- AN EXPLANATION OF DURATION AND/OR LOGIC CHANGES AND ANY RESULTING IMPACT ON COMPLETION OR RESOURCE UTILIZATION.
 - A DESCRIPTION OF THE REMAINING CRITICAL PATH
 - AN EXPLANATION OF PROPOSED PROBLEM-CORRECTIVE ACTION
 - CURRENT AND ANTICIPATED DELAYING FACTORS AND THEIR ESTIMATED IMPACT ON THE WORK AND CONTRACT COMPLETION
8. ACTIVITIES ARE TO BE NUMBERED TO "ROLLUP" TO SUMMARY LEVELS. SEE ATTACHMENT 3 FOR NUMBERING DETAILS.
9. ACTIVITIES LOG SHALL INCLUDE THE FOLLOWING FOR EACH ACTIVITY:
- ACTIVITY NUMBER
 - CREW SIZE, MANHOURS
 - DETAIL DESCRIPTION
 - CONSTRUCTION EQUIPMENT HOURS
 - QUANTITY OF WORK/MATERIALS

**ATTACHMENT 3: ACTIVITY NUMBERING DETAILS
FOR CPM LOGIC NETWORKS AND SCHEDULE REPORTS**



In addition, the following Activity Codes shall be provided for all activities.

1. Responsibility (Contractor, Subcontractor name, city, etc.)
Activities shall be organized such that there is no more than one responsible party for each activity.
2. Area
3. Construction Sequence as outlined in the CS series drawings, or as approved by the SFMTA.
4. Bid Item.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00834: REGULATORY REQUIREMENTS**PART 1 - GENERAL****1.1 GENERAL REQUIREMENTS**

- A. All materials, installation and construction shall comply with the applicable provisions of current laws, codes, safety rules and regulations of the City and County of San Francisco, the State of California, and the Federal Government, and any other applicable authority.
- B. The Contractor shall obtain and comply with all permits required for the Work or for temporary facilities, including indemnification and insurance requirements, and shall pay all fees and furnish any deposits and bonds required therefore.
- C. The Contractor shall keep a copy of each applicable permit, law, code and regulation in its Site field office, and shall ensure that its subcontractors' superintendents and foremen are thoroughly familiar with applicable permits, codes, laws, safety rules and regulations.
- D. Any delays caused by permitting agencies in issuance of permits shall not be cause for unavoidable delay. However, the Engineer may at its' discretion recommend an extension of time if the Contractor waives any additional compensation caused by that delay and the Contractor can show that it has aggressively pursued obtaining such permits.
- E. The Codes referred to shall have full force and effect as though printed in these Specifications. Nothing in the Contract Documents shall be construed to permit Work not conforming to the governing code requirements.
- F. No separate payment will be made for Work covered under this Section unless specifically compensated for by Bid Items indicated in Appendix 28 Cost Proposal Form.

1.2 CODES AND REGULATIONS

- A. Laws, Codes, Safety Rules and Regulations applicable to this Contract include but are not limited to, those referenced in the Contract Documents, and as listed below:
 - 1. California Division of Industrial Safety.
 - 2. California Occupational Safety and Health Administration (Cal/OSHA).

3. California Labor Code.
4. California State Vehicle Code.
5. San Francisco Municipal Code, including San Francisco Building Code, San Francisco Electrical Code, San Francisco Mechanical Code, San Francisco Plumbing Code, San Francisco Police Code, San Francisco Public Works Code, San Francisco Health Code, San Francisco Fire Code, and San Francisco Traffic Code and any department orders adopted pursuant thereto.
 - a. Regulations for Working in San Francisco Streets, prepared by the Department of Parking and Traffic (http://sfgov.org/dpt/regs_streets.htm).
 - b. DPW Order 135,595 Street Opening and Pavement Restoration Regulations for Non Moratorium City Streets.
 - c. DPW Order 135,596 Street Opening and Pavement Restoration Regulations for Newly Renovated City Streets.
 - d. DPW Order 167,840 for the Placement of Barricades at Construction Site.
 - e. DPW Order 171,333 Dust Generation and Control Regulations.
 - f. DPW Order 171,363 Regulations for Excavating and Restoring Streets in San Francisco.
 - g. Article 29, San Francisco Police Code, Regulation of Noise.
 - h. Article 2.4, San Francisco Public Works Code, Excavation in the Public right-of-way.
6. Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities.
7. State of California Public Utilities Commission
 - a. General Order No. 95, Rules for Overhead Line Construction.
 - b. General Order No. 128, Rules for Construction of Underground Electric Supply and Communication Systems.
8. California Code of Regulations (California Administrative Code), Title 8 - Industrial Relations, Part 1 - Department of Industrial Relations, Chapter 4 - Division of Industrial Safety:
 - a. Subchapter 4 - Construction Safety Orders (CSO),
 - b. Subchapter 5 - Electric Safety Orders (ESO),

- c. Subchapter 7 - General Industry Safety Orders (GISO).
9. The Contractor's attention is directed to sections of above Safety Orders, which cover some of the most frequently encountered safety concerns, as follows:
 - a. CSO #1540 Excavations
 - b. CSO #1541 Shoring, Sloping and Benching Systems
 - c. CSO #1598 Traffic Control for Public Streets and Highways
 - d. CSO #1599 Flaggers
 - e. GISO #3380 Personal Protective Devices
 - f. GISO #3381 Head Protection
 - g. ESO #2940.2 Clearances
 - h. ESO #2941 Work On or In Proximity of Overhead High Voltage Lines
 - i. ESO #2946 Provisions for Preventing Accidents due to Proximity of Overhead Lines
10. The Contractor's attention is also directed to all other applicable Safety Orders, including:
 - a. GISO #5003, #5006, #5021, #5022, #5024, #5025 Cranes
 - b. GISO #3646 Operating Instructions (Elevated Work Platforms)
 - c. ESO #2940.7 Mechanical Equipment
11. California Health and Safety Code.
12. National Electric Code.
13. California Code of Regulations (CCR) Title 17, Public Health.
14. California Code of Regulations (CCR) Title 22, Division 4, Environmental Health and Division 4.5, Environmental Health Standards for the Management of Hazardous Waste and Title 26 - Toxics.
15. California Code of Regulations (CCR) 19, Fire Marshal.
16. Code of Federal Regulations (CFR) Titles 29, 40 and 49.
17. The Work Hours and Safety Standards Act (40 U.S.C. 327 et seq.)
18. The Uniform Fire Code, the California Fire Code, the California Code of Regulations (CCR), Title 24, Part 9, and the San Francisco Fire Code.

19. Regulations and Policies of the San Francisco Municipal Railways
20. California Code of Regulations (CCR) Title 17, Public Health, including the Final Regulation Order of 07/22/2002, in Section 93105, on Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying, and Surface Mining Operations (<http://www.arb.ca.gov/toxics/atcm/asb2atcm.htm>).
21. Federal Transit Administration Best Practices Contracting Manual and authorities referenced therein.
22. Federal Transit Administration Circular 4220.1.F and authorities referenced therein.
23. Other regulatory requirements as specified in Appendix 12 of the RFQ/RFP.

1.3 HAZARDOUS MATERIALS

- A. The Contractor shall alert themselves to, shall familiarize themselves with, and shall include in their bid all associated compliance costs for, the following laws and regulations regarding the hazards, control measures, management of hazardous materials and characterization and disposal of hazardous waste as applicable:
 1. Environmental Protection Agency (EPA)
 2. Occupational Safety and Health Administration (OSHA)
 3. California Department of Occupational Safety and Health (Cal/OSHA)
 4. California Environmental Protection agency (Cal/EPA)
 5. Bay Area Air Quality Management District (BAAQMD).
- B. Hazardous and contaminated materials and hazardous waste shall be handled according to applicable laws and regulations in effect at the time of disturbance, transport or disposal of said hazardous materials or waste and requirements of the Contract Documents. In the event of conflict, the more stringent requirement shall apply.
- C. The Contractor is alerted to and shall familiarize itself to the following laws and regulations regarding the generation, management, characterization and disposal of hazardous waste:
 1. Resources Conservation and Recovery Act, 42 U.S.C. Section 6901 et seq. and regulations 40 CFR Part 260 et seq.

2. California Health and Safety Code, Division 20 and regulations, and 22 CCR Section 66000 et seq.
 3. For asbestos hazards: Comply with the applicable requirements of:
 - a. Cal/OSHA Construction Asbestos Standard, 8 CCR Section 1529
 - b. BAAQMD Regulation 11, Rule 2
 - c. Environmental Protection Agency NESHAP and AHERA regulations (40 CFR Part 763, as applicable)
 - d. Occupational Safety and Health Administration (inclusive of OSHA 29 CFR 1926.1101)
 - e. California Environmental Protection Agency (Cal/EPA).Title 22
 - f. Other applicable federal, state, and local governmental regulations pertaining to asbestos-containing materials (ACM) and asbestos waste
 4. For lead hazards, comply with the applicable requirements of the following federal, state and local regulations:
 - a. Cal/OSHA Lead in Construction Standard, 88 CCR Section 1532.1, and Cal/EPA Regulation 22 CCR Section 66000
 - Federal Lead Standard for the Construction Industry, 29 Code of Federal Regulations (CFR) part 1926.62
 - b. California Department of Health Services (17 CCR Sections 35001 - 35099).
 - c. Title 17, California Code of Regulations, Division 1, Chapter 8 Accreditation, Certification and Work Practices in Lead Related Construction.
 - d. San Francisco Building Code (SFBC), Chapter 34, Section as required where there is disturbance to painted surfaces on the exterior of buildings or structures within the City and County of San Francisco.
- D. Respiratory Protection: Assess potential exposures to hazardous materials and conditions and comply with 29 CFR 1926.62 (f) (formerly 29 CFR 1910.134) and 8 CCR 5144. Provide a hazard analysis. Identify the appropriate respiratory protection to be used for the various tasks. Comply with all requirements associated with proper use of respirators.

- E. For PCB ballast Work: Comply with Cal/EPA Regulation 22 CCR Sections 66268.110 and 66508.
- F. For fluorescent light tubes: Comply with Cal/EPA Regulation 22 CCR Section 66699(b).
- G. For Wood Treated with Chemical Preservatives such as CCA treated wood: Federal Insecticide, Fungicide, Rodenticide Act (FIFRA) and by the California Department of Pesticide Regulation (DPR) and Department of Toxic Substances Controls (DTSC) Regulations or the for treated wood waste as per the Health and Safety Code (HSC) 25150.7 and 25150.8.

1.4 PERMITS, INSPECTIONS, AND SERVICE REQUESTS

- A. The Contractor shall obtain and pay for (unless otherwise noted) all necessary permits, inspections and service requests to start and complete Work. Permit costs shall include all associated costs for notifications, walk-through, in-progress inspections, final inspections, oversight, and approvals. These permits include, but are not limited to, the following:
 - 1. Cal/OSHA permits.
 - 2. Night Noise permits.
 - 3. Permits and service requests from Pacific Gas and Electricity (PG&E) and other utility owners, and underground and over-head facilities. This includes notification to PG&E, and following PG&E's procedures whenever there is Work near PG&E's high voltage line (115kv). Notification is mandated by PG&E whenever the line is "daylighted", and once again before the "protective Work" is covered up.
 - 4. State, County, and City transportation permits (overwidth, overlength, overweight, overload).
 - 5. Caltrans permits (as necessary). Caltrans is not associated with Utility Service alert (USA). Contact Caltrans Electrical Maintenance (415) 330 6500 for location of Caltrans' service lines prior to excavation.
 - 6. Rockwheel permit.
 - 7. San Francisco Department of Telecommunications and Information Services permit and notification for fire alarm relocation.
 - 8. San Francisco PUC/BERM sewer discharge permit and notifications. Contact BERM at (415) 695-7321.

9. San Francisco PUC/BWPC use of reclaimed water permit. Contact BWPC at (415) 648-6882 x1378.
10. San Francisco PUC/Water Department/City Distribution Division permits and service requests for water and meters.
11. San Francisco PUC/Bureau of Light, Heat, and Power (BLHP) permit and notification for removal of temporary lighting.
12. San Francisco PUC/ Hetch Hetchy Water & Power (HHWP) application and notification for electrical service connection to PG&E. Contact HHWP at (415) 554- 1596.
13. San Francisco Department of Building Inspection (DBI) permits, notifications, inspections, and approvals.
14. San Francisco Department of Public Health (SFDPH) permits, notifications, oversight, and approvals, including but not limited to:
 - a. Hazardous Materials Certificate of Registration: The Contractor shall obtain and keep current a hazardous materials certificate of registration and implement the hazardous materials plan submitted with the registration application, as per Articles 21, 21A, and 22 of the San Francisco Public Health Code. Contact the SFDPH/HMUPA at (415) 252-3900.
 - b. Well Construction or Soil Borings Permits: A permit is required to construct or operate an environmental or geotechnical well or soil boring. These wells include, but are not limited to, cone penetrometers, inclinometers, piezometers, cathodic wells, exploratory wells, extraction wells, recovery wells, monitoring wells, temporary wells, irrigation wells, industrial wells, dewatering wells, wick drains, hydropunch soil borings and soil borings drilled for geotechnical or environmental purposes (whether or not groundwater is encountered). This information is not intended as a substitute for familiarity with applicable laws and regulations. Contact the SFDPH, Monitoring Well Section at least 15 working days in advance of drilling at (415) 252-3947.
 - c. Well Destruction Permit: A permit is required to destruct an environmental or geotechnical well. These wells include, but are not limited to, piezometers, cathodic wells, exploratory wells, extraction wells, recovery wells, monitoring wells, temporary wells, irrigation wells, industrial wells, dewatering wells, or wick drains. This information is not intended as a

substitute for familiarity with applicable laws and regulations. The application forms are available at:
http://www.dph.sf.ca.us/ehs/waterMonitoring_wells/index.htm. The Well Destruction Permit must also be included in the Destruction Report (see section 02170, 1.14- Destruction of Wells).

- d. Underground Storage Tank (UST) Permits: All modifications, repairs, and installation of USTs shall require approval of the SFDPH, compliance with Articles 21, 21A and 22 of the San Francisco Public Health Code, and its implementing regulations, compliance with applicable provisions of Chapters 6.7 and 6.75 of the California Health and Safety Code, Section 25280 et.al. Contact the SFDPH/HMUPA.

15. San Francisco Fire Department permits, including but not limited to:

- a. The flammable or combustible material storage permit. Contact the SFFD, Bureau of Fire Prevention.
- b. Permit and notification for AWSS relocation.
- c. Permit and notification for removal and installation of above ground and underground storage, fuel or chemical tanks.

16. San Francisco Department of Public Works, Bureau of Street-Use and Mapping permits, including but not limited to:

- a. Encroachment (minor and major) permits - for sidewalks (as required by Section 723.3 of the San Francisco Public Works Code).
- b. Street excavation and utility excavation permits (as required by Article 2.4 of the San Francisco Public Works Code).
- c. Street space, debris box, and temporary occupancy permits (as required by Section 724 thru 724.3 of the San Francisco Public Works Code).
- d. Street improvement permits.
- e. Side sewer connection, borings/monitoring wells, tanks, and noise-night Work permits.

17. San Francisco Police Department permits.

18. San Francisco Department of Parking and Traffic permits and traffic plans, and approvals.

19. Port of San Francisco permits.

20. San Francisco City Planning permits and approvals.
21. Bay Area Air Quality Management District (BAAQMD) permits and notifications, and the California Air Resources Board (CARB) permits, and notifications. The Contractor shall obtain all the permits required by the BAAQMD and CARB. For information on the permit requirements and application forms check the web page at www.baaqmd.gov, <http://www.baaqmd.gov/permit/handbook/default.htm>, and <http://www.baaqmd.gov/permit/forms.htm>.
22. The following BAAQMD permits forms shall be completed for Work involving screening, crushing or grinding, and use of abatement devices.
 - a. Form P-201: General information
 - b. Form P-101B: General information
 - c. Form G: Emission Source (crusher or grinder)
 - d. Form A: Abatement Devices: Wet Spray System
 - e. The Contractor is hereby notified that any screening or crushing operations of excavated materials cannot proceed without the appropriate BAAQMD, and Cal-EPA/DTSC permits.
23. The Regional Water Quality Control Board (RWQCB), San Francisco Bay Region, and the California State Water Resource Control Board (SWRCB) permits and notifications.
24. Cal/EPA, Department of Toxic Substances Control (DTSC) permits and notifications, including but not limited to permit –by-rule, hazardous waste facilities permit, transportable treatment unit (TTU), and treatment storage and/or disposal facility (TSDF) permits.
25. Utility Service Alert (USA) permits and clearance (800) 642-2444.
(See item 5 above)
26. Storm Water Pollution Prevention Plan in accordance with the State Water Resources Control Board (SWRCB) Order No. 99-08-DWQ, National Pollutant Discharge Elimination System (NPDES) General Permit No. CAS000002, Waste Discharge Requirements (WDRS) for Discharges of Storm Water Runoff Associated with Construction Activity.
27. Obtaining Bay Area Rapid Transit permit for tunnel related work

Prior to bid, the Contractor shall contact the governing jurisdiction(s) to determine their requirements, construction constraints, schedule restrictions, and other permitting requirements. Contractor shall include all associated costs in their bid.

1.5 SUBMITTALS

- A. The Contractor shall provide a copy of each obtained permit to the Engineer, prior to beginning of any Work covered by such a permit.

1.6 RESOLUTION OF CONFLICTS

- A. If the Contractor observes that the Specifications or Drawings are at variance with any permits, laws, or regulations, the Contractor shall give the Engineer prompt written notice thereof and the Engineer shall resolve the conflict in accordance with Section 21 of the General Provisions. If the Contractor performs any Work knowing or having reasons to know that it is contrary to such permits, laws, codes, safety rules, or regulations, and without such notice to the Engineer, the Contractor shall bear all responsibility and costs arising therefrom.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

Not used.

END OF DOCUMENT

DOCUMENT 00835 WARRANTY AND MAINTENANCE

PART 1 – GENERAL

1.7 SCOPE OF SERVICE

At all times prior to completion of the Punch List, the Contractor shall be fully and solely responsible for: (1) all system maintenance, as defined below; (2) meeting system Availability requirements specified in [Document 00900, Design Criteria](#), Appendix Twelve, Section 1. After completion of the Punch List, the Contractor shall then provide a two-year warranty.

1.8 TWO-YEAR WARRANTY

The two (2) year Warranty Period shall begin upon SFMTA's Final Acceptance. The following system elements shall be among the items included under the two-year warranty:

- All mobile and portable hardware and software and Mobile Equipment
- All Stationary Equipment including but not limited to base stations, Site controllers, Network Management System, antenna systems, power supplies, computer servers, network equipment, console furniture, facility improvements
- Software including but not limited to application software, database management systems, security software, and Network Management System.

1.9 EXTENDED SUPPORT PROGRAM

As an Optional Service, Contractor shall offer pricing for three subsequent years for an Extended Support Program taking effect after the end of the two (2) year warranty period. Prior to the end of the two (2) year warranty period, the SFMTA may, at its discretion, enter into discussions with the Contractor to provide optional coverage and corresponding level of service on a portion or all of the equipment provided under the Extended Support Program. Unless otherwise specified, Contractor shall assume that each year of the Extended Support Program will provide the same level of service specified below.

PART 2 – PRODUCTS

Not used.

PART 3 – EXECUTION

3.4 SERVICE LEVEL AGREEMENT

- B. All non-conforming or defective equipment shall be immediately repaired or replaced to the SFMTA's satisfaction, according to the Contractor's QA Program Plan.
- C. The Contractor shall provide on-Site response within the times specified below for each class of system failure. The Contractor shall provide diagnostics and replacement of failed component(s) down to the field replacement unit or assembly level.
- D. The Contractor shall review system logs and reports on a regular basis to determine the system status and shall perform remedial investigation and mitigation of issues revealed by the reports on any covered system equipment.

3.5 ONSITE RESPONSE TIMES, STATIONARY EQUIPMENT

- E. Contractor is required to provide system support to the levels described below.
- F. Contractor's onsite response time for Stationary Equipment shall be based on the system failure severity levels defined below:

Severity Level	Problem Types
Severity 1	<p>Major system failure or significant system impairment(s) including but not limited to:</p> <p>33% of Stationary Equipment down</p> <p>33% of Site channels down</p> <p>50% of data channels down</p> <p>Site Environment Alarms (smoke, access, temperature, HVAC Power)</p>
Severity 2	Intermittent problems
Severity 3	Parts questions and upgrades

Onsite response times by Severity Level are listed below:

Severity Level	Response Time
Severity 1	Within 4 hours from receipt of notification, 24 hours, 365 days per year
Severity 2, 3	Within 24 hours from receipt of notification

Remote technical phone support shall also be available Monday through Friday during SFMTA's normal business hours.

3.6 ONSITE RESPONSE TIMES, MOBILE EQUIPMENT

The Contractor shall provide onsite service at each vehicle maintenance facility Sunday through Thursday night for Mobile Equipment, including revenue and non-revenue vehicle.

END OF DOCUMENT

DESIGN CRITERIA PACKAGE**Section 1.2 – Design Documents**

The following Design Requirements attached take into account relevant changes that were issued under addenda to RFAP and RFQ/RFP and later changes made and as agreed to by Harris and SFMTA during discussions from April 2011 to March 29, 2012. Note, for specific answers to questions issued as part of addenda, refer to original addenda to RFQ/RFP and RFAP.

Revised March 29, 2012

Appendix 12	Technical Specifications
Appendix 14	Required SFMTA User Work Stations & Licenses
Appendix 15	Interface Control Document for Onboard Devices and TranksLink©
Appendix 18	FCC Licenses
Appendix 22	Rail Vehicle Material and Workmanship
Appendix 23	Light Rail Vehicle DVAS Technical Specifications
Appendix 26	Codes & Standards
Appendix 27	Permit Process



appendix twelve

Technical Specifications

Table of Contents

1.0 General Requirements **Error! Bookmark not defined.**

1.1 Task Areas of Work **Error! Bookmark not defined.**

1.2 Hardware and Software **Error! Bookmark not defined.**

1.3 Design Criteria **Error! Bookmark not defined.**

1.4 Design Review and Design Acceptance Process ... **Error! Bookmark not defined.**

1.5 System Security **Error! Bookmark not defined.**

1.6 System Time **Error! Bookmark not defined.**

1.7 System Compatibility, Interface and Interoperability Requirements. **Error! Bookmark not defined.**

1.8 Installation Standards **Error! Bookmark not defined.**

1.9 DBI Plan-check Review and Acceptance, Building Permits and DBI Inspection Requirements **Error! Bookmark not defined.**

1.10 City Planning Process **Error! Bookmark not defined.**

1.11 System Redundancy and Availability **Error! Bookmark not defined.**

1.12 Expandability **Error! Bookmark not defined.**

1.13 SFMTA Provided Space and Vehicles... **Error! Bookmark not defined.**

1.14 National and Regional ITS Architecture Compliance .. **Error! Bookmark not defined.**

1.15 For Reference Only Sections and Appendices (This section is not used) **Error! Bookmark not defined.**

1.16 Proposal Requirements List (PRL) Items **Error! Bookmark not defined.**

1.17 Contract Deliverable Requirements List (CDRL) Items **Error! Bookmark not defined.**

2.0 Radio Communications Components **Error! Bookmark not defined.**

2.1 Introduction **Error! Bookmark not defined.**

2.2 Statement of Work **Error! Bookmark not defined.**

2.3 Radio System Performance Requirements..... **Error! Bookmark not defined.**

2.4 System Requirements **Error! Bookmark not defined.**

2.6 Desktop Control Station..... **Error! Bookmark not defined.**

2.7 Portable Equipment **Error! Bookmark not defined.**

2.8 Mobile Equipment **Error! Bookmark not defined.**

2.9 Radio System Fixed Equipment Requirements **Error! Bookmark not defined.**

2.10 Antenna Systems..... **Error! Bookmark not defined.**

2.11 Underground Design and Implementation **Error! Bookmark not defined.**

2.12 Subterranean Cable Car Machinery Structure Coverage **Error! Bookmark not defined.**

2.13 LMR Network Management **Error! Bookmark not defined.**

2.14 Dispatch Equipment..... **Error! Bookmark not defined.**

2.15 Digital Logging Recorder System **Error! Bookmark not defined.**

2.16 Equipment Installation Requirements **Error! Bookmark not defined.**

2.17 Options **Error! Bookmark not defined.**

2.18 Proposal Requirements List..... **Error! Bookmark not defined.**

2.19 Contract Data Requirements List..... **Error! Bookmark not defined.**

3.0 Intelligent Transportation System (ITS) Component **Error! Bookmark not defined.**

 3.1 General Requirements..... 101

 3.2 Base ITS Components..... **Error! Bookmark not defined.**

 3.3 Optional ITS Components..... **Error! Bookmark not defined.**

 3.4 Proposal Requirements List (PRL) Items..... 143

 3.5 Contract Deliverable Requirements List (CDRL) Items..... 144

4.0 Network Requirements **Error! Bookmark not defined.**

 4.1 Background..... 147

 4.2 Existing Network Description 148

 4.3 Network Topology Preliminary Design..... **Error! Bookmark not defined.**

 4.4 Network Architecture Preliminary Design..... 152

4.5 Network Security..... 153

4.6 Network Management..... 154

4.7 Statement of Work..... 157

4.8 Network Equipment Requirements **Error! Bookmark not defined.**

4.9 Proposal Requirements List (PRL) Items..... 160

4.10 Contract Deliverable Requirements List (CDRL) Items..... 160

5.0 System Installation and Cutover **Error! Bookmark not defined.**

5.1 System Installation General Requirements.....**Error! Bookmark not defined.**

5.2 Structural Design Requirements **Error! Bookmark not defined.**

5.3 Electrical and Grounding System Design Requirements**Error! Bookmark not defined.**

5.4 Lenox Way Operations Control Center (Option)**Error! Bookmark not defined.**

5.6 Bernal Heights Communications Facility..... 181

5.7 Central Radio Station Twin Peaks Communications Facility..... 183

5.8 Forest Hill (Mendoza Avenue) Communications Facility..... 185

5.9 One Market Plaza Communications Facility 188

5.10 South Hill Communications Facility..... **Error! Bookmark not defined.**

5.11 Clay and Jones Communications Facility**Error! Bookmark not defined.**

5.12 Underground Communication Facilities 195

5.13 Vehicle Operations and Maintenance Facilities**Error! Bookmark not defined.**

5.14 Vehicle Equipment Installations **Error! Bookmark not defined.**

5.15 System Cutover **Error! Bookmark not defined.**

5.16 Transit Management Center - 1455 Market Street.....204

5.17 Dispatch Console Furniture 205

5.18 Proposal Requirements List (PRL) Items.....**Error! Bookmark not defined.**

5.19 Contract Deliverable Requirements List (CDRL) Items.....205

6.0 Quality Program 207
 (Moved to Supplementary Conditions Document 00824 Quality Program) 207

7.0 Testing & System Acceptance **Error! Bookmark not defined.**

7.1 Test Plans & Procedures **Error! Bookmark not defined.**

7.2 Integrated System Test Plan..... **Error! Bookmark not defined.**

7.3 Test Procedures **Error! Bookmark not defined.**

7.4 Test Records **Error! Bookmark not defined.**

7.5 Reporting of Test Variances **Error! Bookmark not defined.**

7.6 Disposition of Test Variances **Error! Bookmark not defined.**

7.7 Factory Testing **Error! Bookmark not defined.**

7.8 Unstructured Testing **Error! Bookmark not defined.**

7.9 Integrated System Test Program **Error! Bookmark not defined.**

7.10 Proposal Requirements List (PRL) Items..... **Error! Bookmark not defined.**

7.11 Contract Deliverable Requirements List (CDRL) Items..... 222

8.0 Training and Support **Error! Bookmark not defined.**

8.1 Training..... 224

8.2 System Support Services..... 231

8.3 System Maintenance 233

8.4 SFMTA Provided Project Space 235

8.4 Proposal Requirements List (PRL) Items. **Error! Bookmark not defined.**

8.5 Contract Deliverable Requirements List (CDRL) Items..... 235

9.0 Technical Documentation **Error! Bookmark not defined.**

9.1 System Functional Description Document 236

9.2 Hardware Documentation **Error! Bookmark not defined.**

9.3 Diagnostic Program Manuals..... 238

9.4 General Software Documentation..... **Error! Bookmark not defined.**

9.5 Software Functional Requirements Document..... 239

9.6 Program Source Code **Error! Bookmark not defined.**

9.7 Database Documentation 239

9.8 PSVRN and MTMS User Manuals239

9.9 Revenue Service Operator Manuals **Error! Bookmark not defined.**

9.10 Field Supervisor Manual240

9.11 Non-Revenue Vehicle Manual **Error! Bookmark not defined.**

9.12 System Administrator Documentation.....241

9.13 Test Documentation..... **Error! Bookmark not defined.**

9.14 Training Documentation.....242

9.15 Radio Dispatcher User’s Manual242

9.16 Utilization of a Requirements Traceability Matrix.....242

9.17 Options Documentation **Error! Bookmark not defined.**

9.18 Document Quantities243

9.19 Document Review and Approval..... **Error! Bookmark not defined.**

9.20 Drawing Standards244

9.21 Proposal Requirements List (PRL) Items.....244

9.22 Contract Deliverable Requirements List (CDRL) Items.....244

Design-Build Services for the Radio System Replacement

Section 1.0

1.0 GENERAL REQUIREMENTS

These general requirements shall pertain to development of the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN).

It is the SFMTA's intent to procure, via a design-build project, a fully integrated system that includes:

- The MTMS including, but not limited to, digital trunked voice and data communications for all transit operations, computer aided dispatch, automatic vehicle location, integrated incident management/reporting, single-point logon for revenue vehicles, and ADA compliant traveler information
- An interoperable Project-25 compliant PSVRN for joint use by selected the SFMTA staff and CCSF public works employees including the Department of Public Works, Port of San Francisco, and Department of Building Inspection (with no public safety users)
- A number of options including but not limited to interfaces to Automatic Passenger Counting (APC), Traffic Signal Priority (TSP), encryption, and a yard management system.

Note: Appendix Twenty Eight (28), "Cost Proposal Form" requires Qualified Proposers to specify the cost for the combined MTMS and PSVRN.

Radio communications equipment, computer servers, network equipment, and all necessary software will be installed at above ground radio communications sites, the SFMTA's underground rail tunnels and platforms, the SFMTA's Lenox Way Operations Control Center (Option), 1455 Market Street Transit Management Center, vehicle maintenance facilities, and other CCSF sites. These sites will be interconnected using a combination of the CCSF's existing microwave communications system, existing fiber optic cable, leased communications circuits, and the public cellular data networks.

Two separate Options exist for SFMTA's Operations Control Center:

- The Lenox Way Operations Control Center theatre shall be refurbished to accommodate the new dispatch consoles. In order to facilitate the renovation of the Lenox Way Operations Control Center, the existing Line Management Center at the SFMTA's One South Van Ness headquarters will be modified to accommodate rubber-tire vehicle dispatchers.
- The Contractor shall install dispatch consoles at the Transit Management Center at 1455 Market Street.

As part of this design-build project, the Lenox Way Operations Control Center theatre shall be refurbished as an option to accommodate back-up dispatch operations.

This RFP assumes a five (5) site communication (RF) system with two (2) central control sites. The communication sites, as illustrated in Appendix Nine (9), "Drawings" include:

- Bernal Heights
- Forest Hill
- One Market Plaza

Design-Build Services for the Radio System Replacement

Section 1.0

- South Hill
- Twin Peaks.

An additional site at the Clay/Jones building may be retained to house a stand-alone 800 MHz repeater for cable car machinery maintenance operations.

Control sites include:

- Operations Control Center at 131 Lenox Way, San Francisco (Option)
- Transit Management Center, 1455 Market Street
- Vehicle maintenance facilities, emergency operations center and other facilities.

The Qualified Proposer’s approach to the design and construction phases must be flexible to accommodate a different primary Operations Control Center location, with the Lenox Way facility becoming a backup control center. SFMTA firmly believes that the design, construction, system development, system integration, and implementation activities for the Radio System Replacement Project represent a considerable endeavor involving multiple complex interrelated design and construction activities. As such, Qualified Proposers shall clearly and prominently describe in their proposals the following IN DETAIL:

- The philosophies to be followed and methods employed that will be used to manage and track cost, schedule, and budget [PRL 12-1-10 Management of Cost, Schedule, and Budget]

The philosophy to be followed and methods employed that will be used to manage and track the definition, development, and functional verification of all system and subsystem interfaces including mechanical, electrical, civil, architectural, software, and hardware [PRL 12-1-11 Management of Interfaces]

1.1 Task Areas of Work

1.1.1 SFMTA Sites

Work shall be performed at all of the relevant SFMTA sites, including, but not limited to the sites listed to follow. The Contractor shall acquire all necessary safety training and certifications to access and work at these sites, as listed in RFQ/RFP Section 3.0 “Contractor’s Scope of Services”. Site access generally requires the coordination of escorts or clearances. Excluding radio sites, backhaul, and fiber optic cable equipment locations, the SFMTA has the following sites and structures that are relevant to the MTMS and PSVRN:

Site Name	Street Address
Signal Shop	400 Cesar Chavez St.
Cable Car & Rail Systems	1201 Mason St.
Technical Training	501 Cesar Chavez St.
Duboce Station	300 Duboce Ave. (at Church St.)
California and Powell Streets	California and Powell Streets signal tower

Design-Build Services for the Radio System Replacement

Section 1.0

Site Name	Street Address
Flynn Center	1940 Harrison St.
Green Light Rail – Annex	425 Geneva Ave.
Streetcar Carhouse	2301 San Jose Ave.
Green Light Rail – Metro	2200 San Jose Ave.
SFGo	25 Van Ness Ave. #210
Islais Creek – under construction	1301 Cesar Chavez St.
Kirkland	151 Beach St.
Central Control	131 Lenox Way
Muni Metro	East 601 25 th Street
MUNI ETI	Pier 15 @ Embarcadero
Materials Management	1580 Burke Avenue
Marin Street	1399 Marin St.
Overhead Lines	1401 Bryant St./2501 Alameda St.
Pennsylvania	700 Pennsylvania St.
Potrero Division	2500 Mariposa St.
Presidio Division	949 Presidio Ave.
Fare Enforcement and Security	875 Stevenson St.
MTA Headquarters	1 S. Van Ness Ave.
Woods Transportation	1001 22 nd St.
Woods Maintenance	1095 Indiana St.
Transit Management Center	1455 Market St.

In addition, the SFMTA operates in the following below-ground and tunnel structures:

- Market Street Subway and Twin Peaks Tunnel including Muni Metro Turnback and stations
- Muni Metro Sunset Tunnel
- Broadway Tunnel
- General Douglas MacArthur Tunnel
- Stockton Tunnel
- Geary Blvd. underpass at Presidio Ave.
- Yerba Buena Tunnel on Treasure Island.
- Cable car below grade structures
- Central Subway - Under construction

Design-Build Services for the Radio System Replacement**Section 1.0****1.1.2 Site Access**

Before work at a site can commence, the Contractor shall have obtained written permission from the SFMTA to access the site. The request for site access shall delineate and describe, as part of the permission request, any special ingress or egress requirements, including coordination of escorts if necessary.

The Contractor shall have final responsibility to arrange for and ensure site access at proposed sites.

1.1.3 Licenses and Permits

The Contractor shall be responsible for preparing and obtaining any and all applicable approvals, licenses, and permits other than FCC licenses and Association of Public Safety Communications Officials International (Apo) authorizations.

The Contractor is responsible for licensing and permitting of the selected sites and shall include, but not be limited to:

- Researching and reviewing all land titles, tax maps, and reference deed information that might be needed.
- Confirming regulations to clearly understand applicable zoning regulations, environmental regulations, and building permits at the local, county, state, and Federal levels. The Contractor shall work closely with the SFMTA staff to ascertain the adherence to procedures, as required, to obtain zoning and building permits
- Reviewing, preparing, and securing applicable environmental body approval(s), including approvals regarding stream encroachment, flood plains, and wetlands
- Preparing zoning drawings for zoning application(s), including, but not limited to, site plans, elevations, site boundary survey, antenna specifications, and computer-enhanced photograph(s)
- Submitting zoning or planning commission application(s) for the construction or modification of any antenna support structure(s) where required
- Attending zoning or planning commission hearing(s) if necessary
- Requesting necessary Federal Aviation Administration (FAA) clearance(s) using FAA Form 7460-1, Notice of Proposed Construction or Alteration
- Working with the local jurisdiction and any appropriate legal counsel to obtain documentation attesting that all the property taxes on the subject property have been paid and are current
- Reviewing a "title report" to ensure that there are no problems with the title that would affect future lease agreements or zoning applications
- Preparing a request for a Phase I Environmental study to be completed, as needed
- Preparing construction drawing(s) to submit to site managers for the construction or modification of any antenna support structure(s) required, if necessary
- Preparing building permit application(s), including construction drawings, site plan, elevations, site boundary survey, and antenna specifications

Design-Build Services for the Radio System Replacement**Section 1.0**

- Securing applicable building permit(s)
- Preparing and submitting all necessary documentation in support of the SFMTA in meeting California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) requirements.

1.2 Hardware and Software**1.2.1 System Wide Defects**

Any component installed shall be subject to a global replacement in case an annual component failure or non-conformance rate of 10%, where statistically relevant, is exceeded. SFMTA and the Contractor to mutually agree a statistically relevant failure of each equipment type during the design phase. The annual period starts with the first production installation of the respective component type.

In such case, the Contractor shall affect a redesign to correct this system wide defect. The new proposed design shall be submitted to the SFMTA for design review. After correcting the defect, the Contractor shall promptly undertake and complete a work program to implement this change in all existing and future equipment purchased under this Contract.

1.2.2 Hardware

Wherever Windows/Intel or compatible computer servers are used, equipment of a single manufacturer shall be proposed and installed, preferably of a single type. Operating system, database management system version levels of all components shall be consistent with the SFMTA's supported system levels.

The Contractor shall submit a complete list of required IT equipment for the Final Design Review [CDRL 12-1-1 IT Equipment List). These requirements and specifications may be refined and finalized as part of the Final Design Review. The proposed servers shall have redundant layouts for NIC cards, fans, power supplies and support SAN mass storage. As part of their Proposals, the Qualified Proposers shall describe the proposed method for backup of all databases and repositories [PRL 12-1-1 Database and Repository backup].

Tape backup as a physical medium to support the proposed backup methodology is not acceptable. The servers shall be remotely manageable, and be integrated with the Network Management System (Appendix Twelve (12) Section Four (4) "Network Requirements").

The Contractor will be responsible for providing all necessary hardware, software, wiring, cables, cable management systems, racking, and power distribution to interconnect all equipment. The Contractor shall install all computer equipment, dispatch center equipment, dispatch consoles, and monitoring consoles required for the MTMS as specified herein. The Contractor shall also install all rack-mounted servers, mounting hardware, and other components necessary for a complete and fully operational MTMS and PSVRN, along with connecting the equipment to existing utilities, the SFMTA, and City and County of San Francisco (CCSF) computer equipment. Rack mounted servers shall be installed whenever and wherever possible. Other server types, such as tower frames, shall be approved on a case-by-case basis, and only where design constraints may dictate their use over rack mount servers.

Design-Build Services for the Radio System Replacement**Section 1.0**

The Contractor shall conform to applicable local and state safety regulations, procedures and requirements, including statutory requirements. Rack equipment mounting procedures shall prevent damage as a result of seismic activity. This shall also include the construction period and prevent inadvertent damage during construction activities.

As is a requirement for all equipment installed in this project. hardware shall be new, factory built equipment.

1.2.3 Software Rights

The Contractor shall provide a machine-readable copy of all source code, build scripts, installers, and executable files that were developed for the SFMTA. The source code and executables for interfacing the MTMS to other the SFMTA systems that were developed specifically for the SFMTA shall also be provided. The machine-readable, electronic program source code, script and configuration files provided shall contain all the data required to enable the SFMTA to restore, build, reinstall, add, modify, or delete the SFMTA specific applications, displays, reports, and interfaces to other systems. As part of their proposals, the Qualified Proposers shall list the required build tools to create the executable software from source, including, but not limited to, Integrated Development Environments (IDEs), Virtual Machines (VMs), compilers, linkers and debuggers [PRL 12-1-2 Software Build Tools].

For the remainder of the Project, the Contractor shall provide an escrow agreement that guarantees the SFMTA access to all files that are required to build the system's target object or VM executable bytecode. The Contractor, as depositor of the escrow files, shall submit all items required to build the system's target object files (executables), including, but not limited to:

- Source files including source code, resource files such as icons and message texts, binary libraries bound against the source code such as libc or .jar files
- Build scripts
- Application framework such as JRE or .NET, as applicable
- Scripts for the execution of the executables
- Build instructions that describe the generation of object files (executables) from the source files and build scripts in escrow.

All source files shall be archived such that the original directory tree structure is automatically restored when extracted.

The Contractor being unwilling or unable to perform future system software/firmware maintenance or modifications required by the SFMTA will meet the conditions to release the items in escrow to the SFMTA. This condition and the release of the item includes the irrevocable and complete transfer of Intellectual Property rights of these items to the SFMTA.

1.2.4 Software Development, Configuration and Customization

The SFMTA expects the use of off-the-shelf software products that will be customized to meet the specific needs and objectives of the SFMTA, and that meet the requirements of the Contract. As part of their proposals, Qualified Proposers shall describe their software development and customization process [PRL 12-1-3 Software Development/Customization]. This description shall include a description of the Qualified Proposer teams' process of incorporating customizations into future vendor off-the-shelf components or modules, the

Design-Build Services for the Radio System Replacement**Section 1.0**

delineation between configuration and customization, and the Qualified Proposers' configuration change management.

1.3 Design Criteria**1.3.1 Design Criteria and Review**

The Contractor shall develop the design criteria of the intermediate design (65%) and final design (100%) of the MTMS and PSVRN, and call a review by the SFMTA to evaluate and review the design criteria in accordance with the schedule outlined in Appendix Twelve (12) Section Nine (9). The review shall include a description of the design criteria and shall verify whether the information is appropriate and complete to meet the scope of the project. The evaluation shall include, but not be limited to, the following elements:

- Understanding of the entire scope of the project
- The design criteria satisfying the scope of work
- Quality engineering practice
- Conformance with APCO and International Homeland Security Task Force recommendations on system interoperability, planning, survivability/redundancy, and security
- Conformance with Federal Transit Administration (FTA) "Transit Security Design Considerations" for the design of radio system and related communication systems, and facility infrastructure
- Reliability, availability, maintainability (RAM).

The Contractor shall capture design criteria review comments and respond to these comments within two (2) weeks. Any changes shall be incorporated into the design criteria. The completed design criteria shall be the basis for the entire design process and shall be used by design engineers during completion of the final design. The Contractor shall provide a detailed design package and submit this information to SFMTA for review based on mutually agreed upon system objectives.

1.3.2 Designed System Availability Requirements

The MTMS and PSVRN systems shall each be designed for an overall annual availability of 99.999%. Based on 99.999% availability requirement, the MTMS and PSVRN systems shall each be unavailable for no more than 5 minutes per year. The underground voice communications systems shall be considered independently from the MTMS and PSVRN systems and shall also be designed for and meet an overall annual availability of 99.999%. MTMS and PSVRN systems shall include provisions to achieve high availability for critical functions through reliability of subsystems and system components, elimination of single points of failure, through self-diagnostics and reporting of failures, and through maintainability of MTMS and PSVRN systems.

Unavailability

Design-Build Services for the Radio System Replacement

Section 1.0

Downtime occurs whenever the system functions that are designed to meet the requirements of the Contract are unavailable to the users of the system, including but not limited to "passive" stakeholders such as travelers on the SFMTA's system or the 511 system. Downtime is measured from failure report until full service is restored. The following events shall include, but are not limited to, events that constitute downtime:

Radio Site

Repeater site unplanned outage of any entire station site for more than 4 hours for any one event or 0.1% cumulative for one year.

Site Control

Site control or site message switching sub-system unplanned outage for more than 2 hours event or 0.1% cumulative for one year.

Network and Backhaul

Network and backhaul sub-system (contractor-provided equipment only) – unplanned outage of network connectivity to one site for more than 2 hours event or 0.1% cumulative for one year.

Vehicle On-board Equipment

Due to any simultaneous event, Failure of on-board equipment, including radio, antenna, control head, microphone, speaker, ancillary equipment and the CAD/AVL interface in 5% of the SFMTA's combined revenue and non-revenue fleets.

Loss of Power and/or HVAC

Loss of commercial or generator power or environmental controls (where the SFMTA has provided these facilities) or failure of SFMTA and/or CCSF provided equipment are not considered downtime.

Reliability Criteria

Voice Communications

No single point of failure shall disable voice communications from the dispatch center to the vehicle fleet, other than failure of equipment onboard a single vehicle. The MTMS and PSVRN radio systems shall include fallback modes such as Network Voice Fallback with fallback talk groups.

Data Communications

Design-Build Services for the Radio System Replacement

Section 1.0

No single point of failure shall disable data communications from the dispatch center to the vehicle fleet, other than failure of equipment onboard a single vehicle.

Consoles

Each console shall have all functions available at least 99.8% of the time, based on 24 hour a day operation, 365 days a year.

At least half of the consoles shall have all functions available at least 99.9% of the time based on 24 hour a day operation, 365 days a year.

No single point of failure shall disable both radio and telephone communications at more than one console.

Telephone Access

Any system or interface implemented or installed by contractor shall not disable access to telephone lines for incoming and outgoing calls to more than one console.

Onboard MTMS equipment

The full specified functionality for the MTMS onboard equipment for each vehicle shall be available at least 99.7% of the time, based on twenty-four hour a day operation, 365 days a year.

Data Logging

The ability for MTMS to correctly log data from vehicles, without lost events, shall be available at least 99.9 % of the time, based on twenty-four hour a day operation, 365 days a year. Measurement of this parameter assumes that the Vehicle is within MTMS radio coverage.

1.3.3 SFMTA CADD Standard

All design drawings submitted to the SFMTA shall meet the SFMTA CADD Standard which will be provided to the Contractor after contract award.

1.3.4 Standards for Design

The Contractor shall identify and adhere to appropriate codes and standards for the design and implementation of the project. Design, maintenance, and performance codes and industry standards for construction and electrical installations are listed in Appendix Twenty-Six (26), "Codes and Standards"

- American Concrete Institute (ACI)
- American Waterworks Association (AWWA)
- American Institute of Steel Construction (AISC)
- American Society of Testing Materials (ASTM)

Design-Build Services for the Radio System Replacement**Section 1.0**

- American National Standards Institute (ANSI)
- National Electric Code (NEC)
- American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
- Sheet Metal and Air Conditioning National Association, Inc. (SMACNA)
- California Department of Transportation (Caltrans)
- Department of Public Works (DPW)
- American Society of Mechanical Engineers (ASME)
- American Welding Society (AWS).

The Contractor shall ensure that applicable, appropriate, reasonable and comprehensive codes and standards are incorporated into all parts of the system design and its design packages.

1.4 Design Review and Design Acceptance Process

The documents and the exhibits of this RFP represent a 35% Preliminary Design. It shall be used as design input to the Contractor's Intermediate Design.

Intermediate Design Review (IDR) shall be conducted when the system design is 65%.

Final Design Review (FDR) shall be conducted when the system design is 95%, resulting in a SFMTA reviewed 100% Final Design for construction and permitting.

As part of their proposals, Qualified Proposers shall provide a list of the 65% and 95% drawings they will provide for the Design phase. [PRL 12-1-9 List of 65% and 95% Drawings]. Submittals that are required for the design reviews shall be received by the SFMTA at least thirty (30) working days before the start of design review. The design review presentations and discussions shall be conducted at the SFMTA's facilities and are expected to be a week in length, but shall continue until all issues are resolved.

Upon Notice To Proceed (NTP), the Contractor shall begin the detailed design of each subsystem, including system interfaces, software systems, radio communications, antenna and transmission lines, power, remote consoles, remote access stations, cabling, wiring, and grounding. As part of their proposals, Qualified Proposers shall describe their design approach, including design criteria [PRL 12-1-4 Design Approach, Design Criteria). The following Final Design submittals shall be submitted as corresponding Contract Deliverable Requirements List (CDRL) items [CDRL 12-1-2 Final Design Submittals):

- Overall space and facility layout and design
- Total system functional description
- Software system overview and preliminary design
- Radio System design
- Antenna, multi-coupler, and combiner design
- Dispatcher console layout
- Overall MTMS configuration

Design-Build Services for the Radio System Replacement

Section 1.0

- Overall PSVRN
- Communications interfaces
- Network topology
- Power supply, distribution, and loading
- On-board vehicle equipment design, functions, and integration
- System cutover and transition including methods and procedures for all work performed at live sites
- Failure modes, effects, and mitigation
- Hardware and system software requirements the SFMTA provided servers, software, and utility programs
- Environmental considerations, heat loads, ventilation requirements, electrical loads
- System Functional Description
- Software Description Document
- Hardware configuration block diagram showing all Contractor-provided MTMS and PSVRN equipment, including interfaces to other the SFMTA systems, software, and equipment
- Dispatch center and emergency operations center layout plans showing the proper dimensions and locations of the consoles and other MTMS and PSVRN equipment to be installed
- Radio system fixed site designs, including all equipment to be installed at each location, dimensions and locations of the equipment, antenna system designs. and power sources
- Radio system technical data and studies as specified in Appendix Twelve (12) Section Two (2), including final radio coverage area calculations and documentation
- Console layout drawings showing the proper dimensions and locations of all Contractor furnished equipment being installed on or in the consoles
- Custom hardware design documents
- Draft MTMS and PSVRN user's manuals that describes the layout and content of all displays, reports, and user actions required to perform each function available to users.
- Communications interface block diagrams
- Network topology diagrams including IP addressing scheme and security features
- On-board vehicle equipment block diagrams, equipment layouts, equipment installation locations and mounting details (for each type of vehicle), on-board equipment interface descriptions and functional descriptions
- Draft transit operator documentation that provides detailed operating instructions and procedures for each function available to the Transit Operators using the on-board vehicle equipment.

Design-Build Services for the Radio System Replacement

Section 1.0

- Installation and phase-over plan
- Failure modes and effects analysis
- For any options purchased, all applicable documents specified above.

Prior written acceptance of the final designs by the SFMTA shall be required before commencing any further work or procurement or manufacture of any equipment.

The Contractor shall also prepare and provide complete installation plans, test plans and procedures, MTMS and PSVRN cutover plans and procedures, training plans and materials, and an integration plan [CDRL 12-1-3 Installation Plans, Test Plans and Procedures].

The Contractor shall provide a clear and comprehensive plan to ensure that the SFMTA's staff is effectively trained and comfortable with the operation and use of the dispatch and mobile equipment before MTMS and PSVRN cutover. Expectations and assumptions for the SFMTA furnished materials and support shall be clearly stated. These shall align with the requirements of the Contract.

The Contractor shall incorporate any and all comments received from the SFMTA into the design documentation.

It is understood that the SFMTA's acceptance of designs, including, but not limited to, Final Design, does not relieve the Contractor to any degree from the Contractor's responsibility to meet the requirements of the contract.

1.5 System Security

As part of the final design, the Contractor shall provide a detailed description of the physical and logical security features provided with the MTMS and PSVRN, as described in Appendix Twelve (12) Section Four (4) "Network Requirements" [CDRL 12-1-4 Physical and Logical Security]. The Contractor shall agree to support the SFMTA to ensure that network and server security complies with the SFMTA and CCSF policies, practices, procedures and work instructions. Except for new construction, including but not limited to base station shelters, the Contractor will not be required to provide the physical facility security such as locks and fences. The implementation of SFMTA and CCSF policies, practices, procedures and work instructions will be mutually agreeable between the Contractor and SFMTA.

1.6 System Time

The MTMS and PSVRN shall automatically synchronize system time with a coordinated universal time source to be utilized by all system components including mobile and portable units. Daylight savings time switches shall be performed automatically with no user intervention required. Changes to defined daylight savings time switches, such as government mandates, shall be applied, but may involve system administrator intervention prior to the affected dates.

1.7 System Compatibility, Interface and Interoperability Requirements

1.7.1 Equipment Interface Designs

The Contractor shall develop Interface Control Documentation (ICD) describing the physical, mechanical, electrical, software, and functional relationships of equipment being interfaced [CDRL 12-1-5 Interface Control Documentation (ICD)]. Documentation shall include sufficient detail, enabling the designers of the MTMS and PSVRN to meet the interface requirements while designing each subsystem.

Design-Build Services for the Radio System Replacement**Section 1.0**

The ICD shall provide all detailed specifications of each interface point, including physical, mechanical, environmental, and electrical specifications, levels, and protocols.

The ICD shall be submitted for design review and acceptance at IDR and FDR.

1.7.2 Software Interface Designs

The Contractor shall be responsible for the design, licensing, and implementation of all MTMS and PSVRN software interfaces to the specified external systems. It shall be the responsibility of the Contractor to determine the interface capabilities of the external systems. Any deficiencies in those interfaces and external system that may prevent full compliance with the functional requirements of this specification shall be reported to the SFMTA.

Software interfaces to external systems shall be fully documented, non-proprietary, and based on recognized standards developed by official standards-making bodies or Committees (e.g. IEEE, SAE, ITF, etc.). In the absence of a recognized standard, external software interfaces shall be fully designed and documented by the Contractor to an extent sufficient for third parties to implement and/or modify the external side of the interface.

The MTMS and/or PSVRN performance shall not be affected by the level of data transfer activity to and from any or all of the external systems.

1.7.3 Enterprise Network Interface

The Contractor shall agree to work with and assist the SFMTA staff to integrate the required MTMS and PSVRN functions into the SFMTA's enterprise. The Contractor shall support and assist in providing recommendations including but not limited to networking security, gateways, remote login, integration of remote sites and enterprise users in planning and reporting and all other areas with needs for access to functions of the MTMS. Further network requirements are described in Appendix Twelve (12) Section Four (4) "Network Requirements".

1.7.4 Interface Change Management

System interfaces shall be managed through reference to the Interface Control Document. In this document, agreed upon changes to interfaces shall be documented and kept current.

1.8 Installation Standards**1.8.1 General Installation Standards**

Unless otherwise specified, system installation shall conform to the following general standards:

- Workmanship and appearance of work throughout shall be of the best commercial quality and adhere to the latest edition of all applicable standards and codes
- Work shall be performed only by qualified personnel, and shall be supervised by technically competent, trained, experienced supervisory personnel at all times
- All equipment and components shall be easily accessible for adjustment and service. Accessibility shall be supported through the provision and implementation of service loops.
- Cabling and equipment exposed to the elements shall be adequately protected from wind, rain, and dust. Seals, gaskets, packing, sheathing, finishes, mountings, and all other exposed items shall be designed for maintenance-free performance under long-term exposure to weather, including ultra-violet radiation.

Design-Build Services for the Radio System Replacement**Section 1.0**

- Equipment and cabling installed inside vehicles shall be adequately protected and routed to avoid mechanical impacts, water and dust, including but not limited to vehicle cleaning operations
- Equipment requiring adjustments shall be securely installed inside vehicles using existing or new tamper-proof containers, fasteners, etc. Frequent re-adjustment, excluding routine preventative maintenance, shall not be required, and if found necessary, considered a factor of fleet defects.
- Conductors shall be continuous between terminals, without splices
- Conductor gauge, insulation, and shielding shall be adequate for the intended purpose
- Cable and wire shall be run neatly, with adequate lacing or clamping
- Consistent cable and wire color coding shall be used, in accordance with standards such as EIA/TIA-586, as applicable
- All applications requiring physical movement and flexing shall use stranded conductors
- Ring-type, crimped lugs shall be used with stranded wires terminated on screw-type terminals. Connections shall be made only with crimping tools that meet the connector manufacturer's specifications.
- Shielded Wiring, or other means of signal isolation, shall be used wherever necessary to avoid cross-talk, hum, pops, clicks, whine, and other forms of interference. The Contractor shall resolve any interference issues should these occur.
- Unless installed in conduit, wiring within consoles, beneath raised floors, and from outlet boxes to free-standing or desk-mounted equipment shall be neatly installed, bundled with appropriate tie-wrap devices, and tied to supports if practicable
- Dispatch center signal and control wiring, and connection of devices referenced in this Specification, shall be installed in conduits or concealed, and shall be included as part of the work to be performed by the Contractor. Wiring shall be accessible for maintenance. At remote sites and in equipment rooms, open cabling is permitted on cable racks provided they are neatly tied.
- Interconnect cabling used within consoles, equipment cabinets, or in areas where the wiring will not be installed in metallic conduit, shall be insulated with heat-resistant material to minimize pyrolysis and fire hazard
- Cable and wiring penetrations through metal cabinets shall be insulated with dielectric grommets
- Cable and wiring installed in modular furniture shall be run in the trays or channels designed for that purpose
- Extra wiring necessary for equipment movement shall be neatly coiled, tied, and concealed
- Wiring in dropped ceiling areas shall not lie on top of light fixtures or ceiling tiles
- Cable penetrations through building outside walls shall be thoroughly packed and waterproofed

Design-Build Services for the Radio System Replacement**Section 1.0**

- Cables, wiring forms, and terminals shall be identified by permanent labels, tags, or other appropriate means. Marking shall clearly indicate the function or source. Cables shall be identified at both ends with indications of the source and destination of that cable run. The cable identification shall agree with the wiring and interconnect diagrams
- Installation at all sites shall be in complete compliance with all applicable building, seismic, and fire codes
- All conduits and cables shall be identified by permanent labels, tags, or other appropriate means.

1.8.2 Rubber-Tired Vehicle Installation Standards and Mobile Installation

The following requirements apply to all mobile radio and ITS equipment to be installed on the SFMTA's vehicles.

All of the SFMTA vehicle installations shall be subject to inspection and quality control before acceptance, by inspection personnel to be named by the SFMTA. The Contractor shall include a vehicle installation and inspection procedure with FDR.

Vehicle Acceptance shall include, but not be limited to:

- Appearance
- Effective usefulness
- Full programming as set forth by specifications and the requirements of the contract
- Full testing, including power out, deviation, receiver sensitivity, antenna VSWR, and all programmed features, to meet or exceed published specifications.

Prior to any Contractor testing, the coach electrical supply should be verified as suitable and adequate for proposed equipment requirements. Routing, connections and circuit protection for radio and any on board equipment connectivity shall be inspected and approved by the SFMTA.

The Contractor shall make every effort to protect all interconnecting cable runs, especially cables routed underneath the vehicle.

All cabling that is routed underneath the vehicle shall be secured in high impact plastic looms and secured to a stationary support structure.

Ties to such supports shall be stainless steel straps that are designed for this purpose; nylon tie-wraps are not acceptable.

Care shall be taken to avoid the vehicle exhaust system or other areas that create excessive heat.

Where wiring passes through compartment walls, floors, or rooftops, the Contractor shall protect the wiring from sharp edges with rubber grommets and shall ensure waterproofing to interior compartments.

Installation in any vehicle shall not interfere with any functional device, nor shall it affect the safe operation of the vehicle. On vehicles equipped with driver, passenger, and side air bags, the Contractor equipment shall not interfere with deployment. If necessary, the Contractor shall propose and install a passenger side front air bag disabling switch. Modification of any safety equipment or air bags require the SFMTA's approval and shall be performed at the Contractor's

Design-Build Services for the Radio System Replacement

Section 1.0

expense by a US-DOT certified technician and include support for SFMTA registration with the California Department of Motor Vehicles.

All vehicles that have tilt cabs shall be provided with new ground braids between the cab and the frame of the vehicle. This ground braid shall be installed on metal that is free from paint, grease, or dirt, and shall include a star lock washer to ensure a reliable and secure ground connection.

Wiring of the new equipment shall not be connected to existing radio equipment in the vehicle.

All main power leads shall be obtained from the same voltage source as that used by existing radio equipment.

In vehicles that employ electronic sirens, an audio output shall be connected to the siren for effective public address (PA) use through the siren speaker. The SFMTA prefers a design that will utilize a single microphone for both radio communications and PA use.

In vehicles that employ intercom systems, the new equipment shall be connected to the intercom system upon cutover to the new radio system. New radios shall be checked for compatibility with the intercom system at the time of installation.

The new equipment shall not create or receive interference from other electronic equipment in the vehicle. If any modification is required to the Contractor's equipment to correct such interference, such correction shall be performed on all vehicles to ensure uniformity of equipment, at no additional cost to the SFMTA.

All fuses shall be installed in locations that are easily accessible. No fuses shall be installed in locations under the vehicle.

All wiring shall be installed in a manner that is secure and free from interference or damage by the occupants.

All antennas shall be mounted permanently to the roof of the vehicle, with adequate clearance and ground planes, based on but not limited to performance and interference requirements, and manufacturer specifications.

No cable connectors fabricated in the field shall be crimp-type. All connectors shall be soldered using 60/40 solder within heat shrink that incorporates some form of sealant to ensure proper connection.

Reflected power, or VSWR, shall be measured and documented after installation of each antenna and cable. Maximum reflected power shall not exceed 4% of the radio unit's output power.

No wiring shall be spliced within the loom covering that wire.

"LOK" or "f-Tap" style splice connectors shall not be permitted.

No wire shall change color between the source and the radio unit.

The Contractor shall be responsible for making corrections to any and all vehicles that experience dormant operation battery drain, where such drain can be attributed to new equipment installation. The Contractor is encouraged to check vehicle batteries before radio installation to avoid problems. If a vehicle is found to have faulty batteries, the Contractor shall notify the SFMTA and note this on the installation documentation.

Design-Build Services for the Radio System Replacement**Section 1.0**

All statutory and regulatory safety requirements shall be followed at all times. All contractor staff shall be trained and certified to the required safety standards and in accordance with the SFMTA's safety program.

1.8.3 Rail Vehicle Material and Workmanship Standards

Material and workmanship standards for any equipment installed on the SFMTA's fleet of light rail vehicle and historic vehicles are contained in Appendix Twenty-Two (22).

1.8.4 Cleaning

All work and supporting areas shall be cleaned no later than at the end of each workday. On an ongoing basis, cleaning shall support installation performance, safety, quality and work standards and be scheduled and performed accordingly.

The Contractor, at the Contractor's expense, shall dispose of all rubbish, and debris, in accordance with all regulatory and statutory requirements applicable to the work site.

1.8.5 Product Identification and Traceability

The Contractor shall develop and maintain an equipment labeling plan that shall allow the identification of products and materials by suitable means throughout the lifecycle of the Radio System Replacement [CDRL 12-1-6 Equipment Labeling Plan]. This shall include but not be limited to formal configuration management to support and record the configuration of software components.

1.8.6 Decommissioning and Disposal of Existing Equipment

The Contractor shall provide evidence that all material and electronic waste removed from the SFMTA and CCSF sites has been legally and responsibly disposed of and/or recycled.

1.8.7 Regulatory and Statutory Requirements

All work shall be performed in accordance with applicable environmental, safety and labor related regulatory and City and County of San Francisco and the SFMTA statutory requirements, including but not limited to:

- APCO and International Homeland Security Task Force recommendations on system interoperability, planning, survivability/redundancy, and security
- Federal Transit Administration (FTA) "Transit Security Design Considerations" for the design of radio system and related communication systems, and facility infrastructure.
- Federal Transit Administration (FTA) QNQC Guidelines.

The Contractor shall provide a detailed design package and submit this information to SFMTA for review based on the mutually agreed upon system objectives.

1.9 DBI Plan-check Review and Acceptance, Building Permits and DBI Inspection Requirements

Appendix Twenty-Seven (27) contains the SFMTA Permit Process. The Contractor shall follow and meet the requirements of the Permit Process.

1.10 City Planning Process

Please refer to Appendix Twenty-Seven (27), "San Francisco City Permit Process".

Design-Build Services for the Radio System Replacement**Section 1.0****1.11 System Redundancy and Availability****1.11.1 Infrastructure Redundancy**

Critical components of the voice and data system infrastructure shall be designed with redundancy in order to ensure high system availability. General failover capacity shall be provided along the following lines:

- Subsystem inherent fault tolerance. The proposed subsystems shall provide a level of inherent fault tolerance without single points of failure, distributed processing and hot stand-by equipment configurations, as indicated elsewhere in this specification. All computer servers shall be appropriately redundant or clustered in the proposed design to meet availability requirements. Where redundancy has been designed into the MTMS and PSVRN, failover shall be automatic and transparent to the users of the system. There shall be no loss of operating data during the failover process.
- Vehicle ITS autonomy. In case of communication systems failures or coverage and capacity issues, after onboard systems initialization vehicles ITS function shall be capable of autonomous initialization and operation.
- Mutual data and voice radio network fallback support. Data and voice radio network shall have mutual fallback capability, e.g. messaging fallback.
- Dynamic dispatcher and train controller work assignments in case dispatch and control center locations fail. Although a backup control center may not be requested within the scope of this RFP, backup control center capability shall be provided with the MTMS and PSVRN for future expansion.

The SFMTA requires a trunked LMR system that shall not suffer loss of the trunking capability resulting from the failure of a single system component.

The SFMTA's System Administrators shall be notified and event log entries created in the event of any system disruptions or problems.

1.11.2 Failure Modes

In response to the RFP, the Qualified Proposers shall describe the various fallback modes of operation of their proposed system design, from full system functionality to the least system functionality that will support the SFMTA's communications needs [PRL 12-1-5 Fallback Modes of Operation]. Qualified Proposers shall explain the following:

- How their system design is such that the possibility of the SFMTA experiencing a complete failure of radio coverage in the SFMTA's service area is reduced to a minimum.
- Potential single-point failures that will result in a degraded mode of operation.
- How the proposed design will support system reliability requirements for dispatch system facilities with a minimum life expectancy of 10 years from the date of system acceptance.
- Projected system reliability and Mean Time Between Failure (MTBF) for major subsystems and equipment, based on the system proposed.
- How the system will react to a failure of each major system element.

Design-Build Services for the Radio System Replacement

Section 1.0

- The impact of failure of any computer server, storage component (disk array, storage area network, etc.), or network equipment [PRL 12-1-6 Failure Impact].

For the final system configuration, the Contractor shall provide a Failure Modes and Effects Analysis [CDRL 12-1-7 Failure Modes and Effects Analysis].

1.11.3 Radio Coverage

The trunked LMR system shall meet all coverage requirements as specified by the SFMTA.

The coverage of the individual LMR sites shall be designed with the greatest extent of "overlap" of the radio coverage between the various radio sites.

The Contractor shall optimize the cost/performance ratio of utilizing multiple antennas, transmit combiners, and receiver multi-couplers in their site and tower design.

Refer to Appendix Twelve (12) Section Two (2) for further information.

1.11.4 Radio Base Site Infrastructure

The Contractor shall be required to provide redundant critical network control equipment at an additional site, interfaced to the main site such that switch over to the backup site will ensure no loss of full functionality over the entire infrastructure. Refer to Appendix Twelve (12), Section Two (2) for further information.

In the case of redundant simulcast controllers or multi-site switches, both shall remain on-line continuously with parallel updating of the system database to provide minimal interruption of service in the event of failure of the main controller or switch.

Switching from main to standby operation shall be fully automatic, with audible and visual indication of the switchover provided to the supervisory console position or network management system (NMS) at the Operations Control Center

1.11.5 Manual Switchover

Remote switching from main trunking controller or wide area switch to the standby trunking controller or wide area switch shall be provided at the supervisory console as a manual override to automatic switch over.

1.11.6 Failure Statistics

Mean Time Between Failures (MTBF)

The Qualified Proposers shall specify the Mean Time Between Failure (MTBF) for all of its major system components for the PSVRN and MTMS. [PRL 12-1-7 Mean Time Between Failure (MTBF)]

Mean Time To Repair (MTTR)

The Qualified Proposers shall specify all known Mean Time to Repair (MTIR) data for the major system components for the PSVRN and MTMS. [PRL 12-1-8 Mean Time to Repair (MTTR)]

As part of the system design, the Contractor shall use this information when calculating overall system reliability and availability data for its detailed design [CDRL 12-1-8 System Reliability and Availability Calculation].

Design-Build Services for the Radio System Replacement**Section 1.0****1.11.7 Radio Channel Failure**

If a radio channel fails, the system shall permit continued operation of all subscriber units or talk groups originally assigned to that channel. This shall be accomplished by automatic switching of the talk group or subscriber units to another radio channel. This shall apply to either voice or data communications.

Multiple radio channel failures shall sound a major alarm at both the control center and the network manager locations.

1.11.8 Onboard Vehicle Failure

In case of an onboard MTMS data communications failure, the system shall automatically save critical operating data (time point arrival and departures times, passenger counts, and TSP requests) onboard for later upload to the central MTMS. The system shall operate in voice fallback mode. The onboard MTMS shall continue to attempt to re-establish data communications until successful. The voice fallback mode shall provide basic signaling functions to allow participation in trunked voice radio communications, including the signalization of Request to Talk (RTT), Priority Request to Talk (PRTI) and Emergency Alarm (EA) through the vehicle operator controls that are used in regular system operation. On the central side, fallback trunked voice radio and signalization shall be integrated with the console system such that dispatcher control are used that are also used in regular system operation.

Any failures that prevent the preceding conditions to be met shall result in the vehicle considered inoperable and vehicle availability compromised.

1.11.9 System Availability

Full operation of the system infrastructure (even if by backup unit) is required to maintain system availability. This requirement assumes that there shall only be limited subsystem failures, and that the SFMTA shall not experience total LMR system failure over the projected life of the system. Total LMR failure shall be construed as meaning a complete loss of the radio communications system with inability to communicate with any subscriber units using voice communications. The underground communications systems shall be considered independently from the above ground system.

MTMS availability is considered compromised if the MTMS equipment is inoperable on more than 30% of the vehicles.

The Contractor shall include its calculated reliability and availability criteria for each equipment component and full system design with site by site detail in its total detailed MTMS and PSVRN design. [CDRL 12-1-9]

The SFMTA furnishes parts of the network infrastructure, such as dark fiber links and their termination and the microwave backbone infrastructure. It is understood that the LMR and CAD/AVL systems build on these components. SFMTA furnished components shall be part of the reliability and availability analysis during the design phase.

1.12 Expandability

The MTMS and PSVRN shall be sized and contain the capacity to accommodate the SFMTA service expansions such as the Central Subway, without the need for upgrades or changes to the installed system, over the lifetime of the system, except for:

Design-Build Services for the Radio System Replacement**Section 1.0**

- Growth of subscriber unit numbers as specified in Appendix Twelve (12), Section Two (2)
- Expansions to radio coverage
- Wayside equipment such as traveler information or Traffic Signal Priority (TSP) equipment
- Rolling stock installation.

1.13 SFMTA Provided Space and Vehicles

Space for storage and work trailers may be made available, but only on a limited basis, as discussed in Appendix Twelve (12) Section Eight (8). Therefore the Qualified Proposers shall not assume that the SFMTA will provide space for equipment storage, segregation of non-conforming product, work bays, killing, storage of decommissioned materials, personal lockers any other space needed to perform the required work.

The Qualified Proposers shall note that individual divisions might be constrained in their availability to perform night work. Further, the Qualified Proposers shall not assume that vehicles can be made available for installation, quality control or any other activity during daytime revenue service hours. As part of their proposals, the Qualified Proposers shall demonstrate an understanding and discuss the impact of constraints for construction activity at all of the SFMTA and CCSF sites, including railway tunnels, maintenance facilities, and other sites [CDRL 12-1-9 Calculated Reliability and Availability Criteria). The Contractor shall factor ongoing fleet rehabilitation programs into the project planning.

1.14 National and Regional ITS Architecture Compliance

It is the SFMTA's intent to follow the Intelligent Transportation Systems (ITS) engineering methodologies promulgated by the Federal Transit Administration (FTA). The design and build of the MTMS shall conform to:

- Regional ITS system design standards published by the FTA (<http://www.its.dot.gov/standards/index.htm>)
- San Francisco Bay Area Regional Intelligent Transportation Systems Plan as published by the Metropolitan Transportation Commission (MTC) (<http://www.mtc.ca.gov/planning/ITS/index.htm>) .
- The Contractor's design implementation shall follow the recommended processes for team members, system integrators, and designers, as defined in the Systems Engineering Guidebook for ITS, Version 2.0, January 2007 (<http://www.fhwa.dot.gov/cadiv/segbl>).

1.15 For Reference Only Sections and Appendices (This section is not used)**1.16 Proposal Requirements List (PRL) Items**

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

PRL 12-1-1 Database and Repository Backup

Design-Build Services for the Radio System Replacement

Section 1.0

PRL 12-1-2 Software Build Tools

PRL 12-1-3 Software Development and Customization Process

PRL 12-1-4 Design Approach, Design Criteria

PRL 12-1-5 Fallback Modes of Operation

PRL 12-1-6 Failure Impact

PRL 12-1-7 Mean Time Between Failure (MTBF)

PRL 12-1-8 Mean Time to Repair (MTIR) Data

PRL 12-1-9 Understanding of Construction Constraints.

(NOTE: this PRL was shown as deleted by A07 in SFMTA's Conformed AP12_Sec 1 document.)

PRL 12-1-9 List of 65% and 95% Drawings for Design Phase

PRL 12-1-10 Management of Cost, Schedule, and Budget

PRL 12-1-11 Management of Interfaces

1.17 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

CDRL 12-1-1 IT Equipment List

CDRL 12-1-2 Final Design Submittals

CDRL 12-1-3 Installation Plans, Test Plans and Procedures

CDRL 12-1-4 Physical and Logical Security

CDRL 12-1-5 Interface Control Documentation (ICD)

CDRL 12-1-6 Equipment Labeling Plan

CDRL 12-1-7 Failure Modes and Effects Analysis

CDRL 12-1-8 System Reliability and Availability Calculation

CDRL 12-1-9 Calculated Reliability and Availability Criteria

The Contractor is advised that the above list does not necessarily constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole, or by reference, as part of the complete package of deliverables and submittals. Any additional CDRLs required will be mutually agreed during the Design Phase.

2.0 RADIO COMMUNICATIONS COMPONENTS

2.1 Introduction

This section describes the specification requirements for the turn-key implementation of a radio system that shall provide wireless voice and data communications for the San Francisco Metropolitan Transit Agency (SFMTA) and various City and County of San Francisco (CCSF) agencies. This specification document delineates the requirements for the mobile, portable, fixed site and associated network management equipment required to support the Public Service Voice Radio Network (PSVRN), Multimodal Transit Management System (MTMS), and underground radio network requirements.

This section provides a proposed system design that defines the SFMTA and CCSF system and coverage performance requirements. This preliminary design includes the selection of several variables, including, but not limited to, the radio system technology, base station sites, frequency and channel allocations.

This design is presented here as a reference for the Qualified Proposer as to the type of radio system envisioned by the SFMTA and CCSF. This design shall be further considered after a contract is awarded to a Qualified Proposer in the context of preliminary and final system designs that are to be completed by the successful Qualified Proposer and approved by the SFMTA. The final design and performance of the system shall be the responsibility of the Contractor.

It is the intent of the SFMTA to construct and implement a radio communications infrastructure that includes the latest service proven technology and that meets, at a minimum, the standard transit and public safety requirements for performance, coverage, and redundancy.

Public networks may be considered only in cases specifically mentioned in this RFP but, not as a viable alternate solution or, as a qualified communication Proposal for voice, radio, and data services.

The SFMTA radio system shall utilize CCSF's existing backhaul communications system. This comprises a combination of microwave and fiber optic systems at each site (Appendix Twelve (12) Section Four (4) of this RFP). The Contractor shall use these systems to provide redundant backhaul communications between the various component sites of the system. The Contractor shall coordinate with the SFMTA to assure an integrated system design as discussed in Appendix Twelve (12) Section Four (4).

The radio system implementation will achieve the following goals:

- Optimize the efficient use of the SFMTA frequency's
- Provide a high system availability, reliability and survivability
- Enhance the maintainability of the system,
- Easier process to upgrade system components
- Provide a system which can be easily expandable
- Enhanced coverage that meets the SFMTA service area
- State-of-the-art digital technology
- Open architecture interface(s) to neighboring systems, such as the City and County of San Francisco Department of Emergency Management and other of the SFMTA IT systems
- Communications backbone compatibility with the MTMS as described in this RFP

Design-Build Services for the Radio System Replacement

Section 2.0

- Increased system capacity
- Improved operational efficiency and flexibility in communications systems
- Flexibility and simplicity in creating and maintaining multiple talkgroups
- Integration into the regional P25 voice and data core network, when applicable
- Fully integrated radio communications within the existing and the planned SFMTA infrastructure
- Capability to rapidly transition to a back-up control center when available.

2.1.1 Existing Radio System Description

The SFMTA’s existing 480 MHz conventional systems are either single site repeaters or are voted and transmitter-steered; the SFMTA security radio is a two site simulcast system installed in 2008.”The vast majority of equipment is aging and incapable of meeting the SFMTA’s reliability expectations or future spectrum-efficiency requirements. Therefore, they are not considered a viable foundation for the new system. Appendix Eighteen (18) provides details concerning the licensed radio system configuration. Licensees and pending applications are available upon request.

The existing systems use leased communications lines for back-haul from each site. System comparators are located at the Operations Control Center (OCC) at 131 Lenox Way in San Francisco.

The following tables describe the Above Ground (AG) and Underground (UG) Users in the existing networks in more detail:

Exhibit 2.1.1.-1 Coach, Trolley, and Light Rail Network

CH	AG Users	UG Users	Frequencies		Above Ground/AG Sites			Underground Sites (UG) Sites					
			Base TX	Base RX	Mendosa	McLaren Park	B of A	Carl	Church	Eureka	Forest Hill	Montgomery	Civic Center
			(MHz)	(MHz)									
1/A	Lt. Rail Voice	Lt. Rail Voice	484.6625	487.6625	X	X	X	X	X	X	X	X	X
2/B	Trolley Voice		484.5125	487.5125	X	X	X						
3/D	Trolley Voice		484.6125	484.6125	X	X	X						
4/E	Coach Voice		484.7125	487.7125	X	X	X						
5/G	Coach Voice	Lt. Rail Voice	482.8875	485.8875	X	X	X	X	X	X	X	X	X
6/C	Coach Voice	Lt. Rail Data	484.5625	487.5624	X	X	X	X	X	X	X	X	X
7/F	Coach Voice	Lt. Rail Voice	484.7625	487.7625	X	X	X						

X = Repeater/Base Station

BU = Backup Station

Exhibit 2.1.1.-2: Operations and Maintenance Network

CH	AG Users	UG Users	Frequencies		Above Ground (AG) Sites		
			Base TX	Base RX	Christmas Tree Point		
			(MHz)	(MHz)			
1	Operations/Maintenance		3.1.14	31.14		X	

Design-Build Services for the Radio System Replacement

Section 2.0

Exhibit 2.1.1-3: Fare Enforcement and Security Radio System

CH	User	AG Users	UG Users	Frequencies		Above Ground/AG Sites			
				Base TX	Base RX	111 Palo Alto Avenue	One Market Plaza	Christmas Tree Point	Comm Shop
				(MHz)	(MHz)				
1	Security	None		483.0375	486.0375	X			
2	Security	None		483.1375	486.1375	X			
3	Security	None		488.5625	491.5625		X	X	X

Exhibit 2.1.1-4: DPT Network (CERS)

TG	AG Users	Frequencies		Above Group (AG) Sites									Underground (UG) Sites
		Base TX	Base RX	Bernal Heights	Christmas Tree Point	Clay Jones	Forest Hill	Fort Miley	One Market Plaza	SFSU	South Hill	Various	
		(MHz)	(MHz)										
DPT-A1	PCO Dispatch (P/C 7)	Trunked Radio System Common Frequency Pool 866-869/821-824 (23 Channels)	X	X	X	X	X	X	X	X	X	Radiating Cable Coverage of Various MUNI and BART	
DPT-A2	Admin & Engineering												
DPT-A3	Paint Shop/Traf. Sig. Shop												
DPT-A4	Meter Repair/ Signal Shop												
DPT-A5	Special Event												
DPT-A6	Traffic Control Center (Rsrv)												
PD-A11	MUNI, TAC &* Co K												
Scoff	Scofflow (PIC 6)												
Tow	Tow Dispatch (PIC 5)												

TG – Trunked Talk Group X – Repeater Base Station: support all talk groups shown

Exhibit 2.1.1.-5: Cable Car Machinery

CH	AG Users	UG Users	Frequencies		Above Ground (AG) Sites
			Base TX	Base RX	Clay Jones
			(MHz)	(MHz)	
1	Cable Car Machinery	None	855.2375	810.2375	X

Design-Build Services for the Radio System Replacement

Section 2.0

The Existing Public Works Emergency Radio System (PERS) network is an 9-channel, four-site Motorola SmartNet II 800 MHz simulcast trunked radio system which supports approximately 2100 non-public-safety users on 46 talkgroups, as illustrated below. This system is not Project 25 compatible. The PERS simulcast controller and comparators (Prime Site) is located at the City’s Fort Miley/VA radio site. Its trunked controller is located at the CRS site. This controller is shared with the City Emergency Radio System (CERS) trunked public safety network. PERS users will be migrating to the new PSVRN as the subscriber equipment is replaced.

Exhibit 2.1.1-6: PERS Radio Network

TG	AG Users	Frequencies		Above Ground/AG Sites				Underground/UG Sites
		Base TX	Base RX	Twin Peaks	One Market Plaza	Fort Miley	South Hill	Various
		(MHz)	(MHz)					
Qty 5	Dept. of Public Health	Trunked Radio System Common Frequency Pool 86- 869/821-824 (11 Ch)		X	X	X	X	Radiating Cable Coverage of various MUNI and BART Platforms and Tunnels
Qty 22	Dept. of Public Works							
Qty 15	Miscellaneous							
Qty 4	Unified School District							

TG – Trunked Talk Group X – Repeater Base Station: supports all talkgroups shown

2.1.2 Existing Operations

Currently, all of the SFMTA fixed-route radio dispatching operations are managed from the OCC. The operation utilizes ten (10) dispatch workstations with the radio system electronics in an adjacent Radio Equipment Room.

Eight (8) Motorola Metrocom consoles with monochrome terminals are installed at the OCC. The consoles connect to a Motorola TDS-2500 system, which is no longer supported by the vendor. The system performs Computer Aided Dispatch (CAD) functions by managing voice radio channel traffic on closed channels, including relaying messages from the mobile radio communications terminals installed on transit vehicles to the dispatch consoles.

The messages include, but are not limited to:

- Routine Calls (Request to Talk - RTT)
- Priority Calls (Priority Request to Talk - PRTI)
- Silent Emergency Alarm (EA)
- S1- S5 SFMTA-definable messages.

The operational use of these messages is governed by the OCC Communications procedure. The Metrocom system also receives vehicle operator logon by line/run number. Each control head is identified by a fixed 10.

The Metrocom consoles are integrated with Motorola Centracom analog radio consoles.

Exhibit 2.1.2 - 1: Existing Radio console configurations.

Existing Radio Console Configurations		
Console #	Normal	Channel Additional Channels
0	5	1 above and below ground, 2, 3,4, low band
1	1 (primary)	4, 5, low band
2	2	3, 4, 5, low band
3	3	2, 4, 5, low band
4	Low band	1 above ground, 2, 3, 4, 5
5	4	2, 3, 5, low band
6	Backup	1 above and below ground, 2, 3, 4, 5, low band
7	1 (secondary) 2, 3, 4, 5, low band	

Console 1 is the primary console for Channel 1, with Console 7 serving as a secondary console. The backup Console 6 can be used if one of the other consoles fails, or in similar circumstances. Channels have been allocated to Muni operations departments as shown in Exhibit 2.1.2-2.

Exhibit 2.1.2 - 2: Existing Radio Channel Usage

Existing Radio Channel Usage	
Channel	Usage
1	Metro Division Equipment, Maintenance Support, Subway Support Crews, Inspectors
2	Presidio Division lines, Cable Cars, Maintenance Support, Inspectors
3	Potrero Division lines
4	Woods and Kirkland Divisions (selected lines)
5	Flynn, Kirkland, and Woods Divisions (selected lines)
Low Band	Non-revenue vehicles/support units

The Centracom consoles allow dispatchers to dynamically select and unselect incoming voice radio channel audio. A monitor button activates listening into a selected channel, and a red transmit button opens the voice path to the selected transmitter and controls transmitter keying. There are manual site select buttons which override voting and transmitter steering.

Incoming calls through voice channel signaling (which is outside of the data radio messaging in the Metrocom system) are indicated by a call light on the Centracom consoles. This is the case for incoming calls from inspectors and support vehicles which are not equipped with mobile radio communications terminals. Such calls are answered using the call Push-To-Talk (PTI) button in order to generate the continuous coded squelch (PL) tone to open the mobile or portable squelch gate. It can

Design-Build Services for the Radio System Replacement

Section 2.0

also be used to manually call a transit vehicle which has a mobile radio communications terminal; this switches the voice path to the radio speakers on the transit vehicle, as opposed to the operator handset. The dispatchers and train operators have been instructed to make calls to the operator handset, using the transmit PTT button, as opposed to calls to overhead speakers through the call PTT button. The Alert button can be used to generate an audio tone on voice channels. In addition to the transmit button, a foot switch has been installed.

The vehicles in the SFMTA fleet are as listed in Appendix Twenty Eight (28) "Cost Proposal". Exhibit 2.1.2-3 shows the results (for reference only) of a measurement of vehicular traffic over the course of two operational days. The results are correlated to five locations where base stations are called for in the Preliminary Design. These measurements did not account for portable or other subscribers.

Exhibit 2.1.2 - 3: Measured Vehicle Densities

Radio Site	GIS Area	Tuesday, September 08, 2009			Tuesday, September 08, 2009		
		7:30 – 7:31	8:30 – 8:31	9:30 – 9:31	16:30 – 16:31	17:30 – 17:31	18:30 – 18:31
Bernal Heights	BHTS70	163	133	155	137	159	136
Twin Peaks	CRS70	520	439	453	465	495	410
Forest Hill	FRHIL70	275	222	221	230	227	213
One Market Plaza	MPZA70	357	294	372	336	367	294
South Hill	SOHIL70	90	79	61	86	73	69

Radio Site	GIS Area	Wednesday, September 09, 2009			Wednesday, September 09, 2009		
		7:30 – 7:31	8:30 – 8:31	9:30 – 9:31	16:30 – 16:31	17:30 – 17:31	18:30 – 18:31
Bernal Heights	BHTS70	161	165	183	180	128	161
Twin Peaks	CRS70	501	586	547	539	417	524
Forest Hill	FRHIL70	261	304	275	253	202	287
One Market Plaza	MPZA70	336	404	419	401	273	361
South Hill	SOHIL70	87	102	83	94	67	101

The site contours for each of the GIS Areas are contained in Appendix Thirty Nine (39). "Original GIS data files will be provided upon request of the Qualified Proposers.

2.1.3 Existing Underground Network

The SFMTA underground is supported by multiple base station sites feeding radiating cable through the tunnels. The lengths of the tunnels are found in the reference drawings in Appendix Twenty (20) "Existing Underground Communications Drawings".

A bi-directional amplifier exists at one station. All underground base and repeater stations transmit simultaneously on each channel, but are not synchronized together or with the above-ground stations on the same channel. As a result, significant interference occurs at portals and around the intersection of two radiating cable feeds.

Each of the underground repeaters connects with Central Control via the SFMTA analog telephone circuits. The Remote terminal Units (RTUs) utilized leased analog circuits. Station receivers connect to a receiver multicoupler. Each transmitter connects to a transmitter combiner. The combiner and

Design-Build Services for the Radio System Replacement**Section 2.0**

multicoupler output/input ports then connects to the primary, two-way (three port) RF power splitter. At stations with single bores, radiating cables connect to each splitter port and are routed down the tunnels in each direction. Two-bore stations use a secondary RF power splitter, resulting in four ports and four radiating cables. The repeaters, RTU and multicoupler are connected to backup batteries present at each site.

The Embarcadero station is served by a bi-directional amplifier (BOA) system. This BOA supports this station and the Muni turnaround. It connects to radiating cables originating at the Montgomery Station, amplifies all signals (in both directions) to support additional radiating cable.

Due to the close frequency spacing at 480 MHz, significant filtering is necessary on either side of the amplifier. These filters are housed in large cabinets. This isolates signals flowing in opposite directions and reduces mutual-interference. Due to the extreme filtering requirements, these cabinets require considerable space.

2.2 Statement of Work**2.2.1 System Design**

The Contractor shall design, furnish, and install a turn-key voice and data radio communications system required to implement the PSVRN and MTMS described in Appendix Twelve (12), Section Three (3) "Intelligent Transportation System Components" and to fully comply with the system performance requirements.

This document provides a preliminary system design for the radio communications components for the PSVRN and MTMS.

The drawings in Appendix Nine (9) depict the existing conditions at the radio sites and vehicles.

The Contractor shall supply a fully integrated radio system that is capable of providing the following functions:

- Trunked Phase II, P25 TDMA operation
- Trunked voice communications for the SFMTA transit users and other CCSF users
- Proven integrated transit voice and data communications for the MTMS
- Support for P25 operational dispatch consoles capable of supporting the CSSI P25 standard interface at the OCC at 1455 Market Street and other Project and City sites.
- The contractor can provide consoles that support CSSI as the finalized standard and products become available.
- Geographically redundant prime site controller system controllers and console controllers
- Interoperability with other City, County and State government and public service agencies using the ISSI P25 standard
- Provide radio communication services to the SFMTA Security.

If the Contractor cannot provide a Phase II P25 TDMA functional system meeting the schedule constraints of the Project, the Contractor must first notify SFMTA of such condition and request schedule relief. If approved, the Contractor must still provide a Phase I P25 FDMA functional system on schedule and a Phase II P25 TDMA functional system at an agreed upon future date at no additional cost to SFMTA.

Design-Build Services for the Radio System Replacement**Section 2.0**

Upon delivery, the system shall be designed and equipped to include five (5) 800 MHz (License call signs are WQKE739, WQKE988) and nine (9) 700 MHz channels (License call sign is WQMJ646) to support the MTMS and PSVRN. The 700MHz channels shall be used for voice applications. The 800 MHz channels shall be used for data or voice applications. The APCO Region 6 700 MHz committee has determined that the 700MHz band shall be used strictly for voice operations. If the contractor wants to work with the Region 6 committee to allow for both voice and data operations, contractor will coordinate with the SFMTA to support license revisions.

The system shall also be designed and installed to be immediately expandable to eight (8) additional 700 MHz channels (License call sign is WQOA369) which shall be used to accommodate the additional CCSF users in the PSVRN. The design shall only include, at a minimum, wired and configured racks/cabinets, additional ports for the multi-coupler, and combiner space. The installation of the additional infrastructure components, such as base stations, comparator sizing, and professional services for setup/installation has been identified individually as line items in the Cost Proposal Form. These eight (8) channels shall not be counted as part of the 25% growth. The 25% growth shall be based on seventeen (17) 700MHz and five (5) 800MHz channels.

The system shall be designed for a 25% growth. The Contractor shall design the system to allow for an upgrade path to meet this growth requirement. Growth is defined as providing the necessary rack and floor space for the installation of any necessary equipment required for the expansion.

The Contractor's design shall identify space in a rack of similar kind of equipment. The growth calculation shall not be the summation of all available rack space in the initial implementation. Growth shall be calculated based on the space need to expand to the 25% growth figure.

The Qualified Proposer shall describe how they will meet the required growth [CDRL 12-2-1 System Growth Plan]. This expansion will accommodate growth in, at a minimum:

- Channels
- System
- Fleet size.

2.2.2 Cost Proposal Form Configurations

For purposes of developing the Cost Proposal, the combined MTMS and PSVRN system listed in the Cost Proposal shall have:

- Six (6) 800 MHz MTMS data/voice channels
- Nine (9) 700 MHz P-25 compliant PSVRN transit voice channels
- Eight (8) 700 MHz P-25 compliant PSVRN voice channels for use by the City (Option).

2.2.3 Use of Additional or Alternate Sites (Section deleted)**2.2.4 Site Selection**

The Proposal shall include system coverage maps showing both mobile voice, mobile data and portable talk-in coverage for each of the proposed five (5) sites. The coverage maps shall, at a minimum, provide:

- The area coverage percentage provided
- The receive sensitivity used in the calculation

Design-Build Services for the Radio System Replacement

Section 2.0

- The body loss value used in the calculation.

Any proposed design deviation from the previously listed sites shall be justified in portable, voice, and mobile data coverage maps.

Radio Sites

The SFMTA has identified (5) five sites that the Contractor shall use in designing the system.

The communication sites:

Bernal Heights

- Lat/Long: N37°44'35.10, W122°24'54.00
- Tower Height: 70.9 Ft AGL

Forest Hill

- Lat/Long: N37°44'55.00, W122°27'59.00
- Tower Height: 86.9 Ft AGL

One Market Plaza

- Lat/Long: N37°47'36.12, W122°23'39.66
- Tower Height: 589.9 Ft AGL

South Hill

- Lat/Long: N37°42'14.00, W122°25'45.00
- Tower Height: 40.0 Ft AGL

CRS Twin Peaks

- Lat/Long: N37°45'16.74, W122°26'47.88
- Tower Height: 190 ft AGL

Clay/Jones (potential alternative/additional site, currently intended for cable car machinery maintenance operations)

- Lat/Long: N37°47'35.04, W122°24'50.94

The Operations Control Center control point sites include:

- 1455 Market Street, San Francisco
- 131 Lenox Way, San Francisco

2.2.5 Drawings

The thirty-five (35%) percent preliminary engineering drawings are included in Appendix Nine (9). The Contractor may, but is not required, to use these drawings as a basis for the 100% drawings. The Contractor shall be responsible for advancing drawings to one-hundred(100%) percent for construction and permitting.

Design-Build Services for the Radio System Replacement**Section 2.0****2.2.6 Propagation Analysis**

Appendix Nine (9) includes site propagation maps for each of the SFMTA selected sites. This analysis utilizes parameters for portable talk-in. The Contractor shall be responsible to meet the coverage requirements as established in this RFP. It shall be the Contractor's responsibility to design, procure, and install all equipment necessary to meet the coverage requirements for any changes made after Contract award.

As part of the Proposal, Qualified Proposers shall submit the following coverage maps [PRL 12-2-1 Coverage Maps]:

- Portable talk-in for each site
- Portable talk-out for each site
- Portable talk-in Composite
- Portable talk-out Composite
- Mobile data talk-in for each site
- Mobile data talk-out for each site
- Mobile data talk-in Composite
- Mobile data talk-out Composite
- Portable talk-in underground
- Portable talk-out underground.

SFMTA believes there are existing coverage deficiencies along M Line transit routes in the area bounded by 19th Avenue to the west, Holloway Avenue to the north, and San Jose Avenue to the east and south. This issue is summarized along with test results in Appendix Thirty Seven (37) Park Merced Area M-Line Technical Memorandum.

Qualified Proposers shall submit an assessment and description of how this coverage issue can be mitigated and/or improved. [PRL 12-2-21 Park Merced M-Line Coverage Improvement].

2.2.7 Interference Analysis

The Contractor shall conduct an intermodulation analysis for each radio site to determine potential intermodulation products (1M study) and provide the proper equipment to protect the SFMTA, CCSF, and others at the site from intermodulation interference [CDRL 12-2-2: Intermodulation Analysis]. The study shall consider all appropriate site transmitters, the SFMTA receivers, and CCSF receivers.

The Contractor shall be responsible for its resolution if the equipment supplied under this contract is found to be the source of such interference at any site. If the Contractor's equipment is limited to contributing to such interference, the Contractor shall assist with identifying the source of its contribution and make all necessary changes or modifications to reduce its susceptibility and impact.

Interference in this case is defined as a degradation of effective receiver performance by 1 dB or greater. Interference includes Passive Intermodulation (PIM) interference, which must be kept 10 dB below the noise floor of all co-located receivers.

The Contractor shall provide an interference analysis at the tunnel portals and air vent openings in the tunnels [CDRL 12-2-3: Tunnel Interference Analysis].

Design-Build Services for the Radio System Replacement**Section 2.0**

The Contractor shall provide a Time Domain Interference Analysis for the system. [CDRL 12-2-4: Time Domain Interference analysis for the system]

2.2.8 Radio Traffic Analysis

A traffic analysis report was performed on the existing system in 2008. This analysis was used to determine preliminary voice and data loading. This report confirmed that nine (9) 700 MHz and five (5) 800 MHz channels were the minimum number of channels required for the expected grade of service. Please refer to Appendix Nineteen (19), "Radio Traffic Analysis Report", for additional information.

The Grade of Service for the system shall be 1.00% or less with a maximum queue time of 5.0 seconds for those call attempts that do not connect on the first attempt. 99.0% of the calls shall complete in less than 1.25 seconds during the busy hour from the initiation of a push-to-talk. During the design phase, available spectrum and capacity will be analyzed to meet the traffic loading.

The Contractor shall be responsible for the GOS of the system. As such, Qualified Proposers shall review the 2008 traffic study report. If, after this review, they do not concur with the results from the 2008 report, the Qualified Proposer shall provide alternatives to achieve the specified GOS. The Contractor shall provide the assumptions made as part of their air-time analysis [CDRL 12-2-5 Air Time Traffic Analysis Report). These assumptions shall include mean call duration and call arrival rate for all call types, percentage of each call type, and drop time (of message trunking used).

2.3 Radio System Performance Requirements

This section includes the system performance requirements for a new 700/800 MHz radio system to provide radio communications for the SFMTA and other City and County of San Francisco users within the defined service area. The requirements covered include:

- System availability
- Reliability
- Interference
- Malfunctions
- Coverage requirements
- Site selection requirements.

The acceptance testing required to demonstrate compliance with the performance requirements are discussed in Appendix Twelve (12) Section Seven (7) "Testing and System Acceptance".

2.3.1 Radio System Availability

System availability criteria is discussed in Appendix Twelve (12) Section One (1), "General Requirements".

2.3.2 System Unavailability

System unavailability criteria is defined in Appendix Twelve (12) Section One (1), "General Requirements"

2.3.3 Network Access Reliability

Network access reliability refers to likelihood that a subscriber will gain network access for:

- Subscriber registration to the system

Design-Build Services for the Radio System Replacement**Section 2.0**

- An individual voice or data message, in a specified period of time, in an environment with no message contention and having reliable signal strength.

It is intended to verify basic network reliability and performance, including the effects of simulcast (if applicable) on access. The successful system design shall have a system registration interval of less than 2 seconds, in 99% of attempts. No less than 0.01 % of voice message access shall exceed one second from initiation of a push-to-talk.

This performance applies to all subscriber and dispatch workstation equipment supplied.

If the SFMTA experiences network access reliability problems, the Contractor shall perform statistically-valid tests to verify the network meets these requirements at no cost to the SFMTA. The Contractor shall be responsible for correcting the problem at no cost to the SFMTA, if such performance problems contribute in a significant way to delays in final system acceptance,.

2.3.4 Nuisance Malfunctions and Failures

Nuisance problems are recurring operational or functional problems that cause systems or equipment that do not provide the degree of reliability necessary for the SFMTA operations. These types of failures shall not cause the SFMTA to assign significant resources (the SFMTA or staff) to resolve on three or more occasions, on similar models of equipment. Such problems may not reach a formal unavailability threshold described in Appendix Twelve (12) Section One (1), "General Requirements".

Nuisance problems can be caused by software, firmware, or hardware that is faulty or improperly engineered, manufactured or installed.

The Contractor shall be responsible for resolving nuisance problems promptly and at no cost to the SFMTA.

2.3.5 System Failure Modes

Upon failure of the control channel at a site, if appropriate, the system shall automatically reassign the control function to another radio channel. The system shall restore normal operation at the site within two (2) seconds. If a control channel is not utilized as part of the system architecture, the same reassigning of the control function within ten (10) seconds is required.

In the event a portion of the system at a repeater site fails (for example, a voice or data channel repeater transmitter or receiver), the network management system (NMS) shall detect and alarm the failure. The network management shall notify the maintenance and radio dispatcher workstations within ten (10) seconds. The NMS shall not select a defective channel for use, but shall continue to assign traffic to the remaining operating channels.

The system shall provide continued operation in trunking mode upon failure of a remote site Controller or the radio network controller. The Contractor shall furnish a redundant radio network controller, installed at a geographically diverse location, to meet these failure mode operational requirements. The Contractor shall design the system to prevent any single point catastrophic failure of the system or any site.

The Contractor shall design the system for continued operation if the trunking component should fail. This continued operation may be a conventional fallback mode in the event of such failure. For operation in the conventional mode, mobile and portable units shall be pre-programmed to designated channels, and the control stations shall have direct access to predetermined channels.

The Contractor shall provide redundant servers that meet the following failure mode operation requirements:

Design-Build Services for the Radio System Replacement

Section 2.0

- Catastrophic failure of the structure that houses the controller and associated equipment due to fire or earthquake or some other failure mode.
- Failure of the signaling and control system that causes a complete loss of trunking capabilities. The system shall provide, within one minute, an indication in all radio units, at the NMS, and at all dispatcher stations of the failure of trunking. In this event, the system shall automatically switch all elements of the system to conventional mode of operation.
- For equipment that is purchased off the shelf, network management shall be supported as provided by these systems.

All processors, devices, and on-line and background functions in the SFMTA radio system shall be monitored for fatal and recoverable errors. All errors shall be recorded for later review by maintenance personnel and shall be included in the error statistics displays and reports provided by the system manager's software. Each type of error for each device (for example memory access Violation, device reply time-out, or message checksum error) shall be recorded separately and stored for diagnostic review.

Qualified Proposers shall explain the following [PRL 12-2-2 Failsoft Operation Description]:

- What failsoft operation is
- How the system can fall into failsoft operation
- What impact failsoft operation has on the subscribers.

Qualified Proposers shall explain the various fallback modes of operation of the proposed system design, from full system functionality to the least system functionality that will support the SFMTA's communications needs [PRL 12-2-3 Failure Scenario Descriptions]. Explain how the system design is such that the possibility of the SFMTA experiencing a complete failure of radio coverage in any part of the SFMTA system is reduced to a minimum. Respond to, at least, the following failure scenarios and explain how the system design mitigates these failures. Also explain the impact that each failure would have at the site level, simulcast zone level and system level.

Lightning Damage at the Site - describe the impact that a lightning strike would have on the tower top amplifier, the antenna, RF transmission line and base station.

Site Problems - describe the impact of the following:

- a failed base station(s), a multicoupler or combiner failure.
- failure of the site controller to the functioning of the site and overall system.
- failure of the multiplexer supporting the simulcast system, GPS timing failure, or if the simulcast control fails.
- failure of the control channel.

Network Management Failure:

- failure of power at the site and at the cabinet level to the network management equipment.
- failure of modules or sub-component for the audio and control connections to the sites, logging recorders and dispatch consoles.
- failure of the system controller.

Design-Build Services for the Radio System Replacement**Section 2.0**

Simulcast Components - Describe the impact of the failure of anyone or all of the following components/modules: common control, T1 delay, synch, resynch and GPS timing distribution.

Geographic Redundancy - Describe how your system design integrates geographic diversity to minimize downtime due to catastrophic failure of a site or equipment room.

Qualified Proposers shall explain the back-up power system will operate at the sites and control centers and under what conditions will the designed back-up system be activated [PRL 12-2-4 Backup Power Systems Description).

The Contractor shall provide a complete description and failure modes analysis for the LMR systems supporting the MTMS and PSVRN [CDRL 12-2-6 Failure Modes Analysis).

2.3.6 Radio Propagation Coverage Requirements

The following section defines the coverage performance requirements for the radio system. These requirements shall be verified by the Coverage Acceptance Test Plan (CATP). An example CATP can be reviewed in Appendix Seventeen (17) "Example Coverage Test Plan". The Contractor and the SFMTA shall finalize the CATP for a contract deliverable.

The Contractor shall provide the following coverage analyses [CDRL 12-2-7 Coverage Analyses]:

- Portable talk-in for each site
- Portable talk-out for each site
- Portable talk-in Composite
- Portable talk-out Composite
- Mobile data talk-in for each site
- Mobile data talk-out for each site
- Mobile data talk-in Composite
- Mobile data talk-out Composite
- Portable talk-in Tunnel(s)
- Portable talk-out Tunnel(s).

Qualified Proposers shall provide their coverage models based on the five (5) sites identified in Appendix Nine (9) and the underground areas described in Appendix Twenty (20) [PRL 12-2-5 Coverage Models].

Along with the coverage maps, Qualified Proposers shall discuss the following issues:

- The coverage tool used to determine the aboveground models
- The coverage tool used to determine the below ground models
- Define the following values used in the coverage prediction models:
 - Receive antenna height per site
 - Land use and land clutter values
 - Body loss ERP per site

Design-Build Services for the Radio System Replacement

Section 2.0

- Antenna types that were used
- Antenna down-tilt used
- Minimum receive signal to achieve DAQ 3.4/BER <2%
- Mobile antenna height
- Portable antenna height.

RF Coverage Service Areas

For the purposes of RF Coverage requirements, predictions, and Coverage Acceptance Testing; the coverage service area shall be defined as follows:

- 1) For all voice and data communications above ground level, the service area shall be defined as the geographical boundary of the City and County of San Francisco
- 2) For all voice and data communications below ground level, the service area shall be defined as one or any combination of the following:
 - A transportation tunnel
 - A tunnel portal
 - Station concourse (mezzanine)
 - Station platform level
 - Station escalators
 - Station interior floor area

The coverage service area for both mobiles and portables above ground shall be the same.

Critical Locations

Certain locations shall be considered critical to the SFMTA's operations and must be included within the mobile data coverage, underground voice/data coverage, and portable service coverage areas described below. Acceptance criteria and additional critical locations shall be analyzed in the detailed design review. The locations include:

1. The complete length of Market Street Tunnel including the following stations (see Appendix Thirty Eight (38) Muni Metro Underground Stations):
 - Embarcadero station concourse (mezzanine) and platform levels
 - Montgomery station concourse (mezzanine) and platform levels
 - Powell station concourse (mezzanine) and platform levels
 - Civic Center station concourse (mezzanine) and platform levels
 - Van Ness station concourse (mezzanine) and platform levels
 - Church Street station concourse (mezzanine) and platform levels
 - Castro Street station concourse (mezzanine) and platform levels
 - All Market Street Tunnel crossovers

Design-Build Services for the Radio System Replacement

Section 2.0

- Locations specified in Appendix Thirty-Two (32) Metro Subway Tunnel Crossover, Passages and Emergency Exits
2. The complete length of Twin Peaks Tunnel including the following stations:
 - Forest Hill station concourse (mezzanine) and platform levels
 - West Portal station platform level and Portal
 - All Twin Peaks Tunnel crossovers
 - West Portal Avenue between Sloat and Ulloa
 3. The complete length of Sunset Tunnel and Portal
 4. The complete length of Stockton Tunnel
 5. The complete length of Broadway Tunnel
 6. The complete length of Mac Arthur Tunnel
 7. The complete length of Yerba Buena Tunnel
 8. Cable car routes and on the street above the following cable car machinery sheave pits throughout the cable car service area as follows (Please refer to Appendix Thirty-five (35) for a schematic map of the cable car sheave pits):

(HARRIS NOTE: App35 references below. #9-Operation Central Control not listed below.)

- Sheave pit at Eddy and Powell (approx. 2 Powell St) (JC NOTE: App35, #6)
 - Sheave pit at Washington and Powell (approx. 1090 Powell) (JC NOTE: App35, not shown)
 - Sheave pit at Bay and Taylor (approx. 2490 Taylor) (JC NOTE: App35, #8)
 - Sheave pit at Van Ness and California (approx. 1690 California St) (JC NOTE: App35, not shown)
 - Sheave pit at Hyde and California (approx. 1390 California St) (JC NOTE: App35, #4)
 - Sheave pit at Mason and California (approx. 992 California St) (JC NOTE: App35, #3)
 - Sheave pit at Drumm and California (approx. 2 California St) (JC NOTE: App35, #2)
 - Sheave pit at Pacific and Hyde (approx. 1577 Hyde St) (JC NOTE: App35, #5)
 - Sheave pit at Beach and Hyde (approx. 2824 Hyde St) (JC NOTE: App35, not shown)
 - Sheave pit at Victoria Park (approx. 2897 Victory Park) (JC NOTE: App35, #7)
 - Cable car barn (in-building coverage with exception of basement) (JC NOTE: App35, #1)
9. Presidio Division and yard
 10. Potrero Division and yard
 11. Woods Division and yard
 12. Kirkland Division and yard
 13. Flynn Division and yard

Design-Build Services for the Radio System Replacement

Section 2.0

14. Green I Geneva Division and yard
15. Muni Metro East and yard
16. Islais Creek Facility and yard (planned)
17. Scott Facility for Non-revenue vehicles
18. Duboce Portal
19. Ferry Portal
20. Eureka Portal
21. Muni Metro Turnaround
22. Justin Herman Vent Shaft
23. 4th Street Bridge, 150 feet southeast of the 4th Street and King Platform
24. Islais Creek Bridge, 400 feet south of the Marin Street Platform
25. Park Merced apartments for Line # 88 and Line # 17
26. 4th Street and King Street
27. Transbay Terminal
28. 19th Avenue at San Francisco State University.
29. Routes 19 Polk, 29 Sunset, 23 Monterrey, and the 56 Rutland where they serve the Bayview Hunters Point redevelopment area
30. The following locations related to the Central Subway Project:
 - FBS (Fourth/Brannon Station), Freelon / Fourth (On Fourth St, North of Brannan)
 - PORTAL, Perry / Fourth
 - Moscone (MOS), Clementina / Fourth
 - Union Square/ Market Street (UMS), Between Geary and Ellis on Stockton
 - Chinatown (CTS), Washington / Stockton
 - Retrieval Shaft, Union / Columbus

Land Mobile Radio Service Area

The coverage service area reliability is the probability of achieving the desired delivered audio quality (DAQ) and Bit Error Rate (BER) over the defined service area (reference TIA/EIA/TSB88-A-1).

The Contractor shall design and implement a voice radio system that provides a mobile coverage service area reliability greater than 95.0% for a channel performance criterion BER = 2.0% at vehicle speeds from 5 to 50 mph with a confidence level of 99% and a confidence interval not greater than \pm 1.0 dB for inbound communications. The coverage service area is defined as the jurisdictional boundary of City and County of San Francisco (see Appendix Nine (9))

The coverage service area for portable and mobile data are the same.

The required SFMTA service area generally corresponds to the SFMTA service territory, with some exceptions.

Design-Build Services for the Radio System Replacement**Section 2.0**

There are three (3) main categories of coverage requirements within the service area: mobile data coverage service area, underground voice/data service area and portable outdoor coverage service requirements.

The following sections define the coverage requirements for each category.

Mobile Data Coverage Service Area Reliability

The Contractor shall design and implement a system that provides talk-back mobile data outdoor coverage with a 95.0% service area reliability at 2% Bit-Error-Rate (BER) (reference TIA/EIA/TSB88-C) or better throughout the mobile coverage service area.

Data coverage shall provide a 95.0% Message Success Rate (MSR) at vehicle speeds from 5 to 50 MPH with a confidence level of 99.0% for both the inbound and outbound directions. A successful message is defined as having error-free header/routing and payload information, or can be correctable to be error-free, as far as the messaging system is concerned on data channels, based on the fleet polling rate required. The Contractor may recommend a comparable or equivalent test procedure to be mutually agreed upon during the design phase.

Underground Voice/Data Coverage Service Area Reliability

The Contractor shall design and implement a voice radio system that provides a mobile coverage service area reliability greater than 97.0% for a channel performance criterion BER = 2.0% at vehicle speeds from 5 to 50 mph with a confidence level of 99% and a confidence interval not greater than ± 1.0 dB for inbound communications.

Data coverage shall provide a 97.0% Message Success Rate (MSR) at vehicle speeds from 5 to 50 MPH with a confidence level of 99.0% for both the inbound and outbound directions. A successful message is defined as having error-free header/routing and payload information, or can be correctable to be error-free, as far as the messaging system is concerned on data channels, based on the fleet polling rate required. The Contractor may recommend a comparable or equivalent test procedure to be mutually agreed upon during the design phase.

The Contractor shall design the system to minimize, to the greatest extent possible, any Time Domain Interference (TDI) at the portals to the tunnels and at the vent openings to the underground tunnel.

Portable Service Coverage Area Reliability**Portable Radio Coverage Service Area Reliability (Above Ground)**

All portable coverage shall be based on a half-wave (~ 6") antenna mounted on the portable with the portable worn in a case on the hip with a body loss of 12.4 dB for coverage in the inbound direction. The contractor can recommend a body loss prediction to meet the expected coverage requirements.

The Contractor shall design and implement a voice radio system that provides a portable inbound coverage service area reliability greater than 85.0% for a channel performance criterion BER = 2.0% with a confidence level of 99% and a confidence interval not greater than ± 1.0 dB.

Cable Car routes are an exception to the 85.0% requirement for inbound portable coverage and consequently all Cable Car routes shall have a service area reliability for portables inbound greater than 95.0% for a channel performance criterion BER = 2.0% with a confidence level of 99% and a confidence interval not greater than ± 1.0 dB for in-vehicle (wooden open structure) portables along all cable car routes.

Design-Build Services for the Radio System Replacement**Section 2.0****Portable Radio In-Vehicle (10 dB loss) Coverage Service Area Reliability (Above Ground Revenue Vehicles)**

This requirement is for fare inspectors and maintenance personnel using portables on-board surface revenue vehicles as vehicle operators on these vehicles have access to a mobile radio. Based on this requirement, the configuration for the portable for in-vehicle (10 dB loss) coverage shall consider the portable hand-held at the head level.

The portable shall be based on a half-wave (~ 6") antenna mounted on the portable.

The Contractor shall design and implement a voice radio system that provides a portable inbound coverage service area reliability greater than 85.0% for a channel performance criterion BER = 2.0% at vehicle speeds from 5 to 50 mph with a confidence level of 99% and a confidence interval not greater than ± 1.0 dB including an additional 10.0 dB loss for vehicle penetration. This applies to surface revenue vehicles only.

Portable Radio Coverage Service Area Reliability (Below Ground)

The Contractor shall design and implement a voice radio system that provides a portable inbound on-vehicle coverage service area reliability greater than 95.0% for a channel performance criterion BER = 2.0% at vehicle speeds from 5 to 50 mph with a confidence level of 99% and a confidence interval not greater than ± 1.0 dB.

Portables used underground and inside SFMTA facilities by maintenance and security personnel shall be considered to have a surface speed of 2.0 mph.

The Contractor shall use a body loss of 12.4 dB at the hip and 9 dB for at the head loss power calculations. The contractor can recommend a body loss prediction to meet the expected coverage requirement.

Coverage Service Area Calculation and Documentation

The Contractor shall provide radio coverage predictions using a radio wave propagation model as recommended in the TIA/EIA-TSB88. The Contractor's radio wave propagation model shall be subject to SFMTA approval. If multiple models are used to generate a composite prediction, then a detailed explanation shall also be included.

The Contractor shall take into account terrain irregularity, foliage, urban clutter, noise, and long- and short-term signal variations. The Contractor shall quantify the digitized land use/land cover (LULC) database used for the predictions, including the metadata for the terrain and LULC (i.e., resolution, projection, date, etc.). If there are any areas included in the coverage model that uses terrain data or LULC data that is "digitized" at different levels (e.g. a portion of the CCSF contains 100-meter data while the rest of the county contains 30-meter data), then the Contractor shall indicate such variances.

The Contractor shall incorporate as part of the RF coverage predictions regional frequency plans that outline rules affecting RF coverage in the areas of frequency allocation, effective radiated power, channel spacing, channel bandwidth, and other spectrum related parameters.

The Contractor shall provide a complete listing of all site, component, and system parameters used to calculate and generate the predicted RF coverage. These include, but are not limited to the following:

- Link budget and system loss/gain figures for each proposed RF site by supplying a table or drawing listing all relevant parameters
- System gains

Design-Build Services for the Radio System Replacement**Section 2.0**

- System losses
- Signal strength
- Receiver sensitivity assumptions.

The Contractor shall indicate if the design includes a handover threshold for RF site switching as part of the system design, referenced in dBm.

The Contractor shall provide prediction maps indicating the sought coverage requirements. The Contractor shall provide individual prediction maps for each proposed RF base site location highlighting mobile data and portable coverage requirements. The Contractor shall provide a composite prediction map for the complete service area indicating all associated coverage requirements. The Contractor shall provide composite prediction maps for the interoperability system indicating associated coverage requirements.

Prediction maps shall indicate county borders, including adjacent counties, RF base site location(s) and Time Domain Interference (if applicable). The Contractor shall provide a graphical representation of the areas that fall below the radio coverage requirements on the coverage prediction maps.

The Contractor shall provide at least one set of RF coverage prediction maps on D-Size (24" X 36") paper at a scale such that the SFMTA jurisdictional service boundary fills the entire page.

The maps shall depict individual sites, non-simulcast sites, a simulcast composite map and an interoperability coverage composite (as applicable). These maps shall be used as reference documentation. The SFMTA requires maps that show sufficient detail to allow for the identification of known landmarks (i.e. road intersections or rivers). The RF coverage prediction maps shall include a legend highlighting all information represented on the map. The Contractor shall include coverage prediction maps depicting coverage that would result if an event caused any (each) of the transmit/receive sites to be destroyed.

Coverage maps shall be provided using the SFMTA's base map and overlaying the coverage plots to produce the coverage maps. These maps shall be provided in a scale and resolution such that all areas with reliabilities less than that required as clearly shown.

The SFMTA has identified problem areas where coverage is deficient and improvement is required. Such areas include, but are not limited to, the area near the Park Merced Apartments, West Portal Station, 4th and King, Castro Station/Eureka Portal, Van Ness crossover, Muni Metro turn-back Vent Shaft, Ferry Portal, West end of Sunset Tunnel, Church and Duboce, Transbay Terminal, Cole (Sunset Tunnel), Sunset (most areas), and 19th Avenue at San Francisco State University.

All coverage guarantees and field coverage verification/acceptance testing shall be based on the guaranteed vehicle radio specifications (not typical specifications), such as shown in equipment technical cut sheets. This coverage criterion is applicable for talk-out (base-to-mobile; downlink) and talk-in (mobile-to-base; uplink), for all channels provided by the Contractor.

Radio Coverage Outside of the Service Area

The SFMTA operates routes in several areas not shown as part of the Service Area illustrated in Appendix Nine (9), "Drawings". This includes Route 108: Treasure Island, Route 76: Marin Headlands, and La Honda Youth Detention Center Shuttle to San Mateo County. These routes are not in the service area and may not be included within the scope of the Project. The routes may be considered separately by the SFMTA in the future.

Design-Build Services for the Radio System Replacement**Section 2.0**

Coverage of the entire southern route in San Mateo County using the SFMTA's tower sites is not required. However, service access could be accomplished through the use of the Project 25 ISSI (Inter-RF Sub-System Interface). The County of San Mateo is planning to construct a Project 25, 700 MHz network which may provide coverage to large portions of this southern route, and it is anticipated that San Mateo County will implement ISSI. The Contractor's design shall permit SFMTA's future implementation of ISSI to be interfaced with the County of San Mateo's to provide this coverage. This would allow the SFMTA users on this route to switch to the San Mateo County network when necessary and the ISSI would convey the voice message back to the SFMTA network."

2.3.7 Link Budget Analysis

As part of the Qualified Proposer's Proposal and Contractor's design submittal a detailed link budget analysis of above ground and underground shall be provided for the proposed radio system showing the following assumptions to establish measured talk-in, talk-out portable radio signal levels corresponding to the criteria specified in the "Radio Propagation Requirements" section [PRL 12-2-7 Link Budget Analysis]:

- Guaranteed static sensitivity for mobile and portable radios (dBm), and corresponding SINAD (analog) and/or BER (digital) performance
- Faded sensitivity for mobile and portable radios (for DAQ 3.4) in dBm, and corresponding SINAD (analog) and/or BER (digital) performance
- Statistical distribution assumed for multipath fading (Rayleigh, Nakagami-Rice, etc.).
- Statistical assumptions used to account for location variability (i.e. adjustment from a median reliability value of 50% in a given coverage sector or grid segment to provide reliable operation at 95% of the locations in that sector or grid segment).
- Transmit antenna system gain (dBd)
- Transmission antenna system loss (dB)
- Base Station Receiver Multi-coupler Net Gain (dB)
- Base Station Receiver Multi-coupler Noise Figure (dB)
- Mobile radio antenna system net gain (dB)
- Mobile radio transmitter output power (dBm).
- Portable radio antenna system net gain (or loss), including body losses for at the hip level operation, as described above (dB)
- Portable radio transmitter output power (dBm)
- Assumptions regarding talk-out and talk-in path reciprocity (e.g. any offset factor used to compensate for the difference between talk-out and talk-in coverage and to allow talk-out signal targets and acceptance test procedures to be used to confirm talk-in coverage reliability.
- Assumptions regarding any difference between talk-out and talk-in transmission paths and system performance that may affect the validity of the assumption of path reciprocity with an offset for the difference in base station and mobile and/or portable radio transmitter output power, as described in TIA TSB-88, Section 5.7.3.4, Talk-Out vs. Talk-In Testing.

Design-Build Services for the Radio System Replacement**Section 2.0**

- RF propagation prediction model (including version number, if applicable) used to provide coverage predictions. The method of verification of the above coverage criteria is described in "Radio Propagation Requirements" section.
- All of the Qualified Proposer's shall submit talk-in coverage maps for the proposed system shall be based on the calculated link budgets which indicate this is the limiting link in the Qualified Proposer's design. If this is not true then both talk-in and talk-out coverage maps are required for each coverage type. All coverage maps shall be based on the assumptions shown in the link budget analysis described above.

The Contractor shall provide a complete link budget analysis with the above specified information for the entire system including [CDRL 12-2-8: Link Budget Analysis]:

- Underground, portable to donor antenna
- Above ground, base station to portable.

2.4 System Requirements

The radio communication system shall be designed to meet the needs of both the PSVRN and MTMS. The PSVRN is an interoperable Phase II, Project-25 compliant voice radio system for joint use by the selected SFMTA staff and City and County of San Francisco public works employees (Department of Public Works, Port of San Francisco, and Department of Building Inspection). The MTMS shall include but not be limited to, digital trunked voice and data communications for all transit operations, computer aided dispatch, automatic vehicle location, integrated incident management/reporting, single-point logon for revenue vehicles, and on-board ADA compliant traveler information. It is understood that the MTMS may operate independently of the PSVRN but, that they are fully interoperable with each other.

Transit operations includes all Muni fleet modes, including light rail vehicles, cable cars, historic rail vehicles, electric trolley buses, motor coaches, and selected non-revenue vehicles. The new radio systems will also provide radio services to Muni operations and maintenance personnel who use handheld mobile radio and/or handheld mobile data devices.

The radio system implementation will achieve the following goals:

- Turn-key implementation of the design and construction of the system
- Designed for no single fault failures that would create a catastrophic system failure
- Redundancy of major sub-components
- Optimally efficient frequency utilization
- High hardware and software availability, reliability and survivability
- Easily maintainable, upgradeable, expandable systems
- Improved overall coverage with no geographic restrictions between and among mobile and handheld radio units than the current system
- Up-to-date technology with digital infrastructure
- Open architecture interface(s) to neighboring systems
- Communications backbone compatibility of a wireless Intelligent Transportation Systems (ITS) consistent with the San Francisco Bay Area's ITS Regional Architecture

Design-Build Services for the Radio System Replacement

Section 2.0

- Increased capacity to support voice and data transmission requirements
- Improved operational efficiency and flexibility in communications systems
- Flexibility and simplicity in creating and maintaining multiple talkgroups
- Integration into the regional P25 voice and data core network, if applicable
- Communications interoperability with the City and County of San Francisco Department of Emergency Management's radio systems and other regional public safety services
- Capability to interface with the other SFMTA information technology systems
- Fully integrated radio communications within the existing and planned SFMTA infrastructure
- Record talkgroups and dispatch radio and telephone conversations
- Capability to rapidly transition to a future backup Operations Control Center

The radio system shall provide all equipment, software, and services for the turn-key operation of the voice and data communications for the PSVRN and MTMS users operating in the SFMTA's service area.

The Contractor shall be responsible for the integration and operation of all equipment and subsystems provided by the Contractor, regardless of manufacturer.

The Contractor shall provide a complete set of LMR system drawings, including but not limited to [CDRL 12-2-9: LMR System Drawings]:

A. System drawing

B. Site drawings per radio site:

1. Site location
2. Floor plan
3. Equipment Rack-up
4. Tower drawings
5. Designed electrical (primary and secondary power)
6. Designed grounding
7. Site modification drawings
8. Tower drawing with antenna placements

C. Prime Site drawing

1. Floor Plan
2. Equipment rack-up drawing

D. Network drawing

E. Dispatch Drawing

1. Console control and associated equipment rack-up
2. Console control and associated equipment floor plan

Design-Build Services for the Radio System Replacement

Section 2.0

3. Console floor plan F. Antenna System

F. Antenna System

1. Antenna system per site
2. Antenna support for each tower

3. Grounding

2.4.1 Interoperability

To support the region's future interoperability goals, the PSVRN shall support all P25 interoperability standards and capabilities consistent with TIA 102 standards.

The PSVRN shall be capable of providing the SFMTA and CCSF subscribers interoperability to city, local, county, state and Federal agencies. The Qualified Proposer shall discuss how interoperability shall be provided in this system [PRL 12-2-6 Interoperability Design].

The Contractor shall include an open architecture system to system interface as defined in the P25 Inter RF Subsystem Interface (ISSI).

The PSVRN shall be capable of interoperability with the City's Master Site using the P25 ISSI standard. The CERS is in the process of upgrading to a P25 system with an interconnection to the City's master site, at which time the PSVRN could interconnect to CERS through the City's master site. SFMTA will provide coordination services with outside agencies for interoperability.

The PSVRN shall be interoperable with the Interoperable Radio System. This four (4) site simulcast system provides emergency communications for CCSF.

The PSVRN shall interface with the SF 911 Dispatch Center. The specific design approach for this interface shall be defined during the Intermediate Design Review.

MOU's may be developed in the future for system to system links to Marin County, San Mateo County and Golden Gate Highway and Transportation District.

2.4.2 Network Management System Operational Functions

The Network Management System (NMS) shall provide a graphical user interface and extensive on-line help database. Subscribers shall be interfaced to the trunked/conventional mobile radio system through a standard IP interface protocol.

The system shall have capacity for over 40,000 individual radio IDs and over 2,000 talkgroups. Additionally, the system shall support additional radio 10's that may roam into the SFMTA radio system and operate using the ISSI P25 standard.

The Contractor shall anticipate configuring the new radio subsystem with the talkgroups specified in Appendix Twenty-One (21), "SFMTA's Planned Talkgroup List". The Contractor shall work with CCSF and the SFMTA to create talkgroups and fleet maps as needed. The Contractor shall perform two (2) subscriber programming cycles:

- Initial deployment programming of template (e.g. Talkgroups or any other subscriber parameter)
- Reprogramming of subscribers to improve fleet map efficiency and programming error as requested by the SFMTA.

The Talkgroups shall be established as a Final Design Review (FOR) completion item.

Design-Build Services for the Radio System Replacement**Section 2.0**

The Contractor shall be responsible for the correct programming of all system and subscriber equipment. The Contractor shall reprogram all equipment that is incorrectly programmed at no expense to the SFMTA.

NMS access shall be provided within the Operations Control Center for system performance monitoring and maintenance purposes. The network management system shall be accessed through a System Manager Terminal (SMT).

System calls shall be processed using least 10 levels of user priorities in the calling process. Priority to calls, to or from particular voice groups or to particular types of calls, with the highest level of priority assigned to emergency shall be provided.

The system shall assign available voice channels and shall queue calls based on call priority levels. Priority levels shall be programmable via the SMT.

2.4.3 700/800 MHz Trunked and Conventional Operation

The radio system shall be configured as a single trunked network with regard to its architecture for providing wide-area coverage. The radio system and user equipment shall provide fully automatic site registration, channel selection, talkgroup and individual call routing as required between sites within the network and without user intervention as the user "roams" between sites. This shall apply to both voice and data.

2.4.4 Modulation Types and Technology

Base stations, control stations, mobile radios, and portable radios used in the system shall comply with all applicable requirements of Part 90, and in particular Subpart S, Regulations Governing the Licensing and Use of Frequencies in the 806-824, 851-869, 896-901, and 935-940 MHz Bands, and Subpart R, Regulations Governing the Licensing and Use of Frequencies in the 763-775 and 793-805 MHz Bands.

This includes, but is not limited to, the following specific requirements:

- Phase II, TDMA modulation
- Mobile, portable, and control station radios used on the mobile radio system shall be capable of digital or analog conventional and trunked operation in the 700/800 MHz band or 700 MHz band. The SFMTA shall utilize analog for basic interoperable communications.
- Mobile transmitters and receivers shall operate in voice and data modes to support the SFMTA's voice and data requirements.

2.4.5 Voice Calling Functions

The trunked voice portion of the SFMTA radio system shall provide the following types of system calls:

Group Call a call from a Radio Dispatcher to a group of mobile and portable radio users who are members of a single voice group, or a call from one member of such a voice group to all other members of the same voice group.

Private Call a call from a Dispatcher to a single radio user (e.g. to a bus operator in response to a RTI or PRTI), or from one single user (with a unique radio 10) to another single user (with a unique radio 10) on the system.

Fleet Call a call, usually from a Radio Dispatcher, to all members of several voice groups, up to and including all radios on the system.

Design-Build Services for the Radio System Replacement

Section 2.0

Ad hoc Calls to Dispatcher selected subscribers through the selective calling features supported by the MTMS.

2.4.6 System Functional Features

The Contractor shall implement a system that provides, at a minimum, the following features:

- Individual radio enable/disable
- Pre-canned or custom text messaging
- Current unit voice group affiliation (unit search)
- Activity (PTI-ID) Display
- NMS password/access levels
- Trunked and conventional channel conditions (activated/idle/failed)
- Enable/disable selected trunks/channels
- Priority levels (unit and voice groups)
- Unit, voice group and trunk usage reports
- Complete integration with the MTMS.

2.6 Desktop Control Station

2.6.1 Control Station General Requirements

Control stations and desk sets specifications are listed below:

Rated for 10% transmit, 10% receive, and 80% standby.

Equipped with:

- a handset with PTI switch
- integral speaker
- microphone
- volume control
- provisions for adding a desktop microphone.

Fully operational and maintain all settings previously in effect following restoration of power

Capable of operating in trunked mode on the wide-area system

Available in a rack-mount configuration, designed to minimize occupied space for multiple control stations in a single cabinet.

The control stations shall be connected to a facility UPS if available.

Control stations shall be installed at locations defined in Appendix Fourteen (14), "Required SFMTA User Work Stations & Licenses".

Qualified Proposers shall provide a complete description of the proposed desktop control station equipment [PRL 12-2-7 Desktop Control Station Equipment Description].

Design-Build Services for the Radio System Replacement**Section 2.0**

The Contractor shall provide complete description of the mobile equipment provided [CDRL 12-2-10 Desktop Control Station Equipment Description].

2.6.2 Control Station Technical Features

The desktop control stations shall meet the following technical specifications:

Capable of operation on narrowband (12.5 kHz), mid-bandwidth (NPSPAC) and wideband (25 kHz) channels. No software or firmware changes shall be required to change between bandwidths.

Programmable to encode and decode any combination of 37 EIA CTCSS and 83 standard DCS codes.

Coded squelch encode and decode tones shall be channel-slaved, and the radio shall be capable of operating with encode tones that are different from the receiver decode tone. A monitor switch shall be provided to enable or disable the coded squelch function for maintenance.

Capable to reprogram the radio template in the field using a portable computer. The connection shall be accessible without requiring the removal of equipment from its mounting bracket or from the equipment rack.

Housed in rugged cases with the following features:

- Utilize gaskets to seal against dust infiltration at all points of access
- No internal ventilation shall be required
- Cable connectors shall be securely attached to unit.

Metering of all essential circuits shall be possible while the radio is installed and operating, and may be accomplished through software control

A time-out timer shall turn off the transmitter after a time interval (adjustable up to three (3) minutes) of continuous transmit, generate an alert tone on the radio speaker, and reset upon release of the PTT switch. It shall be possible to completely disable the timeout timer. This timer shall not be activated if the security (covert monitoring) microphone becomes operational in a revenue vehicle.

Capable of "cloning" a radio template (without individual ID numbers) to minimize future reprogramming costs.

Capable of individual identification numbers that are transmitted with every PTT.

Equipped with an 8-character alphanumeric display to allow the user to assign a descriptive name to each operating condition.

Displays shall be clearly labeled and visible in a brightly lit equipment room, with variable brightness.

The display shall either be backlit or vacuum florescent for visibility in a darkened room.

Capable of a minimum 128-channel operation with user selectable Talkgroup scanning capability

Arranged to operate in the control station mode using the same transmit and receive frequencies as the mobile units. to provide access to the base stations in the event of a failure of the communications links to the base station sites

The interface between each control station and the SFMTA radio dispatcher workstation shall be provided by Contractor.

Design-Build Services for the Radio System Replacement

Section 2.0

For remote control, each workstation shall have the controls for its associated control station integrated into the Dispatch workstation via the centralized electronics equipment and shall operate in the same manner as any station.

2.6.3 Control Station Technical Parameters

Parameter	Required Performance
Control Station Transmitter	
Frequency Range	763-869 MHz
Maximum Frequency Separation, no degradation	Full BandSplit
Programmable Channel Steps	12.5 kHz
Minimum Power Output (EIA Intermittent)	15 W
Emission Designators	11K3F3E
Spurious and Harmonic Emissions	-60 dB
Control Station Receiver	
Frequency Range	764-776 MHz or 851-869 MHz
Maximum Frequency Separation, no degradation	Full BandSplit
Channel Spacing	12.5 kHz
Sensitivity, 12 dB SINAD/Static BER (5%)	0.30 V
Selectivity, EIA: 12.5 kHz	-65 dB
Intermodulation Rejection	-65 dB
Spurious and Image Rejection	-70 dB
Speaker Output Power (minimum)	3 W

2.7 Portable Equipment

The Contractor shall furnish portable radios operating on any of the primary frequencies in the 763-869 MHz land mobile bands.

It is the intent of this section to describe state-of-the-art portable radio equipment. The equipment shall be comprised of a handheld transceiver, associated accessories, antenna and user functions and controls. The equipment shall be operated in a FDMA and TDMA mode.

The units shall be of current production and shall be capable of withstanding the harsh environment associated with use by public safety and public service personnel.

The units shall be feature and function compatible with the fixed and mobile equipment supplied under this contract.

Portable radios shall be made available in multiple tiers, each of which offers varied feature packages from basic level to advanced functionality. With each of the SFMTA-specified level set forth below, the Contractor shall indicate a single unit/model that best meets each tier's overall requirements. In

Design-Build Services for the Radio System Replacement

Section 2.0

In addition, the Contractor may divide any of the SFMTA-specified tiers, below, into additional tiers and propose subscriber equipment for those tiers. The minimum requirements for each tier are further described below.

Qualified Proposers shall provide a complete description of the proposed portable equipment [PRL 12-2-9 Portable Equipment Description].

The Contractor shall provide complete description of the portable equipment [CDRL 12-2-11 Portable Equipment Description].

2.7.1 Quantities

The SFMTA quantities and types per quantity for portable equipment are listed in Appendix Twenty-Eight (28), "Cost Proposal".

2.7.2 Regulatory Compliance

All subscriber equipment provided shall be type accepted under Part 90 of the FCC Rules & Regulations. Narrowband operations shall comply with 47 CFR 90.547 & 47 CFR 90.548 of the FCC Rules and Regulations.

All portable radios shall be of heavy duty construction, suitable for continuous public safety use.

Portable radios and all their associated accessories shall be capable of withstanding shock, vibration, temperature, humidity, dust, and driven rain, per MIL-STD 810-E.

2.7.3 General Electrical & Mechanical Requirements

The Contractor shall provide portable radio equipment that meets the following specifications:

State-of-the-art and microprocessor based

All operating parameters shall be stored in electrically alterable non-volatile memory technology

Operating frequencies, features, functions and other operating parameters shall be field-modifiable via PC based programmers

The physical and electrical architecture of the equipment shall be such that addition of user features and/or functions at future dates shall not require addition and/or replacement of circuit cards within the unit

All equipment assemblies and sub-assemblies shall be shielded to minimize electromagnetic interference which may be caused to/by electrical equipment in close proximity to this equipment

Self-diagnostic test each time it is turned on. This test shall be automatic and shall include all radio operating parameters. At the conclusion of a successful test, no operator intervention shall be required to activate on the network. A test that is not successful shall notify the operator

2.7.4 Portable Technical Specifications

The minimum required technical specifications for portable radio transmitters measured in accordance with TIA -603, TIA-102.CAAA-B and TIA-102.CAAB-B procedures are as follows:

Portable Radio Transmitter Specifications

Frequency Range	763-869 MHz
Programmable Channel Steps	12.5 kHz
Power Output	2.5 W minimum

Design-Build Services for the Radio System Replacement

Section 2.0

Frequency Stability	+/-1.5 PPM, -20°C to +60° C
Duty Cycle Rating	5% Tx, 5% Rx, 90% standby
RF Output Impedance	50 Ohms
Emission Designator	Per FCC 90.207
Modulation Limiting	+/-2.5kHz
Spurious and Harmonic Emissions	-48 dBc
FM Hum and Noise	-45 dB
Audio Distortion	Maximum 5% @ 1000 Hz

Portable Radio Receiver Specifications

Frequency Range	764-776 MHz or 851 to 869 MHz
Channel Bandwidth	12.5 kHz
Input Impedance	50 Ohms
Frequency Stability	+/-1.5 PPM%, -20°C to +60° C
Sensitivity, 12 dB SINAD/Static BER (5%)	0.35 uV @ 12.5 kHz
Adjacent Channel Rejection	-63 dB
Intermodulation Rejection	-62 dB
Spurious and Image Rejection	-65 dB
Audio Output Power @ 8 ohm	500 mW minimum
Audio Distortion	Maximum 5% @ rated output

2.7.5 Tier 1 Radio Type

Tier 1 portable radio features shall include:

- Volume control
- Talk group/channel selector (minimum of 16)
- Emergency button
- Push-to-talk
- Remote microphone/speaker connector
- Ability to monitor channel/talk group with transmit feature inhibited
- Ruggedized option for severe service conditions such as marine use
- Ability to receive individual calls
- Ability to receive private unit-to-unit calls
- Audible low battery indicator.

2.7.6 Tier 2 Radio Type

Tier 2 portable radio features shall include the Tier 1 radio features plus, at a minimum, the following:

- Display
- Industry-standard data interface

Design-Build Services for the Radio System Replacement**Section 2.0**

- As many as four programmable keys
- Encryption capability.

2.7.7 Tier 3 Radio Type

Tier 3 portable radio features shall include the Tier 2 radio features plus, at a minimum, the following:

- Remote antenna connector
- Alphanumeric keypad that support DTMF and individual unit calling. The keypad shall be a typical 12-bullon configuration to achieve the full DTMF capability
- Ability to send and receive individual calls
- Ability to send and receive private unit-to-unit calls
- Call-book memories (phone numbers, etc).

2.7.8 Visual Display

Tier III portable subscriber units shall have the following visual display features:

- Back-lit display visible in bright sunlight
- Readable in direct sunlight
- Readable in darkness
- Display brightness (for nighttime use) as an operator-adjustable feature
- Ability to fully dim display.

2.7.9 Keyboard

Tier III portable subscriber units shall have the following keypad features:

- Made of a non-slip material
- Provide tactile feedback
- Arranged so as to prevent accidental operation
- Clearly labeled
- Clearly visible
- Keypad shall be back-lit labels for nighttime use
- Ability to emit an audible signal each time a key is pressed.

2.7.10 Power Supply

Power supply equipment shall operate from a negative ground internal battery power source. All power circuits shall provide for reverse polarity protection.

2.7.11 Equipment Housing

The transceiver housing shall house all electronic circuits and/or circuit cards associated with the equipment. The housing shall be constructed of high impact polycarbonate plastic or other suitable high impact material. Removal of the battery from the unit shall not expose its internal circuitry.

Design-Build Services for the Radio System Replacement**Section 2.0****2.7.12 Device Interface**

To provide the highest degree of functionality, the vendor shall provide a solution that provides the capability to interface with independent peripheral devices through the use of standard interfaces.

2.7.13 Operating Bandwidth

Portable units shall operate over the entire 700/800 MHz radio channel allocation without degradation.

2.7.14 Modulation Modes

Modulation mode shall be Phase II, P25 TDMA. The radios shall also be capable of narrowband - 12.5 kHz capable and wideband 25 KHz capable.

2.7.15 Operating Modes

Portable equipment shall support the following operating modes:

- Trunked and conventional.
- Half Duplex and Simplex
- Operating modes shall be field programmable on a voice group and per channel basis.

2.7.16 Communication Modes

Portable equipment shall operate in both clear audio mode and in encrypted audio mode (option).

2.7.17 Audio Output

The audio output power of a Tier III portable subscriber unit shall be at least 500-milliwatts.

2.7.18 Handheld Microphones

Portable subscriber units with a handheld microphone solution shall have the following features:

- Programmable function keys
- DTMF keypad
- Noise canceling
- Lapel clip.

2.7.19 Portable Antennas

Portable subscriber units shall be equipped with a detachable unity-gain antenna.

The antenna shall be field replaceable, without tools.

2.7.20 Knobs

If applicable, portable subscriber units shall have the following knob features:

Made of a non-slip material

- A design, such as a detented surface, to provide tactile feedback.
- Arranged so as to prevent accidental operation
- Clearly labeled
- Clearly visible.

Design-Build Services for the Radio System Replacement**Section 2.0****2.7.21 Battery**

Battery operation time shall be no less than 8 hours at 5% transmit, 5% receive, and 90% standby or a 5-5-90 duty cycle.

Extended battery operation time, beyond the minimum 8 hours, should be accomplished through such techniques as transmitter power management, if offered by the Contractor.

The battery shall be of a type that does not exhibit a "memory" effect for the predicted life of the battery.

The battery shall be of a type that can accept a fast charge rate. An example would be a 1 hour charge rate from fully discharged to fully discharge for a NiCd battery.

2.7.22 Battery Charger

The Contractor shall provide battery chargers for portable subscriber units with the following features:

- Drop-in charger
- Capable of charging portable subscriber batteries to full capacity within 60 minutes
- Auto shut-off feature that stops charging the battery when it has reached full charge and maintains a battery float condition
- Available with a capability to condition the battery during the battery recharging cycle
- Available with an integrated capacity-testing feature
- Available in single and multi-unit chargers
- Available in single unit chargers with a 12 volt DC input power to be installed in vehicles to power spare batteries.

The Contractor shall install the following:

- One (1) battery charger in each non-revenue vehicle
- Two (2) battery chargers in each light rail vehicle.
- One (1) battery charger in each single-ended historic vehicle
- Two (2) battery chargers in each double-ended historic vehicle

2.8 Mobile Equipment

It is the intent of this section to describe state-of-the-art 700/800 MHz trunked mobile radio equipment for the replacement of the existing mobile radio fleet. The equipment shall be comprised of a transceiver, associated accessories, antenna and user functions and controls. The equipment shall be operated in a FDMA and TDMA mode.

Mobile radios shall interface and integrate into the vehicle and a vehicle control head is required in order to meet overall functional requirements for an integrated radio design capable of supporting voice and data communications within one radio. Functionality for volume control of handset, speaker and routing of local audio to the vehicle public address system shall also be provided for vehicles.

The Contractor shall be responsible for the protocol and hardware interface between the radio and the vehicle logic unit (VLU) on any vehicle.

Design-Build Services for the Radio System Replacement**Section 2.0**

All mobile radios shall be of rugged construction, suitable for continuous public safety use. Mobile radios shall be capable of withstanding shock, vibration, temperature, humidity, dust, and driven rain associated with mounting in vehicles per MIL-STD 810-E.

The units shall be of current production and shall be capable of withstanding the harsh environment associated with use in public safety and public transit vehicles

Mobile radios shall be made available in multiple tiers that offer varied feature packages from basic level to advanced functionality.

With each of the SFMTA-specified level set forth below, the Contractor shall offer a single unit that best meets each tier's overall requirements. In addition, the Contractor may divide any SFMTA-specified tier, below, into additional tiers and propose subscriber equipment for those tiers. The minimum requirements for each tier are further described below.

The mobile radios shall be feature and function compatible with the fixed equipment to be provided by the Contractor.

Qualified Proposers shall provide a complete description of the proposed mobile equipment [PRL 12-2-8 Mobile Equipment Description).

The Contractor shall provide complete description of the mobile equipment provided [CDRL 12-2-11 Mobile Equipment Description].

2.8.1 Quantities

The SFMTA quantity requirements are listed in Appendix Thirteen (13), "SFMTA Vehicle Inventory".

2.8.2 Regulatory Compliance

All mobile equipment offered shall be type accepted under Part 90 of the FCC Rules & Regulations. Narrowband operations shall comply with 47 CFR 90.547 & 47 CFR 90.548 of the FCC Rules and Regulations.

Meet or exceed all the requirements of MIL-STD 810E standards for shock, vibration, salt, fog, dust and rain.

2.8.3 General Electrical & Mechanical Requirements

The Contractor shall provide mobile radio equipment that meet the following specifications:

- State-of-the-art and microprocessor based.
- All operating parameters shall be stored in electrically alterable non-volatile memory technology.
- Operating frequencies, features, functions and other operating parameters shall be field-modifiable via PC based programmers.
- The physical and electrical architecture of the equipment shall be such that addition of user features and/or functions at future dates shall not require addition and/or replacement of circuit cards within the unit.
- All equipment assemblies and sub-assemblies shall be shielded to minimize electromagnetic interference which may be caused to/by electrical equipment in close proximity to this equipment..

Design-Build Services for the Radio System Replacement

Section 2.0

- Self-diagnostic test each time it is turned on. This test shall be automatic and shall include all radio operating parameters. At the conclusion of a successful test, no operator intervention shall be required to activate on the network. A test that is not successful shall notify the operator.

2.8.4 Mobile Radio Technical Features

The mobile radios shall have the following features:

- 100% solid-state, frequency-synthesized FM unit designed for reliable, long-term usage under adverse public safety public service conditions.
- Meet all specifications, including oscillator stability, within 3.5 seconds of power-on
- Capable of trunked and conventional repeater operation or talk-around on any of the primary frequencies in the 700/800 MHz land mobile band.
- Receiver selectivity and transmitter voice frequency response, deviation, and transmit power shall be automatically controlled by an internal microprocessor, based on transmit and receive frequency selection. It shall not be necessary to program these parameters for each radio frequency.
- A port on the radio to be used for programming shall be accessible without requiring the removal of equipment from the mounting brackets.
- Protected against damage in the event of DC power lead reversal or over-voltage.
- Internal batteries shall not be required to maintain the radio personality.
- Capable of transmitting an emergency alarm from the vehicle to the Dispatcher Console in fall-back mode
- The radio personality shall be capable of being reprogrammed in the field, using a laptop computer.
- Operating bandwidth shall include the entire 700/800 MHz radio channel allocation without degradation, minimum.
- Mobile radios shall be capable of Narrowband -12.5 kHz capable modulation.
- Operating modes shall be field programmable on a voice group and per channel basis for trunked and conventional operations in either half duplex or simplex.
- Mobile equipment shall operate in both clear audio mode and in encrypted audio mode (option).

Qualified Proposers shall describe their experience with the interfacing the vehicle logic unit (VLU) and a mobile radio without a control head, including any radio protocol and hardware interfaces [PRL 12-2-9 Vehicle Logic Unit Interface to Mobile Radio Description].

2.8.5 Technical Specifications for Mobile Radios

The minimum required technical specifications for mobile radio transmitters measured in accordance with TIA -603, TIA-102.CAAA-B and TIA-102.CMB-B procedures are as follows:

Mobile Radio Transmitter Specifications

Frequency Range 763-869 MHz

Design-Build Services for the Radio System Replacement

Section 2.0

Programmable Channel Steps	12.5 kHz
Power Output	30 W minimum
Frequency Stability	+/-0.00015%, -20°C to +60° C
Duty Cycle Rating	Intermittent (20% Tx)
RF Output Impedance	50 Ohms
Emission Designator	Per FCC 90.207
Modulation Limiting	+/-2.5kHz
Spurious and Harmonic Emissions	-60 dBc
Audio Distortion	Maximum 3% @ 1000 Hz
FM Hum and Noise	-40 dB
Audio Response	Within +1, -3 dB of 6 dB per octave pre-emphasis from 300 to 3000 Hz, referred to 1000 Hz

The minimum required technical specifications for mobile radio receivers measured in accordance with TIA-603, TIA-102.CAAA-B and TIA-102.CMB-B procedures are as follows:

Mobile Radio Receiver Specifications

Frequency Range	764-776 MHz or 851 to 869 MHz
Channel Spacing	12.5 kHz
Input Impedance	50 Ohms
Frequency Stability	+/-0.00015%, -20°C to +60° C
Sensitivity, 12 dB SINAD/	0.30 uV @ 12.5 kHz Static BER (5%)
Adjacent Channel Rejection	-65 dB
Intermodulation Rejection	-80 dB
Spurious and Image Rejection	-80 dB
Audio Output Power (minimum)	3 watts internal / 5 watt external speaker
Audio Distortion	Maximum 3% at rated output
Audio Response	Within +1, -3 dB of 6 dB per octave de-emphasis from 300 to 3000 Hz, referred to 1000 Hz.

2.8.6 Control Heads

The Contractor shall install remote control heads for all non-revenue vehicles. Refer to the vehicle drawings for the placement of the control heads in the various vehicles.

Mobile radios attached to VLU's shall not have control heads.

2.8.7 Mobile Radio - Tier 1

Tier 1 mobile radio features shall include:

- Volume control
- Talk group/channel selector (minimum of 16)
- Emergency button
- Push-to-talk

Design-Build Services for the Radio System Replacement**Section 2.0**

- Speaker
- Auxiliary microphone/speaker connector
- Ability to monitor a channel/talk group with transmit feature inhibited
- A peripheral unit or outboard status panel necessary for signaling status shall be available for mobile subscriber units that do not include this feature
- Ability to receive individual calls
- Ability to receive private calls.

2.8.8 Mobile Radios - Tier 2

Tier 2 mobile radio features shall include:

- Tier 1 mobile radio features
- Display
- Global Positioning System (GPS) capability
- Encryption option.

2.8.9 Mobile Radios - Tier 3

Tier 3 mobile radio features shall include:

- Tier 2 mobile radio features
- Alphanumeric keypad that supports DTMF and individual unit calling. The keypad shall be a typical 12-button configuration to achieve full DTMF capability
- Ability to send and receive individual calls
- Ability to send and receive private unit-to-unit calls
- Nonvolatile user programmable memories (phone numbers, etc.).

2.8.10 Mobile Radios - Tier 4

Tier 4 radios shall have the features of a Tier 1 radio. The Tier 4 radio shall be capable of operating with the Vehicle Logic Unit (VLU) without a control head. The VLU shall function as the control head for the radio. The Contractor shall provide an Application Protocol Interface to the VLU vendor to develop programs to control the radio.

2.8.11 Visual Display

Tier 2 and 3 mobile subscriber units shall have the following visual-display features:

- Back-lit display. which shall be visible in bright sunlight
- Readable in direct sunlight
- Readable in darkness
- Display brightness (for nighttime use) as an operator-adjustable feature
- Ability to fully dim display for covert nighttime operations.

Design-Build Services for the Radio System Replacement**Section 2.0****2.8.12 Keyboards**

Tier 3 mobile subscriber units shall have the following keypad features:

- Made of a non-slip material
- Provide tactile feedback
- Clearly labeled
- Clearly visible
- Back-lit labels for nighttime use
- Ability to emit an audible signal each time a key is pressed.

2.8.13 Standard Speakers

Mobile subscriber units shall have the following audio power output features:

- 5-watt peak audio power output standard
- 10-watt peak audio power output optional.

2.8.14 Auxiliary Speakers

The mobile subscriber units shall have the following auxiliary speaker features:

- Amplified to produce 25-watt peak audio power output for non-radio connected installations.
- Provided with a mating connector set.
- Option for an external, weatherproof speaker.

2.8.15 Handheld Microphones

A handheld microphone shall be included with all mobile radios, with a connector to permit ease of removal and replacement. Tier 4 radios shall use the VLU handset.

The mobile units shall be capable of interfacing to a variety of microphone options suited to the radio use and user. The microphone cord shall be long enough to be used comfortably when seated in the operator's seat of the vehicle, but with minimum surplus slack. The microphone cord shall be coiled.

2.8.16 Power Requirements

All subscriber units shall operate from an external negative ground primary power source supplying a nominal 12 VDC. All power circuits shall provide for reverse polarity protection. The radio shall meet specifications when operating between 11 VDC and 15 VDC, negative ground.

The subscriber units to be installed in the Light Rail Vehicles (LRV) and historic vehicles shall operate using the existing vehicle 37VDC low voltage supply. As such, the Contractor shall have to incorporate a power onverter for these vehicles. The Contractor shall remove and replace the existing Newmar® Model No. 32-12-40 DC-DC converter with a new regulated, low ripple, DC-DC converter of appropriate capacity meeting, as a minimum, the following requirements:

- DC output line regulation within 1% regardless of varying DC input voltage or changing load conditions
- Automatic thermal overload protection

Design-Build Services for the Radio System Replacement

Section 2.0

- Overvoltage protection
- Conformal coated circuit board(s)
- Integral shock mounting
- Rust and corrosion proof case

Breda LRVs 1400-1476 currently use one DC-DC power converter while LRVs 1477-1550 and 1424 incorporate two converters. The Contractor shall provide the same number of converters on each of the LRVs, regardless of the number of existing converters on a particular LRV.

The Qualified Proposer shall design power filter on all of the LRV's.

The Contractor shall design the mobile radio installation to minimize any transient electrical surges. Special light rail vehicle requirements are specified in Appendix Twenty-Two (22).

A power converter shall be made available for any other type of power source that may be encountered on vehicles trains, or cable cars.

A power filter shall be installed on the power circuit to the radio.

The Contractor shall provide a delay timer in line with the power circuit to the radio. The delay timer shall allow the radio and mobile data terminal (MDT) to be shut down after a preset time interval of at least 15 minutes. The delay timer shall have an under voltage sensor to allow for the shutdown of the radio and MDT.

The Contractor shall install new power and ground cables for each radio. Unless approved by the SFMTA, the Contractor shall not reuse any existing radio power lines.

2.8.17 Vehicle Antennas

The Contractor shall install fixed mount antennas for a variety of installation types, including vehicles, trains and cable cars.

All rubber-wheeled revenue vehicles shall utilize transit-style 700/800MHz antenna (i.e. blade).

All non-revenue vehicles shall use a 700/800MHz low-profile antenna (i.e. hockey puck or cylinder type).

Optionally, the Contractor shall provide a combined tri-band (700/800/GPS) antenna for all the SFMTA vehicles. Optionally, a combined GPS and 800 MHz antenna shall be provided for vehicles that require such an antenna.

Optionally, a magnetic-mount antenna shall be provided for applications that require such an antenna.

Optionally, a non-ground plane type antenna shall be made available for applications that require such an antenna, such as some vessels.

Optionally, low-profile, covert antennas shall be made available for applications that require such an antenna, such as cable cars.

The Contractor shall install new transmission lines for each antenna. Unless approved by the SFMTA, the Contractor shall not reuse any existing radio transmission lines.

2.8.18 Knobs

If applicable, mobile subscriber units shall have the following knob features:

- Made of a non-slip material

Design-Build Services for the Radio System Replacement**Section 2.0**

- A design, such as a detented surface, to provide tactile feedback.

2.8.19 Equipment Housing and Physical Requirements

The radio housing shall house all electronic circuits and/or circuit cards associated with the equipment. Palm microphones, external speaker housings and radio housings shall be constructed of high impact polycarbonate plastic or other suitable high impact material. Remote mounted transceiver housings shall be equipped with a base plate. The base plate shall allow for the removal of the transceiver from its mounted location for replacement or servicing. Removal of the radio from the base plate shall not expose its internal circuitry.

Mobile radios shall meet the following physical operating requirements (light rail vehicle specific requirements are found in Appendix Twenty-two (22)):

- Meet specifications under ambient conditions of -200 to +600 C, and 5% to 90% relative humidity.
- Cable connectors shall be securely attached to the mobile via hermetically sealed connectors.
- Fuses or circuit breakers installed in vehicles shall be easy to reach, labeled "Radio", and have the proper replacement fuse amperage identified.
- One spare fuse for each mobile installation shall be provided.
- The radio shall not receive or transmit ignition noise, alternator whine, or other forms of interference. The Contractor shall be responsible to equip radios with noise-reducing hardware and/or redesign installation wiring to eliminate interference problems.
- Details of mounting and installation will vary among vehicle types and shall be coordinated with the SFMTA or their designated representative.

2.8.20 Mobile Radio Operational Features

Mobile radio operational features shall include:

- Non-revenue vehicles provided with a user interface (control panel or control head) containing volume control, voice group and conventional channel select.
- Mobile equipment shall support the following identification modes:
 - Unit ID on Push-To-Talk
 - Emergency Unit ID, operator activated via microphone Push-To-Talk.
- Revenue vehicles provided with no user interface (control panel or control head) containing volume control, voice group and conventional channel select
- An alphanumeric character display to identify the trunked voice group, conventional channel and other users prompts required to operate or diagnose the unit shall be provided.
- The display shall not display less than eleven (11) characters and its brightness shall be user adjustable.
- Provided with a user configurable trunked voice group/conventional channel scan feature.

Design-Build Services for the Radio System Replacement**Section 2.0**

- The scanner shall allow the user to selectively add or omit talk groups or channels from the scanning sequence.
- A mix of talk groups and channels shall be allowed in the scanning sequence. User selectable talk group/channel priority shall be provided.
- All mobile units shall be equipped with an external P25 data port.
- Test equipment, radio-programming devices, etc. shall be capable of connecting to the mobile radio via an additional data port.
- Remote control of mobile radio functions via the microphone
- Signal strength indicator on mobiles.

2.8.21 Device Interface

Device interfaces shall accommodate data input devices that use RS-232 or Universal Serial Bus (USB) connectivity.

2.9 Radio System Fixed Equipment Requirements

This section describes the minimum quality and specification requirements of the radio system fixed equipment and software. All equipment shall be commercially available, service proven, and not in an alpha or beta release state.

2.9.1 General Requirements

The Contractor shall provide new, high-quality, modern, equipment that is designed, manufactured, and installed for public transit service and public safety users. The equipment shall be designed to provide a long life, high reliability, rugged performance under adverse conditions, and low maintenance.

General system requirements include:

- Implementation of the system shall meet the highest current standards for operation in public-transit service.
- Equipment and material furnished shall meet or exceed all the requirements of this RFP and of the manufacturer's specifications.
- Meet all applicable standards equipment providing communication for public transit systems, specifically including the following:
 - FCC rules and regulations, CFR 47 §90
 - TIA - 603 standards and specifications
 - MIL-STD-810E for vibration, shock, humidity, salt, and dust.
- Operate within the manufacturer's specified limits under all reasonably expected operational conditions.
- Capable of operation on narrowband (12.5 kHz) channels mid-bandwidth (NPSPAC) and wideband (25 kHz) selected on a channel-by-channel basis.
- Contractor's shall certify that all equipment proposed has received the requisite certification from the Federal Communications Commission at time of Proposal submittal

Design-Build Services for the Radio System Replacement**Section 2.0**

- Equipment shall be fully solid-state, with the exception of any required relays, which shall be sealed
- All equipment and materials (with the exception of antenna cable and vehicular antennas used for testing) shall be new and unused, of the manufacturer's latest design, of current manufacture, the best of its respective kinds, and without defects in operation or appearance
- All equipment shall be equipped with lightning and surge protection, as appropriate, and shall be properly grounded in accordance with industry best practices.
- All equipment supplied shall be equipped with adequate fuses and/or circuit breakers, with time delay as applicable.
- Fixed-site radio equipment shall be mounted in 19" EIA-standard racks. Height to be determined by facility requirements. Vertical cable management shall be used as required with accessibility to both the front and rear. The racks shall be secured to the floor, have durable corrosion-resistant finishes, shall be earthquake-braced, and shall be separately grounded to the equipment room ground system.
- In areas that require additional security provisions, 19" locked cabinets shall be used.

2.9.2 Base Stations

This section shall apply only if the contractor employs a P25 design. Any other non-P25 solution must meet industry standard.

The following sections describe the requirements for conventional and trunked repeater base stations and associated equipment for the new SFMTA radio system.

General Base Station Specifications

Base station transmitters and receivers shall comply with the most current version of:

- FCC Rules and Regulations, CFR 47, Part 90, Subparts Rand S for 700/800 MHz operation
- TIA-603 standards and specifications
- TIA-102.CAAA-B and TIA-102.CMB-B.

Each repeater base station at each site shall be equipped with an automatic station identifier to transmit the FCC call sign in Morse code at intervals of not more than 30 minutes, in accordance with FCC rules. System users shall not hear the identifier signal. The identifier shall be "polite," such that it begins during an interruption in radio traffic and, if interrupted, resets and attempts to send again, until such time that the complete message has been sent.

Base stations shall be arranged for automatic reversion to the "in-cabinet repeating" mode (for conventional channels) or to "site trunking" mode upon loss of the interconnecting link to the repeater site. In this mode, the base station shall instantaneously repeat the received signal, rather than sending it back to the audio processing equipment. Return to normal operation shall be under automatic control of the Radio Network Controller once the link is restored.

One complete metering package and microphone common to all base stations at a single site shall be supplied. This includes a local speaker and volume control to monitor all on-channel signals.

Design-Build Services for the Radio System Replacement

Section 2.0

Base stations shall be equipped with visual indicators and contact outputs indicating malfunctions in transmitter output power, synthesizer condition, and battery power supply status.

The indication of failure of transmitter power and/or receiver operation shall be transmitted to the SMTs as an alarm.

Repeater base stations shall be frequency-synthesized and field-programmable. Transmitter and receiver modules shall be interchangeable between base stations.

Transmitters shall be equipped to provide a minimum power output of 100 Watts. The transmitters shall be capable of providing sufficient power to produce the licensed ERP (effective radiated power) level while operating at 80% of their rated maximum output power. In-service power shall be determined by coverage requirements and the Contractor’s overall system design.

Transmitters and receivers shall be capable of being programmed in consecutive 12.5 kHz steps, to comply with frequency and modulation requirements of 47 CFR, Part 90. Base station transmitters and receivers shall comply with all requirements of 47 CFR, Part 90 Subpart Rand S for digital operation in the 700/800 MHz bands.

Electrical & Mechanical Characteristics

Base stations shall meet or exceed the following requirements:

Base Station Transmitters

Frequency range	764 to 776 MHz and 851 to 869 MHz
Programmable channel steps	12.5 kHz
RF power output	100 Wf, adjustable downward by 3 dB
Duty-cycle rating	Continuous (100%) EIA
Environment	-30 to +60 C 5% to 90% RH
Power requirements	-48 VDC
RF output impedance	50 Ohms
Oscillator frequency stability	±0.0001%, -20° to 60°C
Spurious and harmonic emissions	-60 dBc
Audio distortion	Maximum 3% @ 1000 Hz, @ 60% of full deviation
Audio response	Within +1, -3 dB of 6 dB per octave pre- emphasis from 300 to 3000 Hz, referenced to 1000 Hz

Base Station Receivers

Frequency range	794 to 806 MHz and 806 to 824 MHz
Channel Spacing	12.5 kHz minimum
Power requirements	-48 VDC
Input impedance	50 Ohms
Sensitivity, 12 dB SINAD/ Static BER (5%)	0.30 µV
Selectivity, EIA: 12.5 kHz adjacent channel	-60 dB
Intermodulation immunity,	-80 dB EIA SINAD
Spurious and image rejection	-90 dB
Service speaker input power	1 W @ +3% distortion, 1000 Hz

Design-Build Services for the Radio System Replacement

Section 2.0

Audio response	Within +1, -3 dB of 6 dB per octave de-emphasis from 300 to 3000 Hz, referenced to 1000 Hz.
Audio hum and noise	-45 dB (at speaker output)
Line Output	Adjustable from -20 dBm to 0 dBm

Each base station shall allow local control.

If a common test set is used, the test set (or base station equipment) shall provide the following controls and functions for local operations:

- Transmitter keying and modulation
- Local receiver audio volume
- Coded squelch encode and decode disable switch (affecting local and workstation)
- Coded squelch decode disable switch (affecting local speaker only)
- Repeater disable
- Intercom to Radio Dispatcher workstation (on voice channel only)
- Transmitter disable - effective in all modes of operation
- Line input/output disable switch for testing purposes
- Local control functions that could cause service interruptions shall be equipped with visual indicators.

2.9.3 Simulcast Equipment

This section shall apply only if the Contractor employs simulcast operation in its system design.

The Contractor shall be responsible for the simulcast performance of the integrated system, and shall provide equipment that will provide such performance.

The Contractor shall provide a method for automatic alignment of simulcast parameters from a central point in the network. This equipment used to perform the automatic alignment shall incorporate remote control capability to disable and enable individual transmitters for troubleshooting.

Simulcast frequency stability shall be maintained with the use of GPS receivers, rubidium clocks, or similar sources or standards at each simulcast site. A single spare source or standard shall also be provided.

The frequency standard equipment shall have the following design features:

- High-stability reference, capable of maintaining the 700/800 MHz transmitter frequency stability required for voice quality at the level of DAQ 3.4, and data transmission with BER <10⁻⁶, with normal maintenance intervals of no more than once per year
- Operational temperature range of -30 to +60 degrees C or from 0 to +60 degrees C if operated in a climate controlled environment.
- Appropriate alarm outputs to alert the SFMTA's SMT and select dispatcher workstations of degradation or failure.

Design-Build Services for the Radio System Replacement**Section 2.0**

The system shall provide for maintaining the audio phase, delay, and equalization parameters necessary for high-signal-quality simulcast operation from the system central control equipment via the interconnecting network. The equalization equipment shall have the following design features:

- Delay equalization equipment shall be capable of adjustment in steps of 1 microsecond or less.
- Bulk audio propagation delay shall be controlled through an automatically adjustable delay line. The delay line shall be digital, and shall automatically adjust for changes in baseband propagation delay as a result of changes in the interconnecting network.
- Audio phase and amplitude equalization shall be controlled automatically. Alignment test signals that are transmitted automatically in the course of alignment shall not be heard by the users of the system.

Qualified Proposers shall describe, in detail, the proposed design from the dispatch console to the subscriber unit [PRL 12-2-10 Simulcast System Design]. In particular, discuss how your system design addresses:

- Method of providing transmitter stability
- Method of equalizing audio delays and audio levels
- Method of synchronizing RF transmit frequencies between all sites
- Requirements for site interconnection (i.e., microwave or fiber or leased T-1)
- Predicted simulcast distortion areas
- Method of optimizing and diagnosing simulcast system
- Description for all equipment items employed in simulcast system
- Contractor's experience in simulcasting digital trunked systems
- The use of the existing microwave and fiber infrastructure.

2.9.4 Comparators

A comparator for each radio channel per site shall be provided to accept and compare the received audio from the multiple base station receivers. Voted audio shall be sent to all primary and backup Radio Dispatcher workstation positions, and shall be simulcast from the base station sites. One spare receive input module and a spare comparator module shall be supplied. The comparators shall monitor all receiver circuits for continuity and automatically adjust for changes in line level.

Comparators shall also provide the following:

- On any transmission, the comparators shall make an initial comparison and selection within fifty (50) ms, and subsequent changes in selection within one (1) ms. as necessary to avoid disruption in the intelligible voice audio or the requirement for Digital Audio Quality of not less than 3.4
- The comparator shall differentiate between a weak signal with a high signal-to-noise ratio (or low BER) and a strong signal with a low signal-to-noise ratio (or high BER), and choose the former based on the performance specifications of the vocoder to achieve the required audio quality

Design-Build Services for the Radio System Replacement**Section 2.0**

- The comparator shall dynamically change receiver selections and have the range of receiver sensitivity and quieting required so that received signals with higher signal-to-noise ratio (or lower BER) are always chosen
- Controls at the comparator shall be provided to allow manual override of receiver selection and the disabling of any receiver line to allow a declared emergency to be received without any system parameter level interruption
- Indicators and controls shall be provided at the comparator to display the received signal status and to allow loudspeaker monitoring of each receiver line
- The comparators shall be capable of using a standard 3002-type line or a 4-wire E&M multiplex voice card to connect to each receiver

2.9.5 System/Site Controller

The digital trunking system shall employ a fault tolerant system of assigning channels at each site. This channel assignment controller may take the form of a dedicated trunked system controller or may be integrated in a control shelf in each repeater station. In either event, the controller shall be backed up with one or more redundant units at the primary site. The loss of the controller or supporting subsystems shall not result in the loss of trunking capability at one or more sites.

In addition to the channel assignment system, the use of a simulcast design may require the use of a master site controller system. This system would be required to maintain the database of system users and assign appropriate sites and channels on each transmission. This unit shall also be configured in a fault tolerant redundant arrangement so that the loss of any component or subsystem at any site will not result in the loss of site and channel assignment capability and will not result in the loss of trunking capability or simulcast operation at any sites.

If a backbone connection to a remote site in a trunked simulcast LMR system is completely lost, the remote site control electronics shall shut down the remote site until the backbone connection is restored unless other technology is employed to ensure that there is no RF interference to adjacent trunked simulcast LMR sites operating on the same RF channels.

Qualified Proposes shall describe how their design provides redundancy for the Prime Site and Dispatch Center including the following [PRL 12-2-11 Prime Site and Dispatch Center Redundancy):

- Geographic redundancy in the system design
- Actions that must be taken to activate the back-up Dispatch Center.
- Impact on the system and subscribers when the Prime Site switches to the redundant site
- The impact on the system with the catastrophic failure of the building housing the Prime Site.

2.10 Antenna Systems**2.10.1 Antenna**

The selection and design of base station antenna systems along with transmitter combiners and receiver multi-couplers shall be the responsibility of the Contractor, and shall comply with the following requirements:

Design-Build Services for the Radio System Replacement**Section 2.0**

- Each antenna shall be equipped with a new, dedicated transmission line to the combiner or multi-coupler equipment
- All antennas shall be mounted so as to minimize the pattern distortion effects caused by tower members, transmission lines, other antennas, and other objects located near the antenna
- Receive antennas shall be mounted vertically above the transmit antennas with the maximum separation as space on the towers permits
- Antennas shall meet or exceed the requirements of Part I of EIA-329-A. Separate transmit and receive antennas shall be provided
- Antennas shall be high-quality, ruggedized models, designed for long-term, high-reliability performance under high wind conditions, and for minimal generation of passive intermodulation
- Antennas shall meet the wind and ice loading criteria as established in the local building codes.

The Contractor shall ensure that the installed antennas shall not exceed the maximum load of the tower. The Contractor shall perform loading analysis of each tower or antenna structure that shall be used in the proposed design. In addition, a geotechnical analysis will be accomplished at each site, as applicable.

Qualified Proposers shall provide a complete description of the proposed antennas [PRL 12-2-12 Antenna Description).

The Contractor shall provide complete description of the antenna systems provided [CDRL 12-2-12 Antenna System Equipment Description).

The Contractor shall provide, under seal of a licensed California Professional Engineer, an antenna tower loading and geotechnical analyses [CDRL 2-13: Antenna tower loading and geotechnical analysis].

2.10.2 Use of Tower Top Preamplifiers

Tower top amplifiers may be used. If used in, the design for repeater base station equipment configurations, the Qualified Proposer shall demonstrate in its Proposal the need for such units, shall provide their performance characteristics, and shall demonstrate how they will be protected from overload and prevented from generating destructive intermodulation products in the typical high density RF environment that characterizes the majority of the SFMTA's service territory.

2.10.3 Transmission Lines

The selection of transmission lines sizes for each site shall be such that the maximum cable loss at 700 or 800 MHz does not exceed 1.00 dB. The contractor shall utilize industry standard cables capable of providing an optimal balance between cost and performance.

Transmission lines shall be terminated in N-type connectors. Connectors shall be constructed of non-ferrous materials, and shall have gold plated inner conductors and silver-plated bodies. Premium performance, Type N male and female connectors shall be used for all transmission line connections.

Flexible cabling shall be used in short lengths where greater flexibility is necessary to terminate to equipment

Design-Build Services for the Radio System Replacement

Section 2.0

Outdoor cable runs shall be continuous lengths, unless cable lengths exceed the maximum length that can be supplied by the manufacturer.

Six-opening entry port panels shall be provided and installed at repeater sites, if the existing panel cannot accommodate the new transmission lines. Entry ports shall be similar to existing ports at the site.

The unused holes shall be capped and weatherproofed.

Antenna connectors shall be weather-proofed. Butyl-rubber tape shall be applied liberally to the antenna connector and protective coating shall be applied liberally over the butyl-rubber tape.

Each transmission line shall be protected from lightning and static discharges with an appropriate Transient Voltage Surge Suppression (UTVSS") device designed with a voltage-handling capability for the quantity of 1 00 W transmitters required.

Antenna systems shall be grounded in accordance with industry best practices.

2.10.4 Antenna Support Structures

The site specific details of antenna mounting shall be determined by the Contractor during site visits. The Contractor shall be responsible to integrate the availability of support structures at each site and the Contractor's specific design. The Contractor shall, in conjunction with the SFMTA's Project Engineer, provide drawings of each antenna support for coordination with each site manager.

The Contractor shall design and install all tower support structures in accordance with TIA-222(G) or the latest revision.

2.10.5 Transmitter Combiners

The selection and design of transmitter combining equipment and arrangements shall be the responsibility of the Contractor.

The transmitter combiner system shall comply with the following general requirements:

- The transmitter combiner design shall include all frequencies specified herein at all radio sites. The combiner shall be capable of expansion to accommodate additional channels in the future.
- Isolator loads shall be sized to protect against damage to the associated transmitter (and isolator) in case of a transmission line or antenna failure at the output of the combiner that result in 100% reflection of the incident transmitter power from the associated transmitter.
- Interconnections shall use flexible, low-loss, hard-line-type cable
- The transmitter combiners provided shall meet or exceed the following technical specifications:

Transmitter Combiner Specifications

Frequency range	763 to 775 MHz
Minimum isolation, Tx-Tx	64 dB
Minimum isolation, Ant-Tx	50 dB
Maximum insertion loss, per channel	5.0 dB
Maximum continuous power input,	125 W (minimum) per channel

Design-Build Services for the Radio System Replacement

Section 2.0

Input impedance	50 Ohms
Maximum input VSWR, all ports	1.25:1
Minimum channel separation	As determined by frequencies obtained at licensing and frequency sets used at each site
Temperature range	-30 to +60 C
Connectors	Type N female

2.10.6 Receiver Multi-Couplers

The selection and design of receiver multi-coupling equipment and arrangements shall be the responsibility of the Contractor, recognizing that most radio sites on this project have significant ambient RF noise and numerous other active antennas. Receiver multi-couplers shall comply with the following:

- The receiver multi-coupler design shall include capacity for the current and future channel requirements at each site subject to Contractor verification of the SFMTA's radio system capacity requirements
- Multi-coupler systems shall be designed to limit receiver desensitization from the SFMTA or other co-located transmitters to no greater than 1 dB. The Contractor may be required to supply additional band-pass filters to reduce interference from nearby transmitters
- All unused ports shall be terminated with a 50-Ohm load
- Interconnections shall use flexible, low-loss cable
- The multi-coupler shall have a visual power supply failure alarm indicator with a Form "An dry contact output.
- A fixed, isolated test port shall be provided
- The multi-coupler provided shall meet or exceed the following technical specifications:

Receive Multi-Coupler Specifications

Frequency range	764 to 824 MHz
Power requirement	-48 VDC
Maximum noise figure, including	4.5 dB bandpass filter(s)
3rd-order intercept point	+34 dBm
Minimum 1 dB compression point	+18 dBm
Minimum system gain	2.0 dB
Minimum Rx-Rx isolation	25 dB
Absolute intermodulation suppression	-120 dBm, with two -35 dBm input signals
Temperature range	-30 to +60 C
Impedance	50 Ohms
Antenna input connector	Type N female
Receiver output connector	Type N Female
Maximum input/output VSWR	1.5:1

Design-Build Services for the Radio System Replacement**Section 2.0****2.10.7 Other Antenna Systems****Control Station Antennas**

The selection and design of control station antenna systems shall be the responsibility of the Contractor, and shall comply with the following requirements:

- A single, unity gain omni-directional transmit/receive antenna, with ½" foam dielectric transmission line, shall be provided for each of the control stations provided.
- Antenna and polarity mounting method shall maximize RF isolation
- Installation of control station antennas shall be at locations coordinated with the SFMTA.

GPS Antennas

Antennas for GPS receivers and antenna mounting arrangements shall be determined by the Contractor and coordinated with the SFMTA. Hardware and installation shall conform to the overall requirements for reliable long-term performance.

2.11 Underground Design and Implementation

The City transit tunnels include the following:

- Market Street
- Twin Peaks
- Sunset
- Stockton
- Broadway (above ground tunnel, covered street level, buses)
- Presidio (above ground tunnel, covered street level, buses)
- Geary Blvd. underpass at Presidio Ave. (above ground tunnel, covered street level, buses)
- McArthur tunnel Hwy 1 (above ground tunnel, covered street level, buses)
- Yerba Buena Island (above ground tunnel, covered street level, buses).

The existing underground tunnels have street level track access via four (4) tunnel portals:

1. Ferry (Folsom to Embarcadero)
2. Duboce
3. West Portal
4. Eureka (abandoned station).

Additional coverage will be required in the general access areas of each station and egress routes. The Contractor shall coordinate with the SFMTA to identify these precise locations of these areas.

Radio coverage is to be achieved by designing and installing a combination of radiating cable with bi-directional amplifiers to propagate signal received from the outside network through the tunnels or from fiber optic cable connecting to fiber donor and remote units to distributing antennas that will be placed at strategically designed locations to distribute radio signal through the tunnels. The Contractor may

Design-Build Services for the Radio System Replacement**Section 2.0**

propose alternative designs to meet this requirement. The alternate design shall meet the previously mentioned coverage requirements.

Qualified Proposers shall provide a complete description of their proposed underground system design for the above tunnels [PRL 12-2-13 Underground System Design].

Qualified Proposers shall describe how the proposed underground design addresses the following issues [PRL 12-2-14 Underground System Design Considerations]:

- If a simulcast system design is used, how will the design mitigate TDI at the tunnel to above ground interfaces (i.e. portals)?
- How does the design allow for the future use of the radiating component of the underground system by commercial cell phone providers?
- How will the design minimize the quantity of equipment installed in the tunnels?

The outside network signal may be received by donor antennas placed near the tunnel portals and connected to the donor fiber amplifier units or the donor bi-directional amplifiers feeding the radiating cable depending on which design option is chosen.

The radio coverage for the Stockton and Broadway open tunnels may be addressed with a receive and transmit antenna at each end of the tunnel with the receive being used to connect to the outside network signal and the transmit utilized to retransmit that signal through the tunnel sections to be received by radios operated inside or passing through the tunnels.

Underground system general requirements include:

- The proposed underground system design may use any combination of donor antennas, BDAs, leaky coax and distributed antennas as deemed required to meet the coverage requirements throughout the underground
- Donor antennas may be placed at the 4 portals and Forest Hill station
- The system shall provide coverage along the entire run from Ferry to West Portal and the Sunset Hill tunnel
- The system shall be designed for the City's 700 MHz and 800 MHz channels (licenses are found in Appendix Eighteen (18))
- Where possible the BDAs shall be mounted in the nearest station for ease of access.
- Where needed, the BDAs should be mounted on the wall of the tunnels without interfering with the light rail vehicle clearance diagram
- In an effort to minimize the maintenance required, the Contractor shall minimize the amount of equipment that will be installed in the tunnels.
- All of the BDAs shall be powered from a Contractor-provided UPS located in a room at the nearest station or mutually agreed location during detail design phase.
- Power may be distributed to the tunnel BDAs via a 240 or 480 volt AC system powered by UPS
- The design shall assume complete new installation
- The new system shall be installed without removing nor interfering with operations of the existing system

Design-Build Services for the Radio System Replacement**Section 2.0**

- The design of the underground radio system shall include an actual power load calculation.

The Contractor's design shall minimize interference at the underground portals and vent openings in the tunnels.

Underground drawings are included in Appendix Twenty (20). The drawings found in Appendix Twenty (20) are included FOR REFERENCE ONLY and shall be verified by the Contractor during the design phase. To assist Qualified Proposer's in developing a cost Proposal, a fixed length of underground radiating cable has been included in the Cost Proposal Form.

The Contractor shall provide a complete design description of all underground communications systems including actual power load calculations. [CDRL 12-2-14: Underground System Design Description]

2.11.1 Radiating Devices

The Contractor shall design and construct a signal booster system to provide voice and data communications to meet the coverage requirements defined in section 2.3.6. The drawings in Appendix Nine (9) utilized a BDA approach. The drawings use a wideband Bi-Directional Amplifier (BDA) to boost the signal in the underground area.

The system shall be designed on both 700MHz and 800MHz channels.

Coverage will be required in the general access areas of each station and egress routes. The Contractor shall coordinate with the SFMTA to identify these precise locations of these areas.

The Contractor shall be responsible to design the power to the BDA units. The SFMTA requires that the BDA shall be powered with 4 hour back-up power. The SFMTA prefers that this back-up power originate from the Station UPS. Contractor shall provide lockout tag out disconnect switches similar to those utilized for the existing CERS system BDA's in the Market/Twin Peaks tunnel. These switches shall be clearly labeled in a manner similar to the aforementioned BDA's.

The Contractor shall be responsible to determine the minimum gain of the BDA to meet the coverage requirements of the SFMTA. The BDA shall have, at a minimum, the following specifications.

- < 1μsec propagation delay
- Maximum input level < 0 dBm
- Maximum <+30 dBm (single carrier)
- 120VAC or 240VAC
- < 100 W power consumption
- NEMA 4 enclosure
- Noise figure < 3.5dBm

2.11.2 Radiating Cable

The radiating cable shall be installed along the wall of the tunnel. The Contractor shall be responsible to install the radiating cable safely within the envelope of the tunnel. The Contractor shall design a method to attach the cable to the wall of the tunnel for the SFMTA review and approval. Underground tunnel clearance diagrams have been provided for reference in Appendix Thirty (30).

Design-Build Services for the Radio System Replacement**Section 2.0**

Drawing SYS-05 shows the estimated cable distances for each tunnel. The Contractor shall be responsible to verify the lengths of each of the runs. In addition, the Contractor shall be responsible to determine the run lengths for the Stations and Emergency Egress Routes.

The radiating cable shall have the following, at minimum, characteristics:

- Fire Retardant outer coating
- Operating band, minimum, 700MHZ - 800MHZ
- VSWR < 1.3
- Copper inner conductor
- Attenuation (dB/100ft) <0.6
- Bending radius, minimum 20 inches.

The Contractor shall ship the cable on cable spools in an upright position. No cable shall be accepted if the spools are shipped or stored on their sides. The Contractor shall be required to replace any cable stored in this manner at no cost to the SFMTA.

2.11.3 Structural Design

The Contractor shall be responsible for the safe clearance of the BOA enclosure with the trains. The train envelope is defined in Appendix Nine (9).

2.12 Subterranean Cable Car Machinery Structure Coverage

The SFMTA maintains several cable car machinery vaults, as shown in the drawing in Appendix Nine (9). These vaults are located throughout the cable car service area and require portable coverage. This coverage is currently being provided by a single 800 MHz repeater at the Clay and Jones Building. The aforementioned performance reliability requirements shall be met in these areas using either the Clay and Jones site or other site. Qualified Proposer's are encouraged to recommend alternative solutions to the single repeater at Clay and Jones, thereby enabling the cable car machinery frequency to be used in the trunked pool and subscribers given access to full trunking features.

2.13 LMR Network Management

The mobile radio system shall be provided with a Network Management System (NMS) and associated System Manager Terminals (SMT). The NMS provides access to operational data and statistics for the trunked radio system. The NMS shall provide user access based upon a defined authorization hierarchy to be configured by the system administrator. The NMS shall provide the data and functions described in this section for the radio system as a whole, including data channels and trunked voice channels.

The core of the NMS shall be installed at one of the CCSF radio sites. The SFMTA recommends that the Bernal Heights site be the selected site. The Contractor shall provide network-wide access for authorized City and SFMTA users to a centrally located SMT application. Access to the SMT application shall also be permissible using VPN and terminal services.

The network management system shall provide for high system availability by monitoring the PSVRN system on a continuous basis through the use of automatic alarms, diagnostics, and interfaces to maintenance technicians through Contractor provided central monitoring equipment.

The radio system shall also provide a method for monitoring the use of the system through statistical reports by agency and for the system as a whole generated by network equipment on demand.

Design-Build Services for the Radio System Replacement**Section 2.0**

Qualified Proposers shall provide a complete description of the proposed LMR Network Management System [PRI12-2-15IMR Network Management System Description].

The Contractor shall provide a complete description of the LMR Network Management System [CDRI12-2-15IMR Network Management System Description].

2.13.1 NMS and Component Subsystems

Subsystems critical to basic simulcast and trunking operation shall be located at the Bernal Heights facility.

Interconnection to the radio system sites and to primary dispatch facilities shall be provided via existing microwave or fiber optic cable. The Contractor shall review these existing facilities to determine their ability in support the Contractor's design. Use of leased circuits will require prior approval by the SFMTA post-award.

All subsystems and associated subscriber units that constitute the PSVRN system shall be under control of a single network management scheme. The scope of the single network management scheme includes the five basic elements of network management:

- Configuration Management
- Fault Management
- Security Management
- Performance Management
- Accounting Management.

Implicit in the ability to manage these elements is the transfer of relevant managed object attributes that can be used, for example, to generate which managed information reports, alarms, management of system components and software levels, shall be able to be performed from a single point. This shall be accomplished in such a manner that an entry change to one database will automatically change all other associated databases without further user action.

Overall system management shall be able to delegate vertical partitioning management, which distributes the columns of a table into several separate physical records, to the organization responsible for the operation of the partition.

The monitoring of system performance and failures shall be described in detail in the Proposal. The Contractor shall describe system management procedures to the dispatch supervisor and radio personnel, at a minimum.

The system shall incorporate a graphical user interface (GUI) system manager/information management system to set selected parameters and allow the supervisory personnel to control and analyze system operation.

Critical failures should be automatically displayed to alert appropriate the SFMTA, CCSF, and Contractor radio personnel. If positive acknowledgement is not received within 30 minutes, then the system shall contact the SFMTA, CCSF, and Contractor maintenance personnel by alternate means (i.e. telephone, pager, e-mail).

The system shall provide to a single terminal, alarm conditions down to board level failures of all network elements.

Design-Build Services for the Radio System Replacement**Section 2.0**

Access to the management system shall be controlled through the use of an encrypted password (not displayed on the screen).

The system shall be capable of remoting a system manager user terminal without degradation of terminal performance. A remote user terminal shall be capable of performing /accessing all the same functions/information that a local terminal can.

The speed at which the remote terminal connecting from within the MTMS network operates shall be equivalent to that of a local terminal and the accessing of information shall not be noticeably different in physical appearance or access time.

The Contractor shall provide the necessary connectivity to remote terminals.

The remote terminal shall be implemented so that a user has access to required system manager capabilities, which at a minimum shall include:

- System configuration-shall be able to control all of the programmable features of the trunking controller and radio infrastructure
- Subscriber management-shall allow an operator to view, set, or modify the talk group IDs, and the unique 10 profiles
- Manager partitioning-System subscriber management functions shall allow user (agency) partitioning. Manager partitioning shall allow a user to view, set, or modify subscriber information pertaining to a particular agency while restricting access to other agencies. The highest level manager shall be able to view all subscriber information. Partitioning shall allow access to as well as prohibit users from different subsystems programming and system management areas, and subscriber 10 ranges (talk groups and individual 10 ranges).
- Diagnostic management-shall allow an operator to view current status and status history of the system. It shall also allow diagnostics to be performed on network devices (e.g., site controllers, base stations, comparators).
- Dynamic radio commands-regrouping of system users, including the ability to predefine, store, and implement regrouping plans as needed. Sending and receiving of status messages to and from subscriber units. Selective radio status information regarding radio operating status (i.e., on/off, inhibited), last talk group affiliation, and last site registration
- Selective inhibit/un-inhibit of control stations, mobile and handheld radios and trunked repeaters
- Subscriber equipment shall be equipped to respond to the system manager commands
- Activity reporting by unit, talk group, department (if available), and system wide
- User database maintenance with automatic sharing of data and updates between the console electronics and the trunking system
- Activity monitor to display the status and activity of all RF channels of the active prime site controller
- Capability of automatically updating the backup site controller when database changes are made

Design-Build Services for the Radio System Replacement**Section 2.0**

- All user terminal positions shall be equipped with system printers to print activity reports or other output produced by the SM/IMS
- The printers shall be high-speed HP Laser Jet units or their equivalent.

2.13.2 Network Management System Functions

The NMS shall be a comprehensive system of software and hardware, backed by the expertise needed to incorporate network information into a complete management tool.

The NMS shall eliminate the slow turnaround of management data, reduce the time and effort spent deciphering network alerts, and provide the facts needed to make effective management decisions, while easily accommodating network growth and the addition of new technologies.

The Qualified Proposer shall supply detailed information on products and descriptive system solutions as part of their Proposal.

The Contractor's response to the NMS shall show an understanding of the SFMTA's requirements for design and integration of the radio network along with each of the systems and the associated elements needing monitoring and control.

Contractor supplied solution(s) shall be tailored to this RFP and the specifications. Other RFP specifications defining the mentioned systems shall be considered by the responding NMS Contractor in order to fully understand the overall issues and requirements of the NMS.

The NMS shall be developed with an emphasis on customizable graphical displays and simplified interfacing to various networks.

The NMS shall be of a modular structure providing end-users with the capability to expand the base system by choosing from a diverse selection of optional software applications.

The software supporting the NMS shall respond to network expansion by enabling modifications to the NMS as new devices are added or deleted.

The NMS shall be provided as a turnkey system(s).

The Contractor shall supply the software and the hardware, coordinate the entire installation, create the initial graphical representations of the network, perform acceptance tests, and conduct NMS system administrator and end-user training.

The NMS shall be a multiuser, multitasking, multinodal system with customized and interlocked access, monitoring, and control functions per entity.

The SFMTA envisions the NMS to be composed of the following systems: system manager and core NMS equipment at the Dispatch Center, remote user terminals at other remote locations, and network elements, element managers, remote terminal units (RTU) and other Supervisory Control and Data Acquisition (SCADA) elements at the remote radio sites.

2.13.3 Radio Subsystem Manager Considerations

The Contractor shall provide radio subsystem managers that allow the system manager to monitor and manage the radio subsystems.

These radio subsystem managers shall also be supplied in such a manner as to allow alarms and control functions from the radio subsystems to be passed to a remote terminal that monitors the entire integrated radio network.

Design-Build Services for the Radio System Replacement**Section 2.0**

The Contractor shall provide detailed information describing this functionality of the radio subsystems and the connection/access between the radio subsystem element manager systems.

2.13.4 Radio Subsystem Monitoring

The radio subsystem shall provide the capability to automatically monitor the following infrastructure components on a 24-hour basis:

- Communications links to base station sites
- Base stations
- Base station controllers
- Servers.

2.13.5 Radio Subsystem Management Services

Management services shall include the following:

- Automatic radio system infrastructure component fault and failure detection and alarm generation
- Audible and/or visual alarm operator alerting
- Diagnostics for isolating and troubleshooting faults and alarms including all communications links and link equipment
- Message volume statistics by radio channels per hour
- Message volume statistics by base stations per hour
- Message volume statistics by subscriber units per hour
- Thirty-day alarm history log file(s)
- Remote dial-in service support capability.

2.13.6 NMS Alarm Monitoring

SMTs shall display alarms from all radio sites indicating the following conditions at a minimum:

- Transmitter output power
- Synthesizer condition
- Loss of audio
- Power supply faults
- Door intrusion
- Smoke
- High temp
- HVAC failure
- Commercial power loss
- Generator on.

Design-Build Services for the Radio System Replacement**Section 2.0****2.14 Dispatch Equipment**

The dispatch system shall provide open channel operations for light rail revenue vehicles.

The dispatch system shall provide closed channel operations for revenue vehicles (except for light revenue vehicles), in conjunction with the selective calling features provided by the MTMS (Appendix Twelve (12), Section Three (3)). The dispatch system shall provide open-channel operations for non-revenue users on the trunked voice channels.

The system capacity requirements to support the loading for the combined voice and data traffic shall be determined, and mutually agreed during the design phase.

The primary radio system control functions shall operate in parallel with, and be capable of independent operation from the automatic radio system controls of the MTMS to allow for independent operation of the voice system should the MTMS become inoperative.

The SFMTA prefers that primary radio control functions be provided via software that runs on the Dispatcher workstation. All such workstation positions that support voice communications shall also include all appropriate workstation-mounted equipment, such as PTT switch, select and un-select loudspeakers, receive volume controls, and headset jacks.

The PSVRN and MTMS shall include all required desktop communications equipment necessary for PTI voice communications to the vehicle Operators from each of the workstation positions, including backup workstation positions.

Radio Dispatcher workstations shall provide a visual and audible indication of service-affecting trunked voice system failures. This may be a summary alarm simply indicating that the system has experienced a failure; specific details need not be provided as these would be evident on the SMTs from the system technicians.

It shall provide, at minimum, the following functions:

- Voice channel selection
- Select indicator
- Mute
- Mute indicator
- Channel busy indicator
- Transmit indicator
- Microphone
- PTT switch
- Receive audio volume controls
- Select and non-select loudspeakers
- VU meter

Qualified Proposers shall provide a complete description of the proposed dispatch system [PRL 12-2-16 Dispatch System Description].

The Contractor shall provide complete description of the dispatch system provided [CDRL 12-2-16 Dispatch System Equipment Description].

Design-Build Services for the Radio System Replacement**Section 2.0****2.14.1 Radio System to MTMS Interface**

The operator console/central electronic systems shall have the capability to interface directly with the MTMS for the performance of all control, status, and monitor functions, as well as the running of system diagnostics.

The radio system messages, alarms, and status information shall be capable of being forwarded by the console controller system to the MTMS using open system protocols and a comprehensive interface facility.

Qualified Proposer's shall identify the types of interface protocols and methods that will be used to interface the radio system to the MTMS. The SFMTA desires an IP based interface.

All the control functions of the operator consoles shall be capable of being integrated into the MTMS client workstations through a IP-based network connection.

All direct inbound radio messages, control functions, and diagnostic information shall be capable of being forwarded to the MTMS system through a network connection using open system protocols.

All console system control, management, and security functions shall be capable of being controlled by an external network interface using open system protocols.

Specifically, the radio console systems shall be capable of seamless integration with the MTMS, including but not limited to, the following:

- Decoded inbound radio Unit ID and the emergency 10 messages
- Selection of any of the equipped talk group/channels, multiple talk group/channels or pre-assigned group of talk group/channels for transmit operations at any authorized network workstation
- Hardware 10 number and the alphanumeric 10 of any unit transmitting on the system
- System alarms and system status records
- System error records with any deviations from standards indicated
- Talk group/channel busy on the related talk group/channel
- Monitoring from all talk group/channels, whether transmit selected or not
- Priority talk group/channel markers from any of the talk group/channels controlled by the system
- Cross talk group/channel patch capability on any of the talk group/channels from all of the consoles
- Single login for operator position provided by the MTMS system with a minimum of four levels of security
- Ability to perform select audio or un-select audio functions
- Predefined status messages generated by subscriber units. These messages shall be displayed on the operator consoles and delivered to the MTMS system interface. A minimum of eight different status messages per discipline shall be supported.

Design-Build Services for the Radio System Replacement**Section 2.0****2.14.2 Console Features**

At a minimum, each dispatch console shall provide the following features, functions, and equipment that:

- Incorporates high quality design standards specifically to support the reliability required for critical public safety operations
- Meets or exceed all applicable FCC, TIA/EIA, IEEE, and APCO standards
- Incorporates the requirements of the TIA-102 P25 Console Subsystem Interface(CSSI). The contractor can provide consoles that support CSSI as the finalized CSSI standard and products become available.
- Supports a state-of-the-art design using distributed processing topologies
- Provides separate electronics bank(s) with surge suppression and redundant power supplies
- Incorporates continual and automatic diagnostics and comprehensive reporting systems
- Includes digital audio processing
- Integrate the telephone and radio audio into one (1) headset
- Incorporates modular construction throughout circuitry and electronics banks
- Facilitates full interoperation between trunked and conventional systems
- Interfaces to single and multiple site trunked and conventional systems
- Provides access and control of single and multifrequency stations
- Provides full capability for individual channel and talk group controls and access
- Provides one gooseneck microphone per position
- Provides dual headset connections
- Provides dual pedal PTT foot switch
- Provides 12/24 hour clock and month, day, year, status
- Facilitates interface to logging recorders, instant call check devices (trunked, conventional, and telephones) and master time source generators
- Provides one liquid crystal display (LCD) flat panel monitor of at least 18 inches for each dispatch operator position with appropriate human interface device (touch screen, and/or trackball, or mouse)
- Facilitates cross-patch function between trunked talk groups and conventional channels
- Provides simultaneous-selection capability (Ali-Points Bulletin) of various talk groups or channels
- Provides multiselect capability of various talk groups or channels
- Allows monitoring of designated facility and radio system alarms
- Provides select and unselect speakers with volume controls

Design-Build Services for the Radio System Replacement**Section 2.0**

- Decodes inbound radio Unit ID and the Emergency 10 message and routes the 10 to all consoles for display and activates the appropriate audio alarms at the consoles
- Allows only one console operator to transmit on a channel/talk group at a time
- Displays a busy indicator on the related talk group/channel at all consoles
- Displays call indication on all inbound channels/talk groups
- Provides for console monitoring of all talk groups/channels
- Allows a priority channel marker to be placed on any of the talk groups/channels controlled by the system
- Displays the alias names of individual radio units and system ID's
- Provides intercom capabilities between operator positions
- Monitors receivers
- Incorporates main and standby power sources
- Provides for remote dispatch position capabilities
- Provides auxiliary input/output interfaces for auxiliary functions as well as audio recording of voice traffic on base stations
- Provides complete network management and message activity system statistics.

Qualified Proposers shall describe the following for their proposed console system [PRL 12-2-17 Console System Design Considerations]:

- How to implement a hot standby dispatch center and prime site. A Hot Standby site would be used to provide catastrophic redundancy to critical components of the system. Backup servers are usually installed in the same rack as the primary or in an adjacent rack.
- Can the backup servers/equipment be physically remoted to another location to increase survivability?
- Describe your firm's experience in interfacing a CAD/AVL to the radio system and console system
- Explain the architecture of the console system and integration of the CAD/AVL with LMR radio system(s).

2.14.3 Operator Control Capabilities

The operator console positions shall provide, at a minimum, the following functions, features, and capabilities:

- All console operator positions shall be capable of dynamically reconfiguring a console for single channel/talk group or multichannel/talk group operation with easy access to setup changes. A color graphic display of multisized channel/talk group control modules is acceptable for channel selection. Displayed radio modules shall be capable of rearrangement by a telecommunicator by work shift or tactical situation.
- Any operator console position shall be capable of automatically selecting and displaying a transmit/receive channel(s)/talk group(s) or preselected group(s) of talk

Design-Build Services for the Radio System Replacement**Section 2.0**

- groups/channels with a single control up to the maximum number of active channels at the console.
- Any primary control function shall be executed with no more than a single operation or keystroke on preselected talk groups/channels, e.g., multiple channel or group transmit selection.
 - All operator console positions shall be equipped with identical control layout capability. The talk group/channel assignment capability for all consoles shall be identical. A control operation shall always be performed at the same location on the control panel or display screen at all consoles.
 - Status of all selected channels/talk groups shall be visible to the operator at all times, e.g., transmit selected, busy, call, selected receive audio, unselected receive audio.
 - An error in a system entry by a console operator shall activate an audible warning and cause an error message or indication to be displayed.
 - The console design shall allow any console to transmit and receive on one or more transmit/receive channels/talk groups, up to the maximum number of active channels/talk groups at a console.
 - The Contractor shall provide 25 headsets are of the over-the-ear and 25 headsets of over-the-head. Each of the operator console positions shall contain two hand- and foot-operated PTT switches. The PTT foot switch shall be capable of operating in parallel with the operator console PTT switch. The foot switch shall be heavy duty, designed for constant use, and shall be designed so that it will not skid on a smooth flooring surface. The Contractor is to supply and install a switch for each operator position. The hand PTT shall be part of the operator's headset and mountable onto a belt.
 - Each console shall transmit on a talk group/channel on a first-come, first-serve basis. All other consoles shall be locked out from transmitting on that talk group/channel until the first transmission is completed.
 - All consoles shall be provided levels of priority transmit to allow override of transmissions on any talk group/channel in an emergency situation.
 - Two freestanding loudspeakers are required at each console; one each for select and unselect audio paths. Additionally, a minimum of one speaker/audio amplifier shall be provided at each console position. Each speaker/audio amplifier shall be capable of receiving up to four audio inputs and shall have independent volume control. These inputs shall be capable of dispatcher selectable automatic muting during any transmission on any talk group/channel.

2.14.4 Console Controller (Section Removed)**2.14.5 Console Telephone Support**

The console design shall allow each of the console positions to have headset and control capabilities to operate the voice radio system and a telephone device supporting administrative telephone systems.

Administrative telephone equipment and radio shall be selectively operated through a single headset worn by the Dispatcher. The call transfer feature shall automatically hold the telephone call and route the dispatcher's audio to the selected channel/talk group whenever the operator depresses any PTT control switch.

Design-Build Services for the Radio System Replacement**Section 2.0**

The radio audio shall be routed to the select audio speaker whenever a telephone call is in process so that the dispatcher can effectively communicate with the telephone caller and with the radio user simultaneously.

2.14.6 Console Reliability and Diagnostic Features

Due to the critical nature of the communications services provided, the communications control consoles and the console's central controller must achieve a high degree of reliability. The systems shall provide continual and automatic self-testing and diagnosis:

- Be automatically fault correcting
- Alert the operator in the event of component or subsystem failure
- Allow continued operation in the event of failure of a console subsystem through isolation of the defective subsystem
- Provide a high degree of modularity to reduce the number of subsystems affected by a single component failure
- Allow repair of subsystems without totally disabling the console system, as continued console operation is necessary during repair.
- Powered from on-line UPS.

The Contractor shall recommend the appropriate level of spare modules and parts needed to promptly restore the console or central electronics to full service following subsystem failure.

Recommended spare modules and parts shall be listed as individual items inclusive of model or part number, description, and cost. These costs shall be part of the system pricing sheets.

The central electronic assembly shall be interfaced with the system/management terminal to supply comprehensive system statistics and diagnostics identifying console subsystem failures and for the purpose of making service-related inquiries.

2.14.7 Fault Tolerance and Redundancy

The console controller system design shall provide for system redundancy including subsystems

The consoles and console controller shall provide for continued system operation in the event of almost any type of failure. The communications center audio and control circuits shall be continuously tested for proper operation. Equipment shall incorporate features that allow continued function in degraded modes following major equipment failures.

Duplication of circuits necessary to attain this performance shall be provided. No single failure shall entirely disable more than one radio talk group/channel or one console, and the loss of one operator position shall not affect system operations.

All critical system components shall be duplicated to form a backup system supporting automatic changeover that will prevent loss of an operator position, a radio talk group/channel, a call in progress, or the system status. Failure of any data bus shall cause an automatic transfer to a redundant bus structure. A failed module shall be isolated from the system bus structure and readily identifiable as needing service.

The console central electronics design shall provide a redundant configuration with one active central controller and one hot standby central controller. The failure of the active controller shall cause the automatic transfer to the standby central controller with no disruption to any portion of the system. To

Design-Build Services for the Radio System Replacement**Section 2.0**

avoid an undetected shelf failure of the standby central controller, the active controller shall continually run fault diagnostics on the standby unit.

The distributed microprocessor design shall provide multilevel redundancy as each operator position and field circuit shall be capable of independent operation. The failure of anyone or more of these units shall not affect normal system operations.

Card replacement, if applicable, while the system is operating shall not disturb system operation or cause damage to an electrical component. A new card shall automatically duplicate the characteristics of the card replaced.

Console will automatically switch to the backup supply or an alternative, available workstation. For example integral power supplies could be fully redundant, such that if a power supply failure occurs. Reserve power supplies or available workstation shall be maintained in a cold-standby mode for isolation from transient spikes or surges

System design reliability shall include on-line spare equipment, redundant system controllers, redundant communication path, and other redundant equipment as necessary to improve reliability. Redundancy is mandatory where any failure will be catastrophic (loss of transmit or receive functionality for voice or data). System design is as critical as the selection of components.

Where redundancy is employed, malfunctions will not be considered system failures if the system is restored to full operation within 2 seconds or less. System failure is defined as any malfunction that causes loss of system or subsystem to depart from acceptable standards.

Qualified Proposers shall provide the following dispatch equipment information [PRL 12-2-18 Dispatch Equipment Fault Tolerance and Reliability]:

- Any potential single-point failures that will result in a degraded mode of operation.
- How the proposed design will support system reliability requirements for dispatch system facilities with a minimum life expectancy of 15 years from the date of system acceptance
- The projected system reliability and mean time between failure (MTBF) for major subsystems and equipment, based on the system proposed
- The proposed system design's major elements and describe how the system will react to a failure of each major element.

2.14.8 Operating Statistics and Reporting

The console controller shall provide channel utilization information to be accumulated by an integral database repository. This statistical information shall be available for printing in the form of statistics to benefit management operations. The reporting systems shall support the transfer of information into commonly used word processing and/or spreadsheet/presentation applications software for further analysis, presentation, and reporting.

Reports shall include, at a minimum, information in the following categories reportable by console position and/or radio talk group/channel:

- Total uplink transmissions per channel
- Total downlink transmissions per channel
- Total elapsed time of uplink transmissions per channel
- Total elapsed time of downlink transmissions per channel.

Design-Build Services for the Radio System Replacement**Section 2.0**

Information collection intervals shall be variable up to a frequency of one (1) minute. The information collected shall be transmitted to the records database at the end of each interval. Elapsed time measurements shall be accurate to a tenth of a second. Information collected shall include date and time of day. Information shall be stored in an industry standard format compatible with the aforementioned common applications.

2.14.9 Maintenance Operator Console

The console controller system shall incorporate a maintenance operator console that will provide information and configuration access to communications system diagnostics, alarms, and monitoring functions. This console position is envisioned for installation in the dedicated equipment room adjacent to the main dispatching floor and will primarily be operated by the SFMTA's radio technical staff. The technical staff operating the maintenance console shall be provided with the capability of monitoring the functional status of the new system, verifying the proper system operation, responding to system alarms, and performing necessary system diagnostics.

Visual and audible alarms shall be provided at the maintenance console. The alarms shall also be presented, at the SFMTA's discretion, at the dispatch consoles and appear on the designated supervisor console. Additionally, all console electronics alarms shall appear as a network interface to the MTMS.

Capability for displaying hardware 10 numbers of radio units transmitting on each of the channels/talk groups shall also be provided and will be capable of being displayed on the maintenance console. Up to 10 IDs shall be available for display on any selected channel/talk group. A separate display of activated emergency 10 numbers shall be provided.

2.14.10 Console Diagnostic Features

The system shall be equipped with a comprehensive set of self-diagnostic subsystems that shall continually monitor and verify the correct operation of each distributed microprocessor, each audio path in the console electronics (between the electronics and each dispatch operator position), and the system controller.

Diagnostic capability shall be distributed among independent and redundant subsystems and shall not rely on one central diagnostic circuit.

Each message on the console electronics digital data bus shall include a Cyclic Redundancy Check (CRC) or its functional equivalent.

All data messages between the console controller and individual dispatch positions shall include checksum security measures.

For non-IP based systems, the console controller equipment shall periodically run audio diagnostics through each transmit and receive audio path in the system. The audio paths shall include the automatic audio level setting circuitry and the line coupling transformers. Should a fault be detected, the designated supervisory console and the maintenance console shall be notified through a user friendly English language display. Fault minimizing routines shall be automatically activated and diagnostic information shall be logged on an associated system printer or to an applicable storage device/repository for subsequent reporting. For IP based systems, the console controller equipment shall be managed by the network management system (NMS) to diagnose IP connections.

Diagnostic messages shall be presented in an easy-to-read text format, which shall enable non-technical dispatch personnel to intelligently evaluate the situation and minimize disruption to normal operations.

Design-Build Services for the Radio System Replacement**Section 2.0**

Diagnostic systems that require the personnel to cross-reference an error code to a fault message are not acceptable.

2.15 Digital Logging Recorder System

A Digital Logging Recorder System (DLRS) shall be provided at Lenox Way (only) for recording the telephone and radio traffic at each MTMS Dispatch position. Lenox Way has an Avaya PBX. The Contractor shall provide a system manufactured by NICE Systems, or equivalent, for maintenance compatibility with the new system to be provided by SFTMA at the Operations Control Center at 1455 Market Street. The DLRS shall record the date/time and channel information to identify the information being recorded. The DLRS shall be capable to connect to a LAN system and handle a minimum of twelve (12) clients. The DLRS shall interface to analog audio input signals and convert these signals to a digital format for storage on a Storage Area Network, and both non-removable disks and record-capable DVDs.

The DLRS shall include a PC-based display and control unit that may be located remotely from the recording equipment. The equipment to be furnished under this Specification shall be designed for redundancy, clustered, and able to operate continuously 24 hours per day, 365 days per year. The DLRS to be supplied by the Vendor shall produce high fidelity recordings of the SFMTA's voice traffic and provide the features and functions listed below.

Qualified Proposers shall provide a complete description of the proposed Digital Logging Recorder System [PRL 12-2-19 Digital Logging Recorder System Description].

The Contractor shall provide a complete description of the Digital Logging Recorder System [CDRL 12-2-17 Digital Logging Recorder System Description].

2.15.1 Storage Media

The DLRS shall utilize tapes (DAT or AIT) or equivalent devices for the archiving media for the SFMTA's purposes. Recording shall be performed at a compression rate of at least 13 kb/s. The DLRS shall also include a Storage Area Network that allows for long term uninterrupted archiving without frequent manual updates.

When the media being used to record communications becomes full or encounters a failure that prevents further recording, the DLRS shall automatically transfer to an available alternative recording deck. The DLRS shall continue recording all communications on the alternative deck with no loss of communications recording during the automatic transfer. The DLRS shall be equipped with sufficient recording decks to ensure that at least one year of communications may be recorded prior to a change of the archiving media. As a minimum, the DLRS shall be equipped with two removable media recording decks.

The DLRS shall also support storage of audio data to the SFMTA provided Storage Area Network resources.

2.15.2 Recording Channels

The DLRS shall be field expandable to support up to the equivalent of 48 analog or digital channels in the future.

The DLRS initially shall record the PSVRN traffic and the telephone traffic at the MTMS Dispatch position. The DLRS shall be field expandable to support up to the equivalent of 48 analog or digital channels in the future.

Design-Build Services for the Radio System Replacement**Section 2.0**

The DLRS shall be designed to allow the audio inputs for each channel to be set for either current sensing, voltage sensing, VOX sensing, or switch closure, and be FCC approved for direct connection to the telephone system.

2.15.3 Playback

The DLRS shall be capable of storing at least 600 channel hours per week for 40 days on the logger hard disk. The DLRS shall be capable of retaining the last 94,000 channel hours of recordings (or 36 months of recordings, whichever is greater) on-line for instant access.

The DLRS shall provide the ability to simultaneously playback multiple recorded channels (at least 6) either from the logger directly or from a Storage Area Network while recording of all channels is active.

The DLRS shall provide the ability to search, locate and playback the recorded information on specified channels at a specified date and time. The system shall also allow the user to go forward and backwards in a recording in order to locate a specific area of interest, and to skip to the next or previous conversation.

2.15.4 Remote Playback

The DLRS shall provide Users the ability to playback the current recorded data residing on the Recording System non-removable media from any authorized computer connected to the SFMTA WAN using a software-based playback application. Using this application, the remote user shall be capable of selecting the recorded messages by talk group, console, or phone line. The user shall be capable of copying portions of the recorded data to the hard drive of the remote computer. The format of the copied data shall be in a .wav file, mp3, or uncompressed non-proprietary file format. This shall allow the remote user to be able to forward the data segment to other agencies, as the user deems appropriate.

The reproduced records should provide a way to delineate the actual recorded timeline in the recorded. I.e., a settable time announcement as the record is reproduced and heard in the playback. The reproduced records should allow a custodian of records to redact confidential audio within the reproduced records.

The remote playback application shall appear as an icon on the users PC screen. The remote playback shall be capable of a default channel configuration. This will allow the user to select the playback button and easily and quickly listen to a conversation. The application shall allow the user to select a non-default channel for monitoring.

Any remote user shall be capable of selecting any recorded conversation (subject to the user's permission level) that is saved to the system hard drive without impacting the operation of the system.

2.15.5 System Display and Controls

The DLRS shall be configured for complete. local control of all voice logging recorder functions via a PC-based workstation station position placed in the Dispatch room adjacent to the recording media transport. This station shall display status and control information to the user and provide convenient controls that enable user to configure and control the operation of the Digital Recording System. This single display and control station provided by the Vendor shall support all 32 channels being recorded. It is not acceptable to use two or more display and control devices in order to support 32 channels. The information to be displayed to the users shall include but not be limited to the following:

- Recording status of each channel
- System status and functions
- Errors and alarms (including recording media errors, media full. etc.)
- Recording capacity remaining indicator

Design-Build Services for the Radio System Replacement**Section 2.0**

- Playback status of each channel
- On-line help
- Date/time
- Beginning and ending dates and times of the recordings on a particular removable media.
- The controls to be supported by the DLRS shall include but not be limited to the following:
 - Ready
 - Record
 - Play
 - Select a channel to be monitored while recording is active on the channel
 - Stop
 - Eject
 - Volume
 - Set system date and time
 - Rewind
 - Search.

2.15.6 Equipment Monitoring

The DLRS shall be rack mountable.

2.15.7 Error Detection

The DLRS shall provide power-on initialization and self checking tests that are executed while the system is operating to ensure that the system is operating properly. A recording error detection also shall be provided. Any detected errors shall be displayed to the Dispatcher at the Dispatch Center and annunciated via an audible alarm.

2.15.8 Security

The DLRS shall provide multiple levels of security, including restricted access to specific drives, subdirectories, recording modules, servers, setup configurations, and recording channels. The DLRS shall provide at least 4 levels of security access: Administrative, Supervisor, Manager, and user. The DLRS shall provide the capability of restricting certain users or playback workstations to specific audio files only.

Design-Build Services for the Radio System Replacement

Section 2.0

2.15.9 Write Protection

The DLRS shall provide a means for write-protecting selected removable media. The system's storage media management function shall be provided with the functionality of automatically assigning a unique, sequential ID to each archived media for tracking, and must automatically keep a library of those records for later use and retrieval.

2.15.10 Variable Level Control

The DLRS shall provide a variable level control for each recording channel to permit operation within nominal levels between -40 dBm to +13 dBm.

2.15.11 Time Accuracy and Synchronization

The time indicated by the DLRS shall be accurate to +/- 10 seconds per week without external correction.

The time and date for the DLRS shall be capable of being set both manually by a user and automatically by an external time source or system net-time.

The DLRS shall include an interface to a customer-provided GPS time reference. The Digital Recorder System time shall be synchronized to this GPS time reference as often as necessary to maintain a Digital Recorder System time accuracy of +/- one (1) second. As a minimum, the Digital Recorder System shall be synchronized to the time reference once a day.

2.15.12 Operating Temperatures and Humidity

The DLRS shall be designed to operate over the temperature range of 5-40 degrees C and a humidity range of 20-80 % relative humidity, non-condensing.

2.15.13 Frequency Response

The DLRS shall be designed to record over a frequency response range of at least 300 - 3400 Hz.

2.15.14 Channel Isolation

The DLRS shall be designed to ensure that channel isolation is a minimum of 55 dB.

2.15.15 Distortion

The DLRS shall limit distortion to less than 3%.

2.15.16 Signal- To-Noise Ratio

The DLRS shall have a signal-to-noise ratio of at least 40 dB.

2.16 Equipment Installation Requirements

2.16.1 General

The Contractor shall furnish all tools, test equipment, supplies, and services necessary to provide a fully operational and satisfactory communications system for the SFMTA.

The Contractor shall provide all the necessary personnel, tools, equipment, and transportation for the successful installation of all equipment provided.

The SFMTA may require that installation begin within 1 week of material delivery to the installing Contractor's location. The installation Contractor shall be prepared to begin installation at that time.

Design-Build Services for the Radio System Replacement**Section 2.0**

The Contractor shall ensure that all material and components are delivered to the proposed sites.

The Contractor shall be responsible for the security of all materials and components that are left at the proposed sites until site installation is completed and security measures are in place, such as fences, gates, alarm systems, etc.

The Contractor is responsible, and shall provide all hardware and supplies necessary for the proper and complete installation of all equipment. This includes bolts, clamps, wire wraps and other hardware, as required.

Installation shall include the removal, cleanup, and responsible disposal of existing radio equipment and ancillary subsystems that will be replaced under this procurement, with the exception of the underground radiax cable. The Contractor shall be responsible for disposing of all equipment, by certified equipment recyclers where necessary. The Contractor shall label the existing SFMTA radiating cable "For Removal".

Optimization, trouble shooting, and adjustment of each subsystem shall be the Contractor's responsibility.

All existing radio communications systems shall remain fully operational during installation of the new system and until the SFMTA provides final acceptance. Because existing systems support current operations, interruptions in service due to the Contractor or Contractor activities cannot be tolerated. If interruptions in service are deemed by the Contractor to be unavoidable, prior written notification detailing the nature and duration of such interruptions shall be provided to the SFMTA for review and approval.

Equipment shall be installed in a neat and workmanlike manner, in accordance with good practice, by competent technicians or installers.

Inspection and approval of all installations will be provided by personnel designated by the SFMTA. Such approval shall be limited in scope to the specific subsystem's physical installation, and shall not be construed to imply full acceptance of the system or subsystem.

Installation of equipment shall be performed by technicians holding a valid FCC general radiotelephone operators license, National Association of Business and Educational Radio (NABER) certification, or industry accepted equivalent.

Notwithstanding the details presented in these specifications, it is the responsibility of the Contractor to verify the accuracy of the material lists and suitability of devices proposed to meet the intent of the specifications.

The Contractor shall be responsible for providing or arranging for all parts necessary for the equipment and its installation up to and including final system acceptance.

2.16.2 Communication Sites

The Contractor shall be responsible for installing all the necessary components associated with the communications system described in these specifications.

The installation of the RF equipment will be provided by the Contractor at the designated location(s) within the equipment shelters at the base station sites. The Contractor shall supply and install all required equipment, accessories, punch-blocks, terminal strips and/or cables needed to interface to new and/or existing facilities.

Design-Build Services for the Radio System Replacement**Section 2.0**

All audio and control cable/wiring to and from the radio equipment shall be shielded and grounded at both ends. Cable/wiring interfaced to the PSTN shall be shielded up to the demarcation punchblocks and shall have premium surge-suppression devices installed and properly grounded at the shelter entry point and for each such circuit.

All external equipment intercabling, whether RF, AC, audio, or control cables and/or wiring, shall be labeled with preprinted adhesive wire markers. Markers shall be placed at each end, adjacent to the connector, plug, or terminus. For cables and/or wiring within the shelter, markers shall be placed at 3-foot intervals along the length of the cable and/or wiring. This data shall be recorded in the installation documentation.

All equipment cables or cable bundles within the shelter, to the greatest extent feasible, will be neatly tied by means of plastic tie wraps and secured by clamps to flat surfaces.

Rack-mounted equipment shall be installed in standard equipment racks using minimal floor space.

All racks and equipment shall be installed to meet seismic 4. Equipment installed in locations without adequate security shall be installed in lockable enclosures to protect sensitive electronic equipment.

All cable/wiring bundles exiting the equipment shall do so through the top of the cabinets. If cabinets are used to rack equipment, rubber grommets or other suitable protection shall be used at cabinet knockouts to protect the cable/wiring. Splicing of AC, audio, or control cable/wiring will not be permitted.

With the doors closed, all Contractor-supplied equipment shelters shall present a sealed and secured enclosure to minimize the entry of insects and to prevent entry of birds, rodents, and unauthorized personnel.

2.16.3 Antennas and Transmission Lines

Each coaxial antenna transmission line shall be cut to length. The radio equipment end of this line shall terminate at a point, where the lengths of jumper cables are kept as short as possible. This terminus shall be secured to a wall, ceiling surface, or overhead cable tray. The ends of the transmission line shall not connect directly to the antenna, to any RF equipment interference protection, or to any combining/multicoupler/multiplexing devices. Connection to these devices shall be through the appropriately sized jumper cables.

All transmission lines shall be shipped with the spools on end. Any spool shipped or stored on its side shall be rejected by the SFMTA and replaced at the Contractor's expense.

The RF transmission line shall be fastened to the external antenna support structure in accordance with the manufacturer's specifications or every 4 feet for vertical runs. Fasteners and associated hardware shall be made of stainless steel and designated expressly for this purpose. Nylon cable ties are not acceptable.

RF transmission lines run inside equipment shelters or buildings shall be supported by a cable tray.

All transmit coaxial jumper cables shall be ~ inch diameter (similar to Andrew Superflex model FSJ4-50B) or approved equivalent.

Coaxial cables used within the shelters for receive signal distribution, such as receiver multicouplers/splitters may be sized by the Contractor to meet signal loss and flexibility specifications.

Jumper cables shall be used to interconnect all interference protection or combining/multicoupling/multiplexing devices with the coaxial antenna transmission line and RF equipment.

Design-Build Services for the Radio System Replacement**Section 2.0**

Jumper cables shall be used to interconnect the antenna(s) to the top end of the coaxial antenna transmission line.

Jumper cables used to reach a side arm-mounted antenna shall be shaped to form a drip loop.

All jumper cables shall be cut to length and shall use type "N male" connectors except as dictated by the connector supplied with the antenna.

To meet cable-bending specifications for strain relief purposes, equipment cabinet intra-cabling will be permitted by the use of 3/8-inch diameter foam coaxial cable (similar to as Andrew Superflex FSJ1 P-50A). These cables shall be kept as short as possible to minimize signal loss.

All coaxial cables exiting the equipment cabinets shall do so through cabinet feed-through similar to the Celwave model PD-395.

All connectors external to the equipment shelter shall be equipped with weatherproofing sleeves.

2.16.4 Grounding and Lightning Protection

The external commercial power feed to all new fixed equipment power supplies provided under this contract shall be protected by surge suppression devices with silicon avalanche diode type primary, with metal oxide varistors (MOV) backup.

All external radio control circuits, such as telephone lines to the new fixed equipment, shall be protected by surge suppression devices that are properly grounded.

All external coaxial transmission lines to the new fixed equipment shall be protected by gas tube surge suppressors that are properly grounded. The surge suppressor connectors shall be type "N."

All surge suppressors shall be placed at the point where the coaxial antenna transmission line connects to the jumper cable from the RF equipment and shall be grounded at the ground window, similarly to the Polyphaser Earth Entry Portal.

All RF and ancillary equipment supplied by the Contractor shall be grounded to the central ground bus.

All grounding interconnections shall be made by using #2 AWG insulated solid copper wire.

All coaxial antenna transmission line outer conductors shall be grounded to the tower. These grounding points shall be below the top connector of the line, above the point at which bends are made to exit the tower or antenna support structure, and at the lower end of the cable just above the point where the cable bends to enter the cable tray that runs from the tower to the shelter or building. This will provide a direct path to ground for lightning to follow without making any sharp turns.

The ground points shall be made by using the proper grounding kits from the same manufacturer as that supplying the coaxial antenna transmission line and in accordance with the manufacturer's installation practices. No grounding-to-tower cross braces is allowed; only direct conductor-to-site ground ring. Braided ground straps are not acceptable.

Cuts made in the outer jacket of the transmission line to install the ground straps shall be thoroughly sealed and weatherized per manufacturer's specifications.

Ground connections to galvanized tower legs shall be made with transition clamps, thereby reducing the oxidation effect of dissimilar metals.

2.16.5 Cable Terminations

Care shall be exercised in wiring to avoid damage to the wiring and equipment.

Design-Build Services for the Radio System Replacement**Section 2.0**

All wiring and connectors shall be installed in strict adherence to standard communication installation practices, manufacturer's recommendations, and all applicable federal, state, and local codes.

All cables, regardless of length, shall be marked and/or numbered at both ends. Marking codes shall correspond to recognized standards and specifications. All cabling shall be neatly laced, dressed, and adequately supported.

System wiring diagrams shall be prepared that show all inter and intra-rack connections for each site. This shall include all signal, power and ground connections. The diagram shall assign designators to all cables and connectors. The designators used shall be identical to those placed on the cables and connectors. The system diagrams shall also show all cable and connector manufacturers used and their part numbers.

All external equipment intercabling, whether RF, AC, audio, or control cable, and/or wiring, shall be labeled with preprinted adhesive wire markers. Markers shall be placed at each end, adjacent to the connector, plug, or terminus.

No splices shall be allowed in system wiring other than at approved designated locations and with approved devices.

Sufficient wiring shall be installed to provide required services to all locations in the CB with sufficient capability (minimum 40%) for future expansion.

To conserve space in the wall-mounted cross-connect backboard, small AT&T type "110" blocks may be used.

All terminations shall be clearly marked and labeled to allow rapid identification of every circuit in the Center and its termination point to facilitate repair or relocation of equipment.

2.16.6 Communications Console

The installation of the new console and associated equipment shall be provided by the Contractor at the designated location in the CB.

The Contractor shall supply and install all required punch-blocks, terminal strips and/or cables needed to interface the new console controller to the existing facilities, such as radio equipment, telephone equipment, logging recorder equipment, and/or auxiliary function and/or control circuits.

All new console intercabling, including those that are to terminate at the existing punchblocks, shall be labeled with preprinted adhesive wire markers. The markers shall be placed at each cable end, adjacent to the connector or plug, and at 3-foot intervals along the length of the cable. All cables and/or cable bundles will be hidden from view and will be neatly secured by means of plastic tie wraps.

All intercabling to the operator positions and to the central electronic assembly(s) shall be provided with sufficient slack to permit movement of the operator position of at least 5 feet in any direction.

The Contractor shall provide a detailed transition plan that describes how the users shall migrate from the existing to the new system. This transition shall not affect the daily operation of the SFMTA dispatch team.

2.16.7 Mobile Radio Installation Requirements

The following requirements apply to all mobile radio equipment to be installed on vehicles operating on the PSVRN.

Design-Build Services for the Radio System Replacement

Section 2.0

As part of the mini fleet test, the Contractor shall install a prototype of each kind of vehicle operating on the PSVRN. The prototype shall be reviewed and approved by the SFMTA prior to installing the rest of the vehicle fleet.

All mobile radio installations shall be subject to inspection and approval before acceptance, by inspection personnel to be named by the SFMTA. Acceptance shall include but not be limited to:

- Appearance
- Effective usefulness
- Full programming as set forth by agreement
- Full testing, including power out, deviation, receiver sensitivity, antenna VSWR, and all programmed features, to meet or exceed published specifications.

The Contractor shall make every effort to protect all interconnecting cable runs, especially cables that shall be routed underneath the vehicle.

All cabling that is routed underneath the vehicle shall be secured in high impact plastic looms and secured to a stationary support device.

Ties to supports that are exposed to the weather shall be stainless steel straps that are designed for this purpose; nylon tie-wraps are not acceptable.

Care shall be taken to avoid the vehicle exhaust system or other areas that create excessive heat.

Where wiring passes through compartment walls, floors, or rooftops, the Contractor shall protect the wiring from sharp edges with rubber grommets and shall ensure waterproofing to interior compartments.

Installation in any vehicle shall not interfere with any functional device, nor shall it affect the safe operation of the vehicle.

All vehicles that have tilt cabs shall be provided with new ground braids between the cab and the frame of the vehicle. This ground braid shall be installed on metal that is free from paint, grease, or dirt, and shall include a star lock washer to ensure a reliable and secure ground connection.

Wiring of the new equipment shall not be connected to existing radio equipment in the vehicle.

All main power leads shall be obtained from the same voltage source as that used by existing radio equipment.

In vehicles that employ electronic sirens or public address systems (PA), an audio output shall be connected to the siren for effective PA use through the siren speaker.

New radios shall be checked for compatibility with the PA at the time of installation.

The new equipment shall not create or receive interference from other electronic equipment in the vehicle, assuming this other electronic equipment is operating within its operational and regulatory compliance. If any modification is required to the Contractor's equipment to correct such interference, such correction shall be performed on all vehicles to ensure uniformity of equipment. at no additional cost to the SFMTA.

All fuses shall be installed in locations that are easily accessible. No fuses shall be installed in locations under the vehicle.

Design-Build Services for the Radio System Replacement

Section 2.0

All wiring shall be installed in a manner that is secure and free from interference or damage by the occupants.

All antennas shall be mounted permanently to the roof of the vehicle. The Contractor is to provide a detailed transition plan of how they will accomplish this while not affecting the current radio and antenna system on each vehicle. In vehicles that have no permanent metal roof (such as brush units), antenna type and installation are subject to the approval of the apparatus officer or his/her designee. Low-profile antennas, or antennas designed to work without a standard ground plane, shall be available as an option for these vehicles. The SFMTA understands that these vehicles may not exhibit as great a coverage range as normal installations; these vehicles shall not be used as the basis for coverage acceptance.

No cable connectors fabricated in the field shall be crimp-type. All connectors shall be soldered using 60/40 solder within heat shrink that incorporates some form of sealant to ensure proper connection.

Reflected power, or VSWR, shall be measured after installation of each antenna and cable. Maximum reflected power shall not exceed 4% of the radio unit's output power.

It shall be the Contractor's responsibility to determine what vehicles require installation of a weatherproof mobile unit.

All mobile units installed in the fleet shall be of uniform type.

Radio units shall be easily moved from one vehicle to another, if required.

No wiring shall be spliced within the loom covering that wire.

No wire shall change color between the source and the radio unit.

The Contractor shall be responsible for making corrections to any vehicle that experiences dormant operation battery drain, where such drain can be attributed to new equipment installation. The Contractor is encouraged to check vehicle batteries before radio installation to avoid problems. If a vehicle is found to have faulty batteries, the Contractor shall notify the SFMTA and note this on the installation documentation.

Acceptance of mobile installation shall not imply acceptance of the radio system.

2.17 Options

Qualified Proposers shall provide a complete description of all proposed radio communications systems options [PRL 12-2-20 Radio Communications Options Description].

The Contractor shall provide a complete description of all purchased radio communications options [CDRL 12-2-18 Radio Communications Options Description].

2.17.1 Over the Air Programming (OTAP) Option

The Contractor shall, as an option, provide a system that allows the SFMTA to remotely reprogram the template of subscriber units. The Contractor shall provide a growth path to allow the SFMTA to add this feature in the future.

The Contractor shall provide a description of the components and software that are required for this feature to operate on the radio system. The Contractor shall provide a description of how OTAP operates.

This discussion shall include, but not limited to, the following concerns:

Design-Build Services for the Radio System Replacement**Section 2.0**

- Impact on system capacity
- Impact on CAD/AVL polling
- Length of time required to program a radio using OTAP.

2.17.2 Over the Air Rekeying (OTAR) Option

The Contractor shall, as an option, provide a system that allows the SFMTA to remotely rekey the encryption code of subscriber units. The Contractor shall provide a growth path to allow the SFMTA to add this feature in the future.

The Contractor shall provide a description of the components and software that are required for this feature to operate on the radio system. The Contractor shall provide a description of how OTAR operates. This discussion shall include, but not limited to, the following concerns:

- impact on system capacity
- impact on CAD/AVL polling
- length of time required to program a radio using OTAP
- how many codes can managed by the system
- management of the codes.

2.17.3 Encryption Option

All voice and data channels on the system shall be capable of end-to-end encryption from a radio dispatcher workstation to a subscriber unit or subscriber to subscriber. The encrypted communications shall not be decrypted at any step in the communication process except at the subscriber or dispatch units. Encryption shall be enabled and disabled manually via a switch or menu function on the radio and/or at the workstation.

Encryption shall not result in any degradation of the voice signal quality compared to a clear voice signal on a radio operating in the same circumstances and location as the encrypted radio.

Operation in encrypted voice mode shall be transparent to users, except that an icon or some other indicator on the mobile or portable radio and at the workstation shall indicate such operation.

Data encryption shall operate in a similar fashion, and shall also be transparent to the user, except that an icon or some other indicator on the mobile or portable radio and at the workstation shall indicate that the channel is operating in encrypted mode.

2.17.4 Intrinsically Safe Portable Equipment

Qualified Proposers shall propose, as an option, portable radio equipment with batteries and accessories that are intrinsically safe.

2.18 Proposal Requirements List

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

- PRL 12-2-1 Coverage Maps
- PRL 12-2-2 Failsoft Operation Description
- PRL 12-2-3 Failure Scenario Descriptions

Design-Build Services for the Radio System Replacement

Section 2.0

- PRL 12-2-4 Backup Power Systems Description
- PRL 12-2-5 Coverage Models
- PRL 12-2-6 Interoperability Design
- PRL 12-2-7 Desktop Control Station Equipment Description
- PRL 12-2-8 Link Budget Analysis
- PRL 12-2-9 Portable Equipment Description
- PRL 12-2-8 Mobile Equipment Description
- PRL 12-2-9 Vehicle Logic Unit Interface to Mobile Radio Description
- PRL 12-2-10 Simulcast System Design
- PRL 12-2-11 Prime Site and Dispatch Center Redundancy
- PRL 12-2-12 Antenna Description
- PRL 12-2-13 Underground System Design
- PRL 12-2-14 Underground System Design Considerations
- PRL 12-2-15 LMR Network Management System Description]
- PRL 12-2-16 Dispatch System Description
- PRL 12-2-17 Console System Design Considerations
- PRL 12-2-18 Dispatch Equipment Fault Tolerance and Reliability
- PRL 12-2-19 Digital Logging Recorder System Description
- PRL 12-2-20 Radio Communications Options Description.

2.19 Contract Data Requirements List

The following CDRL items are required, as specified within this section:

CDRL 12-2-1 System Growth Plan.

CDRL 12-2-2: Intermodulation Analysis

CDRL 12-2-3: Tunnel Interference Analysis

CDRL 12-2-4: Time Domain Interference analysis for the system

CDRL 12-2-5 Air Time Traffic Analysis Report

CDRL 12-2-6 Failure Modes Analysis

CDRL 12-2-7 Coverage Analyses

CDRL 12-2-8: Link Budget Analysis

CDRL 12-2-9: LMR System Drawings

CDRL 12-2-10 Desktop Control Station Equipment Description

CDRL 12-2-11 Portable Equipment Description

CDRL 12-2-11 Mobile Equipment Description

Design-Build Services for the Radio System Replacement

Section 2.0

CDRL 12-2-12 Antenna System Equipment Description

CDRL 12- 2-13: Antenna tower loading and geotechnical analysis

CDRL 12-2-14: Underground System Design Description

CDRL 12-2-15 LMR Network Management System Description

CDRL 12-2-16 Dispatch System Equipment Description

CDRL 12-2-17 Digital Logging Recorder System Description

CDRL 12-2-18 Radio Communications Options Description.

The Contractor is advised that the above list does not constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole, or by reference, as part of the complete package of deliverables and submittals.

3.0 INTELLIGENT TRANSPORTATION SYSTEM (ITS) COMPONENT

3.1 General Requirements

As part of Contract No. 1240, the SFMTA seeks to procure an off-the-shelf Multi-Modal Transit Management System (MTMS) consisting of Computer Aided Dispatch (CAD), Automatic Vehicle Location (AVL), and other Intelligent Transportation System (ITS) components to improve planning and operations of the SFMTA services. This system shall automate data entry and business processes. MTMS components shall include intuitive graphical user interfaces, directed navigation between application windows and screens, simplified data preparation and initialization, automated interfaces, and access to current and archived data and information.

The Contractor shall supply, license, install, integrate and implement the MTMS components on the SFMTA vehicles and fixed sites to provide continuous real time data of the location for revenue and selected non-revenue vehicles. The configuration of the MTMS on-board components shall include a Mobile Data Terminal (MDT) with an intuitive user interface and single point of logon integration, installed on each revenue vehicle. The MDT shall serve as the interface between the vehicle operator and the Control Center, and between the vehicle operator and other integrated onboard systems.

The MTMS shall include all hardware, software, and services necessary to accomplish the design, supply, installation, integration, documentation, testing, training, cutover, system acceptance and warranty of the complete MTMS. The MTMS configuration shall be based upon the SFMTA configurable parameters as required. These SFMTA configurable parameter values shall be propagated and used by all applications throughout the MTMS. Parameters shall include but not be limited to vehicles, operators, fleets, divisions, data messaging, communication settings, application settings, and operational thresholds.

Regardless whether integration options are included in the scope of work, the MTMS shall be capable of integrating with Automatic Passenger Counter (APC), automatic announcements, Automatic Vehicle Health Monitoring (VHM), electronic fare collection including the existing farebox and the optional TransLink® Regional Smart Card System, Traffic Signal Priority (TSP), and customer information systems.

Regardless of whether the option to provide a Geographically Separated MTMS Hot Standby is executed, the MTMS shall be capable of interfacing with and mirroring data to the hot standby system.

The basic workflow for rubber-tire dispatchers and rail controllers shall be exceptions-based. Based on the assigned work, rubber-tire dispatchers and rail controllers shall be alerted when performance deviations occur, e.g. a vehicle running ahead of schedule beyond a SFMTA defined threshold.

Appendix Twelve (12) Section Two (2), "Radio Communications Components", describes the integrated Public Service Voice Radio Network (PSVRN) that the Contractor will implement, and that will support functions described in this section.

The Qualified Proposers and the Contractor must not assume the availability of communications components that are outside of the scope of the PSVRN. If proposed MTMS components drive the need for communications components to meet the requirements of this section, these communications components shall be provided by the Contractor. This applies to both voice and data communications.

Design-Build Services for the Radio System Replacement**Section 3.0****3.2 Base ITS Components**

The MTMS shall integrate the PSVRN, vehicle (onboard) systems, the dispatch communications, the CAD, and data system. Both data that has been generated in real-time and stored by the MTMS shall be available to the other SFMTA data systems and the general public, in a single, consolidated and overarching repository of that transit data. Query capabilities shall be provided that allow users to extract transit data from the repository.

The MTMS shall be designed to accommodate access to reports, data, system tools and applications to all user groups throughout the SFMTA. User groups include, but may not be limited to:

- Rubber tired and rail operations, including interim line management, dispatchers, train controllers, station agents, road supervisors
- Maintenance including rail mobile response units
- Traction power
- Security, proof of payment and emergency management
- SFMTA Management
- Planning
- Scheduling
- Information Systems
- Customer Service (311)
- Marketing and Communications.

Initial deployment shall include installation, licensing, and training support and system maintenance for dispatch workstations (including voice console capability) and web-based terminals throughout the SFMTA's facilities.

In the response to this RFP, the Qualified Proposers shall describe their software licensing terms in itemized form [PRL 12-3-1 Software Licensing Terms). The Contractor shall also provide licenses for data-only workstations capable of accessing the MTMS. The quantities are detailed in Appendix Fourteen (14), "SFMTA User Work Station & License Requirements".

The Contractor shall provide distinct sets of vehicle equipment for each of the SFMTA's modes:

- Rubber tired diesel buses, diesel hybrid electric buses, and electric trolleys. The Contractor shall provide a full suite of vehicle equipment, including options.
- LRVs. The requirements for the integrated on-board traveler information subsystem on LRVs are described in Appendix Twenty-Three (23).
- Cable cars. The Contractor shall provide a limited suite of vehicle equipment for data communications which shall include automatic vehicle location. Some cable cars are dual-ended and the proposed equipment shall accommodate dual-ended operation. The cable car configuration shall not have any passenger facing or operator facing equipment, including control heads or MDT's, and operate without user interaction. The installed equipment shall not be visible to the public, and surveys and installation

Design-Build Services for the Radio System Replacement**Section 3.0**

work shall not commence without the SFMTA's approval. The equipment selected for the cable cars shall accommodate the battery powered environment of the vehicles, and generally be of low power consumption. The Contractor is encouraged to replace existing equipment in place, with no, or only limited penetration of cable car structures, as approved by the SFMTA. In the instance of the cable cars, the use of commercial carriers for data connectivity might be acceptable. In- and outgoing data shall be processed such that records of cable cars, although possibly limited in scope of attributes, are seamlessly integrated with the MTMS.

The selected standard shall be supported by multiple carriers to allow the competitive procurement of carrier services. This requires that the communications equipment shall not be locked to a single carrier, allowing the SFMTA to switch carriers by simply switching Subscriber Identification Modules (SIMs), or the equivalent thereof.

- Historic street cars. The Contractor shall provide a limited suite of vehicle equipment for voice and data communications which shall include automatic vehicle location. Some historic street cars are dual-ended, and the proposed equipment shall accommodate dual-ended operation. Installation and appearance of passenger facing equipment, if any, shall adopt the vehicle interior theme. Equipment enclosures that are visible to the public shall be consistent with the interior materials and color schemes. Incoming and outgoing data shall be processed such that records of historic street cars, although possibly limited in scope of attributes, are seamlessly integrated with the MTMS. The selected standard shall be supported by multiple carriers to allow the competitive procurement of carrier services. This requires that the communications equipment shall not be locked to a single carrier, allowing the SFMTA to switch carriers by simply switching Subscriber Identification Modules (SIMs), or the equivalent thereof.
- Non-revenue vehicles will require equipment enabling voice communications, and selected non-revenue vehicles will require automatic vehicle location, emergency alarm, and service messaging through an MDT. Three variations of non-revenue vehicle configurations are specified in Appendix Twenty Eight (28), "Cost Proposal Form":
 - Configuration "A" - refers to mobile voice only, including a mobile radio and control head. A portable radio charger shall also be provided.
 - Configuration "B" - adds to Configuration "A" by providing Automatic Vehicle Location (AVL) functions, as specified below.
 - Configuration "C" - adds to Configuration "B" by providing a Mobile Data Terminal (MDT).

In the response to this RFP, the Qualified Proposers shall provide a comprehensive list of the major components of the proposed on-board equipment that is typical for each type of revenue and non-revenue vehicle. [PRL 12-3-2 Major On-board Equipment Components List]

Some vehicle types are articulated vehicles. In the response to this RFP, the Qualified Proposers shall provide a description about their approach and experience in equipping articulated vehicles [PRL 12-3-3 Approach to Equipping Articulated Vehicles].

The following existing equipment shall be re-used on a per-vehicle basis, if it is fit for use in the MTMS:

- On-board speakers (internal and external) and cabling

Design-Build Services for the Radio System Replacement**Section 3.0**

- On-board signage: head signs, side sides, tail signs and passenger facing run signs, including cabling
- Gooseneck microphone.

It shall be the Contractor's responsibility to make functional and integrate this existing equipment. Prior to installation of each individual vehicle, a pre-inspection of equipment to be interfaced or integrated with the Radio Replacement Project shall be conducted by the contractor installation crew, recording and signing off on the condition of the vehicle and systems installed on it, including equipment that might be replaced under the above provision. A clear and legible statement shall indicate the reason for replacement. As part of final design, the Contractor shall submit a pre-inspection procedure including pertinent work instructions and form for approval by the SFMTA [CDRL 12-3-1 Pre-inspection Procedure].

The following existing vehicle equipment shall be replaced:

- Covert alarm switch
- Covert microphone
- Vehicle operator loudspeaker and handset.

Existing connections such as EA button to camera surveillance system shall be restored.

As is a requirement for all equipment installed in this project vehicle hardware shall be new, factory built equipment.

Vehicle Logic Unit (VLU)

The MTMS shall include VLUs that include the central processing unit (CPU), memory, data storage and vehicle software residing on each vehicle. As the central point of on-board subsystems integration, the VLU shall interact with all of the vehicle subsystems and support communications via a wireless bulk data transfer network with a central server. The VLU shall meet environmental and vibration standards (MIL-STD-810D, NEMA-4) as well as appropriate electromagnetic immunity standards (SAE 1455 and ESD J1112/13) and protect against surge, and reverse polarity. The VLU shall be of proven design and easy to install and replace.

Regardless whether the SFMTA elects to purchase any or all options specified in Section 3.29, the base VLU and MDT shall be capable of accommodating those options. In order for those options to be fully functional or, if such upgrades or changes are required, the Contractor shall be responsible for the implementation of these upgrades or changes. These upgrades or changes shall be carried out without service disruption to the SFMTA. All software updates needed to implement the options in the VLU shall be provided by wireless update.

The VLU shall be capable of multiple radio control, real time updates, and messaging to and from the vehicle. The VLU shall meet communication requirements for the wireless bulk data transfer network, radio, as well as interfaces for current and future onboard Intelligent Transportation Systems. The VLU shall control and electronically switch all interface audio paths.

Overall, system interfaces whether provided by VLU or the MDT, shall include RS232, RS485 with busy line, TIL, SAE J1708, SAE J1939, USB, Ethernet, TCPIIP, discrete inputs and outputs, odometer, spare 110 pins. audio inputs and outputs, and full IDE capability for PC-type devices. The capability for

Design-Build Services for the Radio System Replacement**Section 3.0**

automatic vehicle monitoring via J1708/CAN provided by the vehicle OEM shall be included as an option.

Means for the quick inspection of the operation of radio keyed, wireless, wireless bulk data transfer, software, proper voltage range, and ignition on shall be provided. Data storage capacity shall be sufficient to store at least five operating days of passenger counts and all event messages in the case of data communications disruption. Sufficient data storage capacity shall be installed to store two sets of complete current transit network, schedule and operator assignment data, pending route schedules, five days of operating data, and associated announcement files with 50% spare capacity for long-term growth. MTMS configuration settings related specifically to the vehicle shall be stored in the vehicle's configuration module installed in the vehicle such that the VLU unit can be swapped out and the unique vehicle information automatically associated with the replacement VLU. Each VLU shall have a unique IP address for purposes of participating in the wireless bulk data transfer network, and for remote monitoring.

Regardless of whether the SFMTA elects to purchase any or all options, the base VLU shall be capable of accommodating those options. Purchasing any or all of the options shall not require any VLU firmware or hardware upgrades in order for those options to be fully functional.

Automatic Vehicle Location (AVL)

The Automatic Vehicle Location (AVL) subsystem shall provide a derived location using an on-board Global Positioning System (GPS) receiver and other location determination devices (e.g. Wide Area Augmentation System (WAAS), gyroscope, electronic odometer) as needed to provide automatic location accuracy within ten (10) meters of actual vehicle location. The use of active wayside components such as signposts, hub odometers, or obsolete technologies such as LORAN-C or inductive loops are not acceptable. In the response to this RFP, the Qualified Proposers shall provide a description that specifies the accuracy of the proposed AVL subsystem [PRL 12-3-4 AVL Subsystem Accuracy]. MTMS vehicle location shall be determined by a navigation algorithm that collects inputs from multiple sources and calculates a solution based on the reported reliability and weighting of each input device. Location determination devices other than GPS shall automatically calibrate and require no operator or maintenance personnel intervention for daily use. Proper operation of the onboard systems relying on location reporting shall not be interrupted for vehicles leaving from an enclosed storage area.

The GPS antenna shall be a low-profile unit housed in a rugged and weather tight enclosure. The GPS antenna shall be securely mounted and sealed on the exterior of the vehicle, clear of obstructions, and clear of interference from other devices or Radio Frequency interference. The GPS system shall provide a spare NMEA-string based GPS output that is made available over the Vehicle Area Network.

The GPS system shall have a cold acquisition time of no more than two (2) minutes, warm acquisition time of no more than fifteen (15) seconds and update the current position at least every five (5) seconds. The GPS system shall include multi-path rejection capabilities to help eliminate inaccurate signals caused by reflections off of buildings or other structures. Vehicle location shall be transmitted at least once every one (1) minute to the central MTMS for display and storage purposes and every fifteen (15) seconds during an Emergency Alarm.

Design-Build Services for the Radio System Replacement**Section 3.0**

GPS delay time from location acquisition to formatting for transmission shall not exceed one (1) second. The GPS system shall store the most recent location to provide as the "last known good" location in the event that location reporting is interrupted. Location messages transmitted to dispatch shall indicate messages status as current, or "last known good".

On board of the LRVs, location-based traveler information is provided to the passengers based on ATCS-triggered announcements. This is available when LRVs operate in auto mode within the ATCS territory. On-board AVL to drive AVL and all other functions shall be provided regardless whether trains are operating in auto, or cut-out mode. At the central side of the ATCS, parameterized data consisting of ASCII text messages is uni-directionally (from ATCS to the SFMTA network) streamed via internet/telnet. This is factored in to the NextBus system's predictive arrival information. By use of a parsing routine, the information can be made human readable for development use. The key to breaking out the parameters of each message resides in an AWK script file that can easily be imported for use by a programming language such as C/C++ or Java. MTA will supply the AWK file on request. The data provided includes time-stamped status reports on various objects in the subway. Messages are event-driven: for example, a message is generated when a train reports arrival at a station platform, doors are reported open, when doors are closed, and when the train departs the platform. It is possible to use this data to track any train through the subway. Many of the messages contain reference to logical location called a "track section", which in turn can be mapped to geographic coordinates by use of a reference table. MT A will provide the reference table necessary to make the conversion from track section to lat/long.

Given these existing capabilities, the SFMTA strongly recommends that this data stream be factored into the AVL subsystem to provide vehicle location updates to the central system, as well as to the vehicles operating in the ATCS territory, for a seamless integrate of the underground portions of the light rail system with the above ground portions.

Mobile Data Terminal (MDT)

The Mobile Data Terminal (MDT) shall be a color graphical screen capable of displaying fonts of variable size and adequate to display the relevant communications and Computer Aided Dispatch (CAD)/Automatic Vehicle Location (AVL) information to operators and maintenance technicians. The MDT shall be designed with appropriate functional buttons capable of controlling other onboard ITS systems (e.g. fareboxes, head signs, card readers) including a numeric keypad. For a hard key user interface, the MDT buttons shall provide tactile feedback for positive recognition of engagement. The user interface of a touch screen unit shall not require additional cleaning and provide positive recognition of screen taps.

The MDT shall provide brightness controls to provide for clear and easy viewing in day, night, or high glare conditions. The screen shall be scratch and glare resistant. The MDT shall be easy to install and replace, be durable, and be suited for use in the SFMTA's environment. Status and configuration data of all integrated onboard systems including GPS, communications network, discrete signals, passenger counters, farebox, wireless bulk data transfer network, applications software updates, and odometer, shall be available for query by a service technician. This function shall require separate authentication in order to lock out other users from accessing status and system configuration data.

The MDT shall display the vehicle's actual progress relative to the route pattern stops, and display schedule and headway adherence, depending which mode is active for the route. The MDT shall

Design-Build Services for the Radio System Replacement**Section 3.0**

display the MTMS-determined time in a user selected format, including 24 hour and AM/PM presentations. The MDT shall display vehicle status including data transmission, pending messages, and communication mode to the regular user. The MDT shall have the capability to trigger individually different audible signals to identify the type of incoming service messages. The MDT shall be capable of providing onboard information and interface to onboard systems during operation of the vehicle including:

- Logon, integrated with Fare Collection (Cubic farebox and optional TransLink system) for a single point of logon
- Request-to-Talk (RTI) and Priority Request to-Talk (PRT))
- Emergency Alarm (EA)
- Service messaging
- Transfer notification
- Schedule adherence
- Manual headsign control
- Automatic Passenger Counts
- Manual stop announcements
- Current trip and schedule
- Route
- Destination
- operator ID
- Context sensitive on-screen help.

When the power is turned on, the MDT software shall automatically perform a power-on-self test, followed by configuring and initializing the MDT to the SFMTA-specified default values. The MDT shall be self-restarting and shall not become unresponsive or require manual restarts to continue operations. The MDT shutdown process will be controlled by the MDT software and shall only be possible when the ignition is in the off position.

A SFMTA configurable shutdown delay shall be provided to continue operations and to initiate the shutdown procedure that shall automatically close all files, save values, and send a shutdown message to be recorded in the MTMS system.

A warning shall be displayed on the MDT if a logon has not occurred after a vehicle is moved beyond a SFMTA configured distance outside of a yard. This warning shall be transmitted to the central MTMS for storage, and displayed on the dispatch workstations.

A logon process shall be provided for maintenance purposes to enable a vehicle to be moved throughout a facility for servicing and maintenance purposes without triggering alarms.

Design-Build Services for the Radio System Replacement**Section 3.0**

LRVs and other steel wheel vehicles are double-ended and require multiple sets of vehicle operator facing equipment, including MOTs. The Contractor shall provide a full set of vehicle operator controls on each end of dual-ended vehicles.

The MDTs and VLUs shall be physically separated units. The MDT shall be designed for space efficient installation on the dashboard or other determined location, and minimize the number of cable runs needed. Power, and a data connection to the VLU, shall suffice to integrate and operate the MDT.

Single Point Logon

The Contractor shall integrate the existing farebox, existing ITS on-board systems (as required), and existing legacy systems with the MTMS in a manner that allows the vehicle operator to logon to the integrated on board systems, using the MDT only. The relevant data elements shall be derived from the operator logon procedure, and transmitted to the integrated on-board systems. The Contractor shall design the operator logon procedure and the derivation of the relevant data elements as part of the final design.

Operator input to the integrated system shall not be needed. The MTMS shall include a method to automatically detect trip changes within a block or train, and update peripheral systems (i.e. farebox Optional TransLink®, APC, etc.) with new trip information, as needed. The peripheral systems shall provide the VLU with fault and alarm codes. These fault and alarm codes shall be returned to the central MTMS via the wireless bulk data transfer network.

On the MDT, vehicle operators shall be prompted to enter the following data elements to log a vehicle on to the Computer Aided Dispatch (CAD) system: block or train number, run number, employee number, and fare set. These data elements shall be propagated to the integrated on-board systems, and drive all on-board functions without the need further intervention by the vehicle operator.

A log-over feature shall be provided that keeps block or train, run and fare set, but allow the entry of a new employee number only.

Integrated on-board systems shall remain easily accessible and maintainable, and existing diagnostics functions shall remain intact.

In response to this RFP, the Qualified Proposers shall indicate their approach and assumptions to provide the requested level of on-board integration [PRL 12-3-5 On-Board Integration Approach].

The SFMTA currently uses multiple vehicle types in five different modes. Existing revenue vehicle equipment is summarized in Appendix Twenty Eight (28), "Cost Proposal Form".

The Contractor shall be responsible for the implementation, build, verification, validation, and installation of all subsystem interfaces.

Automatic On-Board Traveler Information System

The automatic on-board traveler information system provided by the Contractor shall use Automatic Vehicle Location (AVL) and logon data elements from the Mobile Data Terminal (MDT) to trigger the relevant automatic on-board traveler information throughout a block or train. The SFMTA's revenue fleet shall be equipped with automatic on-board traveler information systems as detailed in the mode specific sections below.

Design-Build Services for the Radio System Replacement**Section 3.0**

All existing and new on-board passenger displays and audio shall be under the control of the automatic on-board traveler information system. The network and schedule data along with announcement files shall be provisioned through the wireless bulk data transfer infrastructure at the divisions (yards) and other parking points that are equipped with a back-end wireless infrastructure.

The on-board sign shall display the following real-time information:

- Stop approaching
- Stop requested signal (initiated by travelers)
- Route and destination when doors are open
- Time
- Vehicle operator identification (employee ID)
- Public service messages, as set up and configured by the SFMTA. The frequency and duration of these messages shall be configurable by the SFMTA.
- On-board internal audible announcements shall mirror the on-board signs in accordance with the ADA.
- Route and destination shall be announced on the external speakers when the vehicle is at a stop or station berth, and the doors are open. The audio volume of external announcements shall be automatically adjusted by time of day, as configured by the MTMS system administrator.

If multiple messages need to be displayed simultaneously, the messages shall alternate on the on-board signs, based on rules specified and proposed by the Contractor and agreed upon by the SFMTA, prior to final design review.

The run number shall be displayed on the existing dashboard mounted, outward facing sign.

Audible automatic next stop announcements shall be transmitted through the on-board speakers (internal). The speakers are also used for passenger announcements by the vehicle operator or the control center. This drives the requirement to integrate the voice path infrastructure with the automatic next stop announcement system and the Contractor shall integrate all on-board voice paths relevant to traveler information (automatic and otherwise) with under the control of the VLU.

The SFMTA anticipates cases where manual intervention on board of the vehicle may be required to adjust or completely disable automatic on-board traveler information. A function to manually override announcements and sign displays shall be provided and controlled through interactions with the MDT (control head). This function shall be available to vehicle operators, however only when the vehicle is standing still.

Mode specific requirements: Rubber tired fleet

The SFMTA's rubber tired fleet is currently equipped with the Dynamic Vehicle Announcement System (DVAS). The internal, destination and run signs, as well as the loudspeakers (internal and external) shall be re-used, unless replacement is required due to defects. Whether replacement of existing equipment is required shall be assessed and recorded prior to any vehicle installation activity. In the response to this RFP, the Qualified Proposers shall include a contingency budget to cover the cost of

Design-Build Services for the Radio System Replacement**Section 3.0**

these replacements. The existing DVAS equipment shall be decommissioned and removed, except for equipment that is needed to interface with the existing signs.

Mode specific requirements: Light Rail Vehicles (LRVs)

Currently, automatic passenger announcements are generated by the SFMTA's Advanced Train Control System (ATCS). This arrangement does not include on-board displays or any automatic on-board traveler information capability outside of the ATCS territory. The SFMTA is undertaking an upgrade to this system, installing a Digital Visual and Audio System (DVAS) on the LRV fleet. This system will provide internal signs and cover the entire LRV territory. The Contractor provided onboard systems shall interface with the DVAS through the interfaces provided by this system. The following functions shall be provided through these interfaces:

- Automatic triggering of announcements, based on logon to a block or train number
- Automatic triggering of internal sign displays, based on logon to a block or train number
- Automatic control of head- and run signs, based on logon to a block or train number
- Switching of the DVAS audio paths to connect audio sources such as the voice radio with the operator speakers
- Operator manual override of the above functions
- Operator manual triggering of announcements and setting of on-board signage
- Logging of triggered messages, for both automatic and manual manuals.

The requirements of this integrated on-board traveler information subsystem are described in Appendix Twenty-Three (23).

Mode specific requirements: Historic Fleet and PCC Street Cars

Automatic on-board traveler information is not required for the historic fleet and PCC Street cars.

Mode specific requirements: Cable Cars

Automatic on-board traveler information is not required for the cable car fleet.

3.2.1 Communications

Communications in the MTMS system shall be event driven. Active monitoring of screens and other devices shall not be required in order to allow the fulfillment of staff duties. A variety of message types shall be used to signal operational events

Emergency Alarm

The Emergency Alarm (EA) is a message type which is sent when the silent alarm is activated. Emergency alarms shall have the highest priority of all data messages. The EA event shall be transparent to anyone on the vehicle, except to vehicle operators. The EA button circuitry shall incorporate power-on-self-test features and have the capability to detect malfunctions such as open and short circuit conditions. The on-board system shall report malfunctioning EAs as a vehicle health

Design-Build Services for the Radio System Replacement**Section 3.0**

condition. The EA switch shall guard against accidental activation due to vibration, and shall have a guard to preclude accidental activation by the operator.

When a dispatcher receives an EA the following events shall occur, in sequence:

1. On dispatch workstations, an audio alarm is triggered and the vehicle is continuously traced on the AVL map display in a separate window. The refresh rate for location reporting shall be fifteen (15) seconds or faster, based on shortened vehicle location update reporting or polling.
2. An EA acknowledgment message shall be sent from the central system to the vehicle, and discreetly displayed on the MDT.
3. A dispatcher responds to the emergency by listening in to the vehicle through a "hidden" microphone integrated into the MDT or installed within the vehicle operator work area.
4. The dispatcher shall have the ability to downgrade an EA, if conditions warrant. This action shall be recorded and included in following reporting.
5. The dispatcher shall be required to fill out an electronic EA incident report. An EA event, downgraded or not, and the incident shall not be closed and is incapable of being dismissed until the EA incident report is completed.
6. The incident report shall be pre-populated to include time, date, vehicle location, operator ID, vehicle ID, and route (if applicable).
7. On board of the vehicle, the EA switch shall interface to the onboard camera system processor to allow the camera system to mark and protect the recorded video footage surrounding and including the time around an EA event. In case the camera system processor does not offer an input to connect the EA switch, a dry contact shall be provided that allows wiring the EA alarm into a possible future on-board replacement camera system.

The Contractor shall submit a complete description of Emergency Alarm Operation on board the vehicle, and from the dispatcher perspective [CDRL 12-3-2 Emergency Alarm Description of Operation].

On-board Voice Communications

A loudspeaker, handset, magnetic hook switch, and armored cable shall be installed for mobile radio voice communications. The handset shall be located such that the cable is long enough for vehicle operator convenience without causing a safety hazard when not in use.

Vehicle operators shall be limited to pressing either the Request-To-Talk (RTT) or the Priority-Request-To-Talk (PRTT) function keys to initiate a request for voice communication with a dispatcher or train controller. The vehicle operators shall receive visual confirmation on the status of their RTI or PRTT. In the event the message could not be transmitted to the central system due to failure of the data communications subsystem, the VLU shall revert to voice fallback mode where the capabilities of the voice radio subsystem shall be used to communicate. It is understood that such communications may not provide the full functionality of the data communications system, but at a minimum, the MTMS shall include the capability to signal RTTs, PRTTs and EAs through the voice radio infrastructure. These messages shall be terminated on dispatch workstations or radio console as appropriate. The fallback mode shall continue until the MTMS re-establishes data communications

Design-Build Services for the Radio System Replacement**Section 3.0**

When a dispatcher, train controller or other authorized user initiates a voice call to a vehicle, the MDT shall issue an SFMTA configurable aural and visual notification of a pending individual voice call. Group calls and fleet calls from dispatch shall also be preceded by a notification, and the vehicle operator shall have the option of listening through the onboard speaker or by picking up the handset. The call types shall be distinguishable through different aural and visual notifications, as configured by the SFMTA. All switching and set up of voice communications shall be automatic without the need for manual assistance through the vehicle operator.

Transfer Requests

The MTMS shall provide an automated process to protect the transfer of passengers at designated transfer points. A vehicle operator may select a route to "hold", direction and mobility aid after receiving a customer request for a transfer. Upon selection, the MTMS shall evaluate the request and either approve or deny the request based upon allowable parameters. The maximum allowable hold time shall be definable by the MTMS system administrator.

The sending vehicle shall receive notification of the MTMS decision and if the request is approved the target vehicle shall receive a hold notification indicating the location and route to complete the transfer. The transfer request process shall not require dispatcher intervention. Using a transfer request display, the dispatcher shall have the capability to review transfer requests and intervene as deemed appropriate by the dispatcher. This display shall provide a function that allows dispatcher to filter by transfer status, including but not limited to failed and scheduled transfers.

3.2.2 Wheelchair Ramp or Lift Test

Wheelchair lifts and ramps shall be monitored and data recorded for each cycle. If a wheelchair lift or ramp is not cycled prior to leaving a garage/storage area at startup then the MDT shall display a warning to the operator and transmit the warning to the central MTMS for storage and display at the dispatcher workstation.

The Contractor shall submit a complete description of wheelchair ramp or lift test operation on board the vehicle [CDRL 12-3-3 Wheelchair Ramp or Lift Test Description of Operation].

3.2.3 Vehicle Area Network/Wireless Router

The Contractor shall provide a vehicle area network wireless router that offers shared, standards-based access to communications infrastructure to existing and future on-board systems. There are on-board systems such as Automatic Passenger Counters and video surveillance that use their dedicated wireless networks. Integration of these existing system will not be required. Future systems that have a wireless network component however shall be able to use the vehicle area network wireless router to support their bulk data transfer needs. The vehicle area network wireless router shall be compatible with the wireless bulk data transfer network. On-board, the vehicle area network wireless router shall provide routing of IP-based traffic to and from the wireless bulk data transfer network. This wireless router shall support system segregation through Virtual LANs (VLANs), support IPsec VPN tunneling, include a deep inspection firewall, and provide the quantity of eight (8) One Gigabit Ethernet ports. The vehicle area network wireless router shall also be an on-board hub to distribute the following real-time information to complement existing stands-based interfaces:

- NTP System time

Design-Build Services for the Radio System Replacement**Section 3.0**

- Vehicle Health Monitoring and other discrete signals via port server
- NMEA GPS string, via port server.

While allowing bulk data transfer of connected systems such as the VLU, the wireless area network and wireless router equipment shall not place an undue burden on the on-board power supplies, in particular batteries. Remaining powered beyond the actual periods of wireless data transfer shall be managed such that vehicle batteries are not taxed and discharged.

The Contractor shall submit a complete technical description of the vehicle area network wireless router including provision for future interfaces. [CDRL 12-3-4 Vehicle Area Network Wireless Router Description].

3.2.4 Computer Aided Dispatch

Computer Aided Dispatch (CAD) includes functions such as transit operations and information management, AVL map displays (including clear display of one way streets), data and voice communications management, and playback capabilities. The dispatch workstation with integrated voice radio console is the central organizing area for daily operations. The dispatch workstation shall be provided with at least two computer screens. Dispatchers and train controllers monitor vehicle communications and initiate actions according to the information provided on these screens.

The MTMS shall provide the capability for dispatcher assignments based on the SFMTA transit operating divisions, fleets, routes, vehicles, or the SFMTA configurable geographic regions. Distribution of un-assigned vehicles calls shall be to all logged-in dispatchers. A capability to configure all dispatch workstation to display and manage EAs shall be provided.

The dispatch workstation and integrated voice radio console configuration shall support voice communications with both a volume controlled speaker, microphone, and double headsets. A telephone system interface shall be provided. Audio path switch of speakers and microphones to radio consoles shall be integrated in the CAD user interface of the dispatch workstations.

The CAD software shall enable dispatchers to set pre-approved display preferences and enable those preferences upon dispatcher logon.

The CAD system shall ensure that the sequence of vehicles operating on a route shall be represented correctly. It shall not be acceptable that vehicles operating on a fixed track are tracked and displayed in an incorrect order at any time or location. In the response to the RFP, the Qualified Proposers shall describe the method to ensure the correct sequencing at places where routes converge [PRL 12-3-6 Sequencing Routes Converge]. On a conceptual level, the Qualified Proposers shall include a description how this method would be employed at the West Portal entry to the Twin Peaks tunnel where routes converge, and at the Embarcadero turn-around, where some routes pass while others return outbound.

Light rail vehicles are operated in single and multiple car consists. The CAD screens shall clearly identify a multiple vehicle consist as a single operational unit, yet show the configuration of the consist.

The Contractor shall submit a complete technical description of the MTMS computer aided dispatch capabilities. [CDRL 12-3-5 Computer Aided Dispatch System Description).

Design-Build Services for the Radio System Replacement**Section 3.0****3.2.5 Control Center Voice Communications**

Under normal operating conditions, voice calls to the fleet will be initiated by a dispatcher or train controller. The MTMS shall be designed to support this operating approach. The dispatcher shall be able to call based on manually or semi-automatically created groups: an individual vehicle, a group of vehicles, a specific route, geographic selection, vehicle operator ID, vehicle operator name, run, block or train, vehicles of a division, or all vehicles. The dispatcher shall be able to direct an individual call to the vehicle operator handset, vehicle operator loudspeaker, or the on-board public address system as appropriate per call type.

- Emergency Alarms shall have top priority and generate an audible alarm
- Dispatchers shall have the ability to select any call in the queue at any time
- Only one call request shall be retained and displayed when multiple call requests from the same vehicle are received determined by the request with the highest priority and oldest message
- For each call, the dispatchers shall have the option of opening an incident report.

The MTMS shall integrate all subscribers of the system and allow the dynamic formation of groups spanning across all types of subscriber units, as selected by dispatchers, train controllers and other users of the MTMS.

The users shall be able to contact the operator of the consist by a call the operator number, vehicle or consist number, the schedule block or train number, or the run number.

3.2.6 Service Messaging

The Contractor shall provide the transmission of service messages to manually or semi-automatically created groups. In case a subscriber unit such as a tier I portable does not support the presentation of service messages, these units shall be clearly identifiable in the dispatch and train controller user interfaces. Dispatch and train controller service messages shall either be keyed in as free-form text, or selected from a list of pre-defined canned service messages. The maximum length of service messages shall not be less than 128 characters. Standard service messages shall be configurable by the SFMTA. Dispatchers and train controllers shall have the option to require a vehicle operator acknowledgement upon viewing the message, and shall be able to monitor the status of message acknowledgement. The MTMS shall provide dispatchers and train controllers with the ability to send any service message designated as store-and-forward. Store-and-forward message duration shall be a dispatcher defined time period.

On board of the vehicles, the MDT shall allow vehicle operators to send service messages to central control, from a set of the SFMTA configured canned messages. The MTMS shall provide the capability for the SFMTA administrator to group messages into categories for quick selection by the vehicle operators. The MDT shall support the display of service messages longer than can fit on one line of the display, and a minimum of twenty-four (24) buffered messages shall be supported. Messages received from the central system shall initially be marked as unread. The service messaging shall support acknowledgement messages back to central control and send an acknowledgement message back to central control once the vehicle operator has acknowledged a message that the dispatcher or train

Design-Build Services for the Radio System Replacement**Section 3.0**

controller previously flagged as requiring acknowledgement. Service messages shall be either deleted or saved by the operator after viewing.

The MTMS shall allow the SFMTA system administrator to configure messaging such that messaging is selectively enabled or disabled, including, but not limited to direction (call-in, call-out) and fleet type (LRVs, buses, trolleys). System administrators shall further be able to disable messaging based on the detection of vehicles moving, effectively disabling any messaging capability when the vehicle is moving. The SFMTA system administrator shall also be able to define message type routing to selected user groups, including but not limited to the routing of VHM messages to maintenance, as opposed to central control.

The Contractor shall submit a complete technical description of the MTMS service messaging features, capabilities, and administration. [CDRL 12-3-6 Service Messaging Description]

3.2.7 Textual and Tabular Displays

Basic dispatch textual capabilities shall be implemented in an easy to use and intuitive graphical user interface (GUI), and shall include the following basic functions:

- Multiple message queues for data messages, schedule and headway adherence, request to talk, emergency alarms, service messages, maintenance alarms, system health, and other event messages. The parameters for display and delivery of messages to users such as dispatchers and maintenance, shall be configurable by the SFMTA.
- Assignment of priority levels ordering and filtering by message type within the message queues
- Voice path options to switch to vehicle operator handset, vehicle operator speaker, or passenger facing PA speakers.
- Emergency Alarm listen in, audible alarms
- Schedule information by block or train number, run, vehicle, operator ID, including real time status of a vehicle
- Route information including schedules, vehicles and real time adherence status
- Pull-in and Pull-out status from the SFMTA divisions, including alarms for late and missed pull-ins and pull-outs
- Roster information for logging in/out of operators and assignment changes
- Remote vehicle operator logon or logoff by dispatchers and train controllers, with operator acknowledgement, if requested by the dispatcher or train controller
- Vehicle information indicating current availability, schedule adherence status and all other CAD/AVL tracked information
- Real time vehicle monitoring status including query capability for the history of vehicle health status messages. The real time vehicle monitoring shall include, but not be limited to the frequent vehicle updates (including accelerated vehicle location

Design-Build Services for the Radio System Replacement**Section 3.0**

updates as required in Emergency Alarm situations), and vehicle health monitoring messages.

- Same day service adjustments for the addition, cancellation of trips, short-turning, and offsetting of trips. These adjustments shall be transmitted to the affected vehicles, and the affected on board functions, including but not limited to automatic on-board traveler information shall be adjusted accordingly.
- Off-route monitoring including both off-route and back-on-route notification
- Communication history for reviewing recent voice and data communications with the ability to create incident reports from within the history list
- Review of operator generated transfer requests and capability for dispatches to intervene in the transfer process as operationally required
- Detour description storage and display capability displayed by route with the capability to transmit detour notices as a service message
- Context sensitive on-screen help. Context sensitive on-screen help shall be made available to the different users of the MTMS, including but not limited to dispatchers, customer service agents, street supervisors.

In general, features that have been disabled for individual vehicles or fleet types, shall not interfere with the performance or operation of other features.

The Contractor shall submit a complete technical description of the MTMS textual and tabular display features, capabilities, and administration. [CDRL 12-3-7 Textual and Tabular Display Description]

3.2 8 Geographic Displays

Real-time mapping shall display the following functions in an easy to use and intuitive graphical user interface:

- Import and display of standard format vector, raster image, and point-based map layers
- Map layer feature labels provided based upon zoom level or with hover-over by a pointing device
- Continuously refreshed real-time updates of vehicle location and status
- Definition of multiple map views and ability to save at the dispatcher level
- Definition of shared views for use by any dispatcher to be saved in default set of views
- Zoom, move, center, and fit to window independent within each map view
- Filtered map views based upon parameters such as vehicles by route, login status, fleet, and mechanical status
- Map layer that includes current route traces for each fixed route selected by the dispatcher

Design-Build Services for the Radio System Replacement**Section 3.0**

- Options to display different vehicle icon labels including but limited to vehicle number, adherence, route number, vehicle operator ID, vehicle operator name, and run number per map view
- Vehicle icons that are configurable and contain context sensitive information that includes adherence, login, transfer, and maintenance status
- Query tools to locate vehicle and routes based on vehicle, route, operator, block or train number, run number, or intersection variables
- Capability to establish voice/data communication by individual vehicle or by banding a group of vehicles together
- Access to a distance measuring tool
- Print capabilities of any customized map view
- Automated focus and continuous vehicle tracking during an Emergency Alarm condition.

3.2.9 Schedule Adherence

The MTMS shall monitor schedule adherence by comparing actual vehicle location versus the published schedule for all vehicles logged into the MTMS. Schedule adherence data shall be stored and include parameters for analysis such as, but not limited to, vehicles, routes, timepoints, block or train, runs, and vehicle operator ID. Both the time of arrival and departure at all scheduled timepoints shall be accurately recorded and stored.

The SFMTA shall be responsible for providing the schedule data used by the Contractor-provided interface between the scheduling system and the MTMS. As part of the system implementation and throughout the duration of Contractor provided system maintenance, the Contractor shall perform the stop and route geo-surveys required to provide base data for the MTMS. The Contractor shall provide validated data (Stopid, Stopabbr, Onstreet, Atstreet, Lat, Lon, Stop type(mid block, pole stop, island, etc)) after the survey for SFMTA to import to Trapeze.

Real-time (predictive to a timepoint or stop) schedule adherence shall be displayed to the dispatchers and train controllers, and made available to customer information applications. The MTMS shall be capable of identifying vehicles that are predicted to be running early by more than a predefined number of minutes or late by more than a predefined number of minutes in real-time. The SFMTA shall have the capability to set schedule adherence parameters independently by route, with separate early and late user provided values.

The on board MDT display shall be configurable to either inhibit display or display the predicted status relative to the schedule adherence displayed in one minute increments. If the MDT display is configured in the display mode, the schedule adherence display will be presented to the vehicle operator regardless of dispatcher selected parameters. Schedule adherence shall be calculated, tracked, transmitted, and stored regardless of the onboard display setting.

The Contractor shall submit a complete technical description of the MTMS schedule adherence functions, features, both on board the vehicle, from the dispatcher perspective, data maintenance, and reporting. [CDRL 12-3-8 Schedule Adherence System Description]

Design-Build Services for the Radio System Replacement**Section 3.0****3.2.10 Ad Hoc Detours, Bus Bridges**

The MTMS shall support central control in establishing and monitoring of ad hoc, same day detours and bus bridges. In the response to this RFP, the Qualified Proposers shall describe their methods of establishing and monitoring of detours and bus bridges as part of their system [PRL 12-3-7 Detours and Bus Bridges Monitoring]. At a minimum, these functions shall propagate the relevant information to all affected revenue vehicles, and adjust all affected subsystems to reflect the resulting operational changes of detours and bus bridges, including but not limited to automatic on-board traveler and other traveler information systems.

The Contractor shall submit a complete technical description of how ad hoc detours, bus bridges, and other service restoration features operate. [CDRL 12-3-9 Detours and Bus Bridges Monitoring]

3.2.11 Pre-Planned Special Events

The MTMS shall provide the SFMTA planners with the capability to establish pre-planned events over a pre-determined time period. In the response to this RFP, the Qualified Proposers shall describe their methods for pre-planning events in terms of special revenue services, operational service messages and traveler facing messaging [PRL 12-3-8 Special Revenue Service]. This description shall also include a description how central control monitors special events during their duration. Special events shall also allow SFMTA to establish priority talk groups, readily available to central control for communication to vehicles and other subscribers, as configured by the SFMTA.

3.2.12 Route Adherence

The onboard MTMS shall detect off-route status and alert to the vehicle operator when off-route status is reached. This shall also be transmitted to central control for dispatcher notification. The off-route notification shall identify and include the name of the last known stop when a vehicle is further than a pre-defined distance from the assigned defined route. The off-route distance value shall be a MTMS system administrator definable parameter. The Qualified Proposer shall describe the applied process of how route adherence is detected, and the required base data to support this function. [PRL 12-3-9 Route Adherence]

The Contractor shall submit a complete technical description of how the route adherence features operate including notifications to dispatchers, detection, customization, and reporting. [CDRL 12-3-10 Route Adherence]

3.2.13 Daily Schedules

The MTMS shall hold network, schedule and assignment data for the current and one future scheduling period, and automatically be provisioned with the daily schedule of blocks or trains, runs, operator assignments, and vehicle assignments. The MTMS shall continuously support service that continues past midnight and service that overlaps in operating days, i.e. the MTMS shall support twenty-five (25) hour plus operating days.

Future schedules or assignments shall automatically be activated based on a SFMTA defined future activation date. Individual operating divisions may have schedule and assignment activation dates that are offset by several days. The MTMS shall accommodate selective activation of new schedule or assignment data by the SFMTA transit operating division.

Design-Build Services for the Radio System Replacement**Section 3.0**

The MTMS shall support multiple service types such as school in, school out, weekday, Saturday, Sunday, and holiday to accommodate service variations at the route and trip level. Each schedule day shall permit assignment of multiple service types. School day service may be called or cancelled only a day in advance, and the MTMS shall accommodate these short notice daytime changes.

The Contractor shall submit a complete technical description of how the daily schedules features operate. [CDRL 12-3-11 Daily Schedules].

3.2.14 System Administration

Throughout system implementation and the duration of Contractor provided system maintenance, the Contractor shall administer and tune the performance parameters of the MTMS and PSVRN systems. After conclusion of Contractor provided system maintenance, these systems shall be configured by an SFMTA system administrator, and as a minimum, the system administrator shall have the ability to change polling length cycle and number of retries, as well as all functions identified as "configurable by the SFMTA" throughout this RFP. The Contractor shall provide tools, documentation, and training to the SFMTA to put the SFMTA in a position to administer, tune, and verify the performance parameters of the entire system.

The MTMS shall enable authorized users to perform remote system administration and diagnostic analysis in a secure manner via VPN or remote terminal sessions.

The MTMS shall log communications failures and alert the SFMTA system administrators when excessive or system critical failures occur. The MTMS shall interface with the SFMTA's electronic e-mail server via SMTP or other means to send users messages via e-mail or commercial wireless carrier text message. The Contractor shall specify the messaging of system failures as part of the final system design [CDRL 12-3-12 System Failures Messaging].

Alarms for critical hardware system failures shall also be communicated through the PSVRN's network management system (Appendix Twelve (12), Section Two (2)).

3.2.15 System Access Privileges

As part of the final system design, the Contractor shall identify the SFMTA user groups and access privileges to system functions such as administration, service messaging, diagnostics and voice communications [CDRL 12-3-13 SFMTA User Groups and Access Privileges]. In the response to this RFP, the Qualified Proposers shall describe the management of system user roles and access privileges [PRL 12-3-10 User Roles and Access Privileges], and as a minimum, SFMTA's system administrators shall have the ability to configure profiles for different classes of users through defined groups. The profiles shall permit system administrators to define access rights to applications as well as functions within applications. The system administrators shall be able to set permissions including any combination of read, write, change, and delete to applications and functions within applications.

The map, textual, and tabular displays shall be designed such that unavailable functionality based upon access rights and permissions are either hidden or clearly identifiable as not accessible. The map, textual, and tabular displays shall be designed such that unavailable functionality based upon access rights and permissions does not hamper the ease of GUI navigation within and between applications.

Settings that users can configure, within the limits of the user access privileges shall be saved upon exiting the MTMS CAD application(s), and restored in the Subsequent user session.

Design-Build Services for the Radio System Replacement**Section 3.0****3.2.16 Wireless Data Network**

One of the primary goals of the MTMS data communications network is to support the command and control functions. The Contractor shall provide a robust data network that enables the SFMTA to minimize voice communications and support accurate real time information through periodic vehicle location updates and status messaging.

The Contractor shall provide all necessary hardware and software to interface to the SFMTA's Wide Area Network (WAN). The connection of the WAN to the MTMS shall be a trust relationship that isolates the MTMS network from the SFMTA or other City department WAN activity.

The Contractor shall specify the integration and separation of communications networks in the Final Design. In the response to this RFP, the Qualified Proposers shall describe their approach to communications network integration and separation [PRL 12-3-11 Communications Network].

The Contractor shall submit a complete technical description of the wide area wireless data network theory of operation and system description, including the software processes, polling algorithms, failure management, and statistical reporting. [CDRL 12-3-14 Wide Area Wireless Network System Description]

The wireless bulk data transfer network shall utilize dedicated and licensed spectrum. The Contractor shall apply for and obtain all licenses necessary to support the proposed wireless bulk data transfer network.

Throughput & Capacity

The wireless data network shall acquire the location of VLU equipped, powered-up vehicles within one (1) minute. Vehicles in EA shall be monitored in a shorter cycle. In the response to this RFP, the Qualified Proposers shall describe the proposed mobile unit polling algorithm, and the calculated time interval for the SFMTA's fleet size operating in revenue service [PRL 12-3-12 Unit Polling Algorithm]. Calculating channel utilization as a function of a fixed polling interval is not acceptable. Signaling such as RTTs, PRTTs and calling a vehicle from the control center shall not be based on polling, and be completed within three (3) seconds from initiation by the user.

Vehicular traffic densities with respect to base station location is discussed in Appendix 12 Section 2.1 and Appendix Thirty Nine (39).

The data subsystem shall provide the capability for fleet messaging, and provide the following functions:

- Schedule adherence
- Route adherence
- Request to talk/priority request to talk
- Emergency alarms
- Canned messages (inbound to central system and outbound)
- Free service messages (outbound).

Design-Build Services for the Radio System Replacement**Section 3.0**

The data protocol shall be robust and provide forward error correction, error detection, burst error protection, and verification of the delivery of critical data.

Automatic verification by the data network of message transmission completion shall be required together with automatic retries in the event of message failure.

Bulk data collection such as passenger counts and programming updates can be processed over a wireless bulk data transfer network when the vehicle returns to a division or other parking point.

The Qualified Proposers shall provide a load analysis, including data storage and bandwidth requirements [PRL 12-3-13 Load Analysis]. Using the proposed data architecture, the analysis shall assume transmission of 1.5 messages each minute from each vehicle.

Wireless Bulk Data Transfer

The Contractor shall provide a wireless bulk data transfer network for data exchanges between the vehicles and the central MTMS at division facilities and vehicle parking points. The wireless bulk data transfer network shall be capable of transmitting data while the vehicle is moving in the coverage area of the wireless network. The bulk data transfer radio needs to be mutually agreeable by MTA and Contractor. The radio has to use standard interface.

The wireless bulk data transfer shall use and interface with the vehicle area network wireless router.

The wireless bulk data transfer network shall use the most current proven standards for communications and security (e.g. IEEE 802.11 i), and use licensed spectrum. WiFi or similar unlicensed bands must not be used. Security provisions shall prevent unauthorized users from accessing transmitted data or gaining access to the SFMTA's network infrastructure through the wireless data system. In the response to this RFP, the Qualified Proposers shall provide the standards designed and incorporated into the proposed wireless bulk data transfer network [PRL 12-3-14 Wireless Bulk Data Transfer].

The Contractor shall provide a wireless bulk data transfer network that meets the following criteria:

- 36 dBm EIRP transmit power
- -93 dBm receiver sensitivity at 3 Mbps
- NEMA 4 enclosure to sustain outdoor/mobile environments
- Layer 2 routing engine for faster route changes, low hop latency (less than 5ms) and complete transparency to IP layer.
- Lighter form factor less than 5 lbs for individual on-board components
- Multiple Virtual LAN (VLAN) support for differentiated service
- 802.11 equality of service (QoS) support
- Ability to use 10Mhz 4.9G channels
- SFMTA provided backhaul to each Maintenance Facility and 10 MBps wireless transfers.

The Contractor shall provide wireless bulk data transfer infrastructure at the following divisions and parking points:

Design-Build Services for the Radio System Replacement

Section 3.0

- Woods
- Flynn
- Kirkland
- Potrero
- Presidio
- Muni Metro East (MME)
- Green LRV yard
- Islais Creek.

The wireless bulk data transfer network shall utilize licensed frequencies. The property owner (SFMTA) is responsible for obtaining public safety 4.9 GHz licenses. The Contractor shall provide support for SFMTA's application to apply for these licenses.

The SFMTA will finalize wireless bulk data transfer network installation requirements with the Contractor pending any changes to existing wireless bulk data transfer network infrastructures or facilities after contract award.

The wireless bulk data transfer network shall be available to all onboard MTMS equipment that requires the transfer of data files such as system-critical data, stored operating data, and firmware upgrades through the vehicle area network and wireless on-board router. Transfer of data files shall be by a proven standard protocol such as FTP. The Contractor shall provide software that uses a centralized method of transferring files for distribution to multiple division and parking points as listed above.

Data transfers shall be transparent to the user and occur whether or not the vehicle is logged into the MTMS. Vehicles shall be capable of receiving and sending data when in range of an access point at startup, shutdown, or at scheduled times. Wireless bulk data transfer network communication sessions shall be capable of being managed through an MTMS system administrator remote workstation to monitor, track, and verify data integrity on a vehicle-by-vehicle basis. Under daily conditions where vehicles return to a yard and park within the coverage area, vehicles will have a sufficient time to complete data transfer for critical information.

The SFMTA currently has wireless LANs (WLAN) in place for other systems such as the TransLink® and mobile video surveillance systems. Other neighboring wireless LANs may also impact wireless LAN performance. To avoid interference between different access points (and systems), the Contractor shall perform a wireless survey at each site, and ensure that wireless bulk data transfer network access is secure, has sufficient throughput capability, provides uninterrupted coverage, and does not interfere with other systems [CDRL 12-3-15 Wireless Bulk Data Transfer System Surveys].

Turning off vehicle ignition shall not interrupt the wireless bulk transfer. On-board systems such as VLUs and MOTs that utilize the wireless bulk transfer, shall be automatically managed such that components that actively use the wireless bulk data transfer are shut down after the completion of the wireless data transfer. Vehicle battery discharge to a degree that affect service and other on-board systems shall not occur. Contractor to work with the SFMTA during the design phase to define an appropriate "keep alive time" that balances wireless bulk transfer download requirements with vehicle battery performance.

Design-Build Services for the Radio System Replacement**Section 3.0**

Interrupted wireless bulk transfers shall be continued after wireless connectivity has been restored.

Optionally vehicles entering wireless bulk transfer system covering while in service shall not engage the wireless bulk transfer, unless a planned layover allows for sufficient time for the required data exchange.

3.2.17 Data Communications Controller

The data communication system shall support connections from multiple the SFMTA departments and future additional City agencies while maintaining data integrity and security to allow different agencies, departments and divisions to use the RF data infrastructure while at the same time segmenting and securing each agency's data. The data communications system controller shall be capable of segmenting data, by department and agency, for the purposes of real-time CAD/AVL displays and off-line reporting.

The data communications system controller shall effectively manage communication resources in the area of where system subscribers and units operate, and provide the following features:

- Manage inbound and outbound data communications including supplying periodic loading information to the mobile units for hand-off and roaming coordination as needed.
- In overload situations manage Intra Site Load Balancing and command "hand-off" of selected mobile units from one channel to another to balance tower loads.
- Provide software fail-over capability in the event of a failure of any of the data communication channels by monitoring the health of all associated channels and provide input to the vehicles by broadcasting this information.
- Capability for "Store and Forward" functions when a mobile is in a transition state changing to another channel.
- Support base station hand-offs throughout the RF coverage area, which allows the mobile to transparently switch to different radio sites within the coverage area.
- Subscriber units shall support roaming as defined in their respective system protocols.
- Active and passive load balancing on channels on the same site if applicable. Passive balancing is done when a channel is determined to be in an overloaded condition as mobiles come onto the network. Active balancing is done as a result of a poll rate increase or failure condition.
- The data communications system controller must be able to provide message success rate coverage area reliability as required in Appendix Twelve (12), Section Two (2), for vehicles traveling at speeds up to 75mph.
- The impact of a loss in data radio connectivity on the fleet or individual vehicles and subscribers shall be minimized in a fashion that on-board automatic traveler information and AVL functions, including the logon procedure, remain functioning except for the discrete elements that require data radio connectivity for their proper operation. If other subsystem capabilities cover all or parts of the lost functionality,

Design-Build Services for the Radio System Replacement**Section 3.0**

these subsystems shall be integrated such that their support is available to affected system functions.

3.2.18 Security

A security scheme that controls individual and group access management shall be provided that ensures a secure computing environment and limits access to authorized users.

The MTMS access shall require a logon process that includes a username and password. A database of all MTMS user access shall be maintained. Passwords shall be encrypted.

It is preferred that MTMS security management integrate with the SFMTA's active directory infrastructure for logon and access rights to features and functions within the MTMS.

The SFMTA definable groups shall set user access rights to restrict access to functions and set permissions for read, write, edit, and delete data at the group level. Users shall be allowed to be members of multiple groups with access and permissions determined by the highest assigned privileges.

Capability shall be provided to generate and print reports providing lists of the configured security groups, access settings, and user activity. Access from outside the SFMTA WAN/LAN shall be secured to prevent unauthorized users from gaining access to the SFMTA's network environment. t

3.2.19 Interfaces

Throughout project execution, the Contractor shall control all interfaces through an Interface Control Document (ICD). Specifications that do not conform or that are not compatible with industry standards, shall be published, open, thoroughly documented and made available to the SFMTA for agency use in the implementation, operation and maintenance of the MTMS. Contractor shall develop and provide automated data exchange (bi-directional if required) using web service or point-to-point database table updating to transmit data in real time or subscribed interval to SFMTA's existing major applications, including Trapeze (OPS and FX), TransitSafe, NextBus (if the final design will not replace this application), 511, Cubic and ATCS.

External Interfaces**On-board Destination and Run Signs Interfaces**

The VLU shall interface with the existing destination and run signs. The VLU shall automatically send sign codes for every route and direction change during revenue service to set these signs accordingly. The MDT shall be capable of providing codes for the operator for manual selection of destinations and runs. This feature shall be available as a manual override to the automatic setting of displays. Vehicles that have manual curtain signs shall have an interface cable run from the VLU to a pre-determined area, coiled, and securely fastened in the event that electronic signs are installed at a later date.

Adequate protections and maintainability shall be provided to sustain cable runs that cross articulations and that run in other stressed areas, including LRV couplers, over the lifetime of the MTMS.

The Contractor shall submit a complete technical description of the onboard destination and run sign interface. [CDRL 12-3-16 On Board Destination and Run Sign Interface Description]

Design-Build Services for the Radio System Replacement**Section 3.0****TransLink® (Option)**

For reference, a portion of the TransLink® interface specification (as relevant SFMTA) is included in Appendix 15, "Interface Control Document for Onboard Devices and the TransLink® Driver Console". The quote for this interface only includes all the hardware and service cost from contractor side. The cost of TransLink side of the interface is not included.

The Contractor shall submit a complete technical description of the TransLink® interface. [CDRL 12-3-17 TransLink® Interface Description]

Farebox

The existing fareboxes, which are currently being refurbished, shall be integrated. The farebox interface specification shall be provided after NTP. The Contractor shall integrate the farebox, and shall receive and process farebox alarms. Farebox alarms shall be sent to the central system through the data communications network, to the SFMTA configurable recipient such as central control dispatchers, or maintenance. This alarm shall allow the SFMTA to raise awareness of farebox alarms in real time.

The Contractor shall submit a complete technical description of the farebox interface. [CDRL 12-3-18 Farebox Interface Description]

Existing Traveler Information System (NextBus system)

The MTMS shall interface with the existing SFMTA Traveler Information System (NextBus system). Data elements that are necessary to drive the existing traveler information system in its current form shall be sent from the MTMS. This implementation of the MTMS shall render the existing NextBus Tracker equipment on board of the revenue fleet obsolete.

As part of the vehicle installation with the MTMS provided equipment, the Contractor shall decommission and uninstall the existing NextBus Tracker equipment. In response to this RFP, the Qualified Proposers shall describe the data elements and methods of data transmission from the MTMS to the existing traveler information system [PRL 12-3-15 Data Transfer to Existing Traveler Information System]. The Qualified Proposers shall also describe the cutover method from the existing tracker and ATCS interface inputs over to the MTMS interface [PRL 12-3-16 Tracker and ATCS Interface Cutover]. The Contractor shall be responsible for the design, implementation, and testing of this interface, The updating or upgrading the existing traveler information system shall be evaluated and designed for a mutually agreeable solution that may leverage existing systems and infrastructure.

The Contractor shall submit a complete technical description of the NextBus system interface. [CDRL 12-3-19 NextBus System Interface Description]

MTC Real Time Information 511 Interface

The Bay Area 511.org system is a free phone and web service that consolidates Bay Area transportation information, including route, schedule, and fare information for the Bay Area's public transportation services. The 511.org web site is the Bay Area Traveler Information Web Portal and features the 511.org transit page that provides links to the SFMTA and other agencies' schedules. The 511.org transit trip planner also incorporates the SFMTA's scheduled information into its database.

Design-Build Services for the Radio System Replacement**Section 3.0**

The Contractor supplied MTMS shall support the exchange of data with the Bay Area's regional 511.org traveler information system operated by the Metropolitan Transportation Commission (MTC). Data exchange shall consist of:

- Export of real-time arrival information to 511.org
- Export of MTMS status information to 511.org

(XML) document type definitions (DTDs) for the messages exchanged between the transit agency Java Message Service (JMS) client and the 511.org system's JMS server are included in Appendix Sixteen (16), for reference only.

The Contractor shall submit a complete technical description of the MTC 511.org real-time interface. [CDRL 12-3-20 MTC 511.org Interface Description]

Internal Interfaces

The MTMS system internal interfaces that support the data transfer to configure, operate, and maintain the MTMS shall be provided by the Contractor. A standards-based, or, in the absence of an applicable standard, open and published file transfer shall be used for transferring the data for the following interfaces:

- Trapeze FX shall be the static source of information for routes, schedules, and services for the MTMS. The interface supplied by SFMTA shall be the current version of the Trapeze-Contractor FX block interface specification at the time of implementation.
- Trapeze Ops (daily dispatch administration module) shall be the source for pre-assigned employee, vehicle, and roster information for the MTMS. The MTMS master employee and vehicle lists shall be kept current and consistent with Trapeze Ops. Same day changes to vehicle and operator assignments made within the Trapeze Ops shall be provided in real-time to the MTMS. Assignment changes which the MTMS captures when vehicle operators log on, or when control center dispatchers and train controllers take corrective action, shall be transferred from the MTMS to the Trapeze Ops system in real-time. The Contractor shall implement this bi-directional interface based upon the SFMTA's Trapeze Ops installation and shall be specified prior to the final design review. The interface supplied and implemented by the Contractor shall be the current version of the Trapeze Ops interface specification at the time of implementation. SFMTA will provide Trapeze Ops license.
- The SFMTA uses a Geographic Information System (GIS) to maintain stop information. In the response to this RFP, the Qualified Proposers shall describe the provision of a bi-directional interface for Stops Geographic network to/from ArcGIS that updates stop locations in the GIS following changes to accommodate the Automatic Vehicle Location (AVL) functions of the MTMS [PRL 12-3-19 Stops geographic Network Bi-Directional Interface].
- Safety related data shall be reported to the SFMTA's safety systems and automatically create database records reflecting this data (Interface with SFMTA existing TransitSafe system as an option). The scope for this optional interface does not include any services to modify the existing TransitSafe system.

The Contractor shall be responsible for all licensing arrangements beyond the scope of the SFMTA's license agreement required for map data used by the MTMS.

Design-Build Services for the Radio System Replacement**Section 3.0****3.2.20 Reporting, Archival Data and Support for Queries to Real-time Data**

The SFMTA shall have the rights to access, use, and distribute data to create interfaces to the MTMS, export MTMS data to the SFMTA and third-party licensed systems, publish schedule, real-time and report data, generate reports, and for the other SFMTA purposes to use the MTMS data. The SFMTA will retain all rights to the data consumed or generated by the MTMS.

Real-time operations shall not be affected by the SFMTA reporting and data access by users outside of dispatch, train controller and supervisor operations. Adequate safeguards shall be put in place to ensure that dispatchers and supervisors cannot overload the primary database server with faulty or ill-formulated queries. A secondary database server that takes the processing load off of the primary realtime database shall be provided for the purpose of data retrieval for reporting, queries of real time data, data analysis, replication, backup and archival. Enough online data storage shall be provided to keep at least three (3) years of historical data. The historical data shall be accessible by the Contractor provided MTMS applications and tools. Data replication from the primary real-time server to the secondary data storage server shall be an automated process.

Data and database schema to access the data that are more than three years (3) old shall be saved to long term storage media. This archived data shall be deleted from the main or secondary database(s). Data management and restoration tools to copy archived data from long term storage to either a stand-alone database machine or onto the current MTMS database(s) shall be provided. These activities shall be possible by either a graphical user interface or via the command line for automating tasks.

The Contractor shall submit a complete technical description of the database management system, hardware, hardware failure redundancy, and data retrieval methods. [CDRL 12-3-21 Database Management System Description]

3.2.21 MTMS Software Tools

Software for the maintenance and troubleshooting of the operation of the MTMS shall be supplied. Such software shall provide access to individual message level activity related to data communication, data transmission, and network health. Access to these software tools shall be controlled by login or other security measures. The MTMS software shall include tools and applications that assist with setup, configuration, reporting, securing, and managing the MTMS applications, data, databases, network" and communication systems. These tools and applications shall be designed for ease of use and provide a high level of control over the operation of the MTMS. MTMS software tools shall assist with:

- Performance monitoring and tuning
- Backup, restoration and recovery
- Anti-virus detection and protection in accordance with the SFMTA guidance
- Modification, extension, and adding of database structures.

3.2.22 Route Data Initialization and Preparation

A transit data management application that facilitates route level data preparation necessary for the proper functioning of the CAD/AVL subsystem shall be supplied. This application shall automate and simplify the data preparation to the maximum extent possible and shall provide tools to help identify data anomalies. The transit data management application shall be capable of importing routes, stops

Design-Build Services for the Radio System Replacement**Section 3.0**

and schedule from the Trapeze FX software scheduling package. The transit data management application shall allow authorized the SFMTA personnel to:

- Edit/Input internal and external annunciation indexes
- Manage digital announcement files
- Edit/Input headsign indexes
- Merge schedule and geographic data
- Validate Trapeze FX scheduling software data
- Edit/Input Transit Signal Priority (TSP) reference points
- Generate Mobile Data Terminal (MDT) files used by the vehicles
- Define zones related to announcements, arrivals, departures
- Define speed at the interval level
- Complement vehicle configuration properties such as VHM, APC, farebox, dead reckoning calibration and configuration as necessary.

An import utility shall be provided for a seamless data conversion to convert standard GIS formats (MapInfo, AutoCad, ESRI, Integraph, etc.) data into the MTMS base map. Images for background display as well as common map layers shall be imported and made available for display including routes, patterns, stops, roads, interstates, railroads, parks, and waterways and their associated labels.

A field survey tool shall be used that provides the capability to accurately geo-code the locations of routes, patterns, stops, and timepoints. Geo-code attributes shall include latitude, longitude, compass direction and distance between stops. Entering attributes of collected data points shall be possible while using the survey tool. Location shall be determined by the use of GPS and Differential GPS (DGPS) technologies. Data captured through the field survey tool shall be capable of being merged with the Trapeze FX scheduling data for use within the MTMS.

3.2.23 Historical Reporting (Playback)

A historical event display shall playback all pertinent historical messages (including but not limited to messages sent and received by: vehicle mobile data terminal (MDT), operator, dispatch, and garage). The display shall be by a sequence of events on a geographic map. The playback of these events shall include the capability to perform the following functions:

- Allow selection by vehicle(s), vehicle operator(s), route(s), fleet(s), blocks or train(s) or run(s) for specific time frames through a query action window
- Configurable speed of replay for moving forward through events as well as restarting at any specific location of historical events
- Graphic representation of event data on a common MTMS map
- Selectable display of map layers including but not limited to stops, streets, routes, points of interest, and geographical attributes

Design-Build Services for the Radio System Replacement**Section 3.0**

- Text display of attributes of each vehicle event message including messages related to other onboard systems including farebox alarms, and automatic passenger counts
- Individually step forward in discrete increments in time, controlled by the user through adequate controls such as a GUI button
- Step backward or jump to a different start point
- Pause the historical display of events
- Zoom, move, center, and fit to window views within the map window
- Distance measuring tool
- Vehicle attributes shall include number, schedule and headway adherence, route, vehicle operator, block or train and run
- Vehicle icons that are configurable and display schedule and headway adherence, login status, transfer status, and maintenance status
- Locate vehicles, routes, intersections and objects
- Display route traces
- Date and time messages are logged
- Print the historical display
- Same day playback.

The Contractor shall submit a complete technical description of the historical reporting and playback features provided. [CDRL 12-3-22 Historical Reporting and Playback Feature Description]

3.2.24 Reports

A reporting module shall be provided that gives access to a set of standard reports that are provided with the MTMS. The report module shall produce standard FTA (Federal Transit Administration) NTD (National Transit Database), incident, bus, fleet, and employee management reports. The Contractor supplied reports shall be available on demand and be capable of being queried by such attributes as date ranges, time ranges, and any combination of operational parameters such as vehicle IDs, vehicle operator IDs, route numbers, incident report types, etc. Reports shall be formatted in order to be distributed electronically to other SFMTA users and systems. Reports shall be capable of being generated automatically and scheduled for distribution via email on a regular basis. The Contractor shall provide transportation mode specific reports for the SFMTA's operational divisions.

The Contractor provided database(s) shall include a data dictionary and data schema that fully describes and documents the contents, organization, and meaning of all CAD/AVL subsystem database tables, fields, and keys [CDRL 12-3-23 Data Dictionary, Data Schema]. Access, use, and distribution of the data by authorized SFMTA personnel shall not require additional support, documentation, or licensing from the Contractor. The database dictionary and schema shall provide sufficient information to retrieve any operational or MTMS related CAD/AVL stored data.

Design-Build Services for the Radio System Replacement**Section 3.0**

The database(s) shall be ODBC compliant to allow connection from third party reporting tools such as Crystal Reports ®.

The Contractor shall provide a reporting tool for ad hoc queries and custom reports. In addition to the Contractor supplied standard reports the Contractor shall work with the SFMTA to provide support for developing (30) customized reports and two hundred (200) hours of report development support once the SFMTA has become familiar with the use of the reporting system of the MTMS.

The suitability of the Contractor's standard reports shall be evaluated for meeting the SFMTA's needs. The reports shall support transportation mode specific reporting on the SFMTA's revenue operating divisions. The report module shall provide detail and summary reports from the following topic areas:

- APC counts, as acquired through the APC system integration
- Incidents
- Route activity
- Schedule and headway adherence
- Transfers
- Voice and data communications activity
- Dispatcher activity
- Vehicle operator activity
- MTMS health
- Vehicle miles and hours
- Passenger miles
- Revenue vehicle miles and hours
- Non-revenue vehicle miles and hours.

3.2.25 Incident Management System

An electronic incident management system shall be provided that gives dispatchers, train controllers, road supervisors and other authorized users involved in transit operations and management the ability to record and document incidents in a central database. The incident management system shall be based on the SFMTA created and managed incident forms. The Contractor shall provide a tool that provides the SFMTA the capability to create and edit incident form layouts through a Contractor provided software tool. This tool shall allow the free placement of form elements such as data fields, labels, drop down boxes, commit and dismiss buttons. Only authorized users such as the SFMTA administrators shall be permitted to make changes to form layouts. Subsequent changes to form layouts shall not inhibit the ability to view forms that were filled out using previous form layouts. The Contractor shall provide an initial set of templates and assist the SFMTA in the development of the SFMTA specific forms, and fifty (50) hours of incident management system template development support once the SFMTA has become familiar with the use of the incident management system of the MTMS.

Design-Build Services for the Radio System Replacement

Section 3.0

When an incident report is created, the system shall automatically generate a unique incident identifier. Users such as dispatchers and train controllers shall be able to select the applicable incident form from a forms list. Data elements such as user identification, vehicle number, block or train number, employee number, vehicle location and a timestamp shall automatically be filled into the related form entry fields. Text entry field input shall be checked by an automated spell checker. This spell checker software shall allow the SFMTA administrators to add terms as valid, in order to allow the introduction of transit and SFMTA specific language. After committing and closing an incident form, entries in the form entry fields shall remain permanent. The SFMTA shall be able to re-open an incident and add additional information. This shall automatically be marked with a user identification and timestamp, and included in the form presentation.

Upon receipt of an EA, the relevant incident report shall automatically be created on the assigned dispatch workstation. Repetitive EAs that are being triggered by defects such as defective vehicle EA subsystems shall be effectively filtered.

Incident forms shall have the capability to link to other incident forms, and to attach files such as pictures, video clips and audio files.

After the initial submission of an incident form to the central database, the SFMTA defined distribution lists shall be used to email or text message synopsis information to a SFMTA configured list of recipients. This synopsis shall include a hyperlink to the relevant form data to allow quick discovery of an incident in the central database.

The incident management system shall automatically delete incidents after the expiration of the SFMTA configured retention period. It shall be possible to define indefinite retention, i.e. prevent the deletion of incidents.

The incident management system shall provide a user-friendly, "dashboard" that allow the query of the central database. The dashboard shall display a list of open incidents. User shall be able to sort and filter the list by timestamp, user and other relevant aspects.

An open incident shall not be editable by more than a single user at a time. The SFMTA administrators shall be able to selectively unlock incident reports.

Past and closed incidents shall remain available to users for reference purposes. The Incident Management System shall allow users to find past incidents through context searches, which allow the logical combination of search terms, time range and search by similar terms and wildcard characters. Queries and searches must not impact the system's responsiveness. Given the expected growth of the central database throughout the lifecycle of the system, system performance shall remain constant and responsive.

As the central database grows with the use of the MTMS, user transaction times and interactions with the incident management system shall remain constant, below 500ms.

Users shall be able to print completed incident forms. Dashboard queries shall also be printable, both interactively and in SFMTA defined batch printing. Batch printing shall occur in the SFMTA configured intervals and times.

As part of their Proposals, Qualified Proposers shall submit a complete description of their existing incident management system. [PRL 12-3-27 Incident Management System Description]

Design-Build Services for the Radio System Replacement**Section 3.0**

The Contractor shall submit a complete technical description of the incident management system including use case gathering requirements, incident management system setup, operation, and customization. [CDRL 12-3-24 Incident Management System Description]

3.2.26 Passenger Facing Service Messages

The MTMS shall allow authorized users to create and electronically distribute service messages to the following external systems:

- Underground platform flat screen panel displays, excluding the existing platform LED departure signs if the predictive Arrival Information System is optionally selected.
- Traveler information system web site and surface level stop if the predictive Arrival Information System is optionally selected.
- 311 customer service agents

The Contractor shall submit a complete technical description of the design and operation of the passenger facing service messaging utilities, features, and operation. [CDRL 12-3-25 Passenger Facing Service Message System Description]

3.2.27 Light Rail Vehicle Digital Visual and Announcement System

***** Qualified Proposers are cautioned that installation of Digital Visual and Audio Announcement System on the SFMTA Light Rail Vehicles is a complex endeavor that will not resemble the configuration installed on the rubber-tire fleet. Installation on the SFMTA Light Rail Vehicles will entail a significant electrical and mechanical system integration effort. Special attention should be given to the unique light rail operating environment, high voltage considerations, and material properties.

The Contractor shall provide an integrated Digital Visual and Audio Announcement System on the SFMTA's fleet of Light Rail Vehicles. Currently a digital voice annunciation system exists on the SFMTA LRVs. This system is available in the Advanced Train Control System's (ATCS) territory underground, when the train operates in ATCS auto mode. As part of this contract, the function of the existing digital voice annunciation system on the LRVs shall be upgraded to include above-ground announcements, as specified in Appendix Twenty-Three (23). LRV wiring diagrams are included for reference in Appendix Twenty-Nine (29). Material and workmanship standards are specified in Appendix Twenty-Two (22).

As part of their Proposals, Qualified Proposers shall submit their approach to implementing the Digital Visual and Audio Announcement System on the SFMTA's fleet of Light Rail Vehicles including considerations for training, fleet cutover, and vehicle installations. [PRL 12-3-26 Light Rail Vehicle Digital Visual and Announcement System Description and Integration]

The Contractor shall submit a complete technical description of the design and operation of the Light Rail Vehicle Digital Visual and Announcement System including the following: [CDRL 12-3-26 Light Rail Vehicle Digital Visual and Announcement System Description]

- Design drawings showing all modifications to the vehicle
- Vehicle electrical and mechanical interface documentation

Design-Build Services for the Radio System Replacement**Section 3.0**

- Theory of operation while under ATCS control and otherwise, including failure modes and abnormal conditions
- System installation plan.

3.2.28 Traffic Signal Priority (Option)**Background**

San Francisco is a “Transit First” City. This policy to favor transit was adopted by the Board of Supervisors in 1973 and was strengthened in 2000 by inclusion into the City Charter. An important aspect of promoting transit is Transit Signal Priority (TSP). San Francisco (“the City”) has over 100 intersections with active TSP.

Both the traffic signal system and the transit agency (Muni) in San Francisco are operated by the SFMTA. The goal of SFMTA is to provide TSP eventually on all signals along transit lines. The immediate emphasis is on the Rapid Network proposed by the Transit Effectiveness Project (TEP). Since the purpose of TSP is to reduce traffic signal delay to buses to the greatest extent possible, accurate and reliable information about the location of the bus as well as the bus route number must be transmitted to the intersection. Similarly, the goal of SFMTA is to provide emergency vehicle detection on all fire engines with communications to all traffic signals.

Currently the City standard for Transit Signal Priority and emergency vehicle preemption is to use Fourth Dimension (D4) software with type 2070 Traffic Signal Controllers. The means of communicating the location of a Addendum No. 14 Page 21 of 33 Contract No. 1240 transit/emergency vehicle to the D4/2070 has not been standardized. Several techniques are now in use in San Francisco. These include:

- Vetag detectors for LRVs
- Overhead wire detectors for trolley buses
- Infrared emitters for diesel buses and fire engines
- Video detection for bus queue jumps
- GPS detection with radio communication for fire engines

In conjunction with the Radio Replacement Project, the TSP task is intended to provide equipment to detect transit vehicles and to transmit the vehicle location, schedule, headway and passenger load to the intersection traffic signal controller (2070). It is the intent of the SFMTA to utilize this technology extensively in coming years. The City has selected GPS/radio based technology as the preferred means to detect and transmit transit vehicle data.

In 2009, SFMTA investigated the potential of adding the TSP task to the proposed Radio replacement project. Later that same year, SFMTA Transportation Engineering approached five vendors to demonstrate the capability of their equipment to communicate via radio with D4 software in 2070 controllers to provide TSP. This was intended to show how the TSP function could be incorporated into the Radio Project.

During December 2009 and January 2010, five vendors demonstrated their products:

Vendor	Contact Person	Phone No.	Location for Demonstration	Demo Date	Frequency Tested
Emtrac Trapeze	Kris Morgan Jim Jarzab Richard D'Alessandro	(618) 204-0888	Mission @ 9 th 10 th , 11 th Sts	12/2/2009	2.4 GHz
E-views	Ralph Boaz	(858) 352-6281	Mission @ 9 th , 10 th , 11 th Sts.	1/22/2010	900 MHz
GTT	Ken Martin	(858) 248-7678	Mission @ 3 rd , 4 th Sts	1/15/2010	2.4 GHz
Iteris	Jim Curry	(213) 200-0862	Mission @ 9 th , 10 th , 11 th Sts	12/10/2009	2.4 GHz
Tropos/ Novax	Franck Sala	(604) 525-5644	Mission @ 9 th , 10 th , 11 th Sts	1/7/2010	4.9 GHz

Discussions about the demonstration project also took place with all prospective radio replacement vendors at that time: Init, ACS, and Continental.

The demonstration showed that all of the vendors successfully communicated with the D4/2070s. We also concluded that the bulk data transfer equipment on the buses, in conjunction with the AVL/GPS equipment included in the Radio Project, would make it unnecessary to add any hardware to the buses to implement TSP, i.e. only software is necessary on the buses. Antennas and radios are necessary at the intersections.

Scope of Work

In the response to this RFP, the Qualified Proposers shall include:

- An onboard interface to transmit Traffic Signal Priority (TSP) requests to intersections on primary San Francisco corridors where SFMTA operates. This interface must implement the D4-GPS protocol over the air. Appendix 43 “Intersection Traffic Signal Priority Protocol” contains the specification of the D4-GPS protocol for reference. The Contractor shall expand the protocol to include additional data such as passenger count, ahead/behind schedule, door open/close, route pattern ID, timestamp, etc. .
- Wayside equipment, traffic signal controller integration, installation, and testing at six (6) SFMTA identified intersections on a SFMTA selected corridor. SFMTA shall provide a traffic signal controller cabinet to the Contractor to facilitate system development. SFMTA shall be allowed to observe and support the installation at these intersections at SFMTA’s discretion,
- The Traffic Signal Priority solution shall be scalable from the six intersections to support a minimum of 1000 intersections with no additional central equipment or changes to the fleet

Design-Build Services for the Radio System Replacement

Section 3.0

- Equipment, training and manuals for installed equipment with provision for a subsequent build-out of additional intersections by the City beyond the base installation,
- A set of test equipment to test and analyze wayside equipment.
- A set of test equipment to test and analyze vehicle equipment, .
- TSP equipment shall be added to and integrated with the vehicle equipment mockups and test units.

As part of the response to this RFP, the Qualified Proposers shall describe all Traffic Signal Priority functions, data management, and reporting [PRL 12-3-36 Traffic Signal Priority Functions]. This shall include a description how the local wireless backhaul infrastructure is made open to SFMTA to carry other, future applications, including, but not limited to, streaming video.

The Contractor shall submit a complete description of the Traffic Signal Priority functions, data management, testing and reporting. [CDRL 12-3-37 Traffic Signal Priority Functions]

Vehicle On-board Provisions

The VLU shall generate and output TSP requests through the equipment installed on board of the fleet. Control of the output shall be configurable via remote software update. The TSP requests and the associated data elements shall be sent automatically. Manual intervention must not be required, and all revenue transit vehicles shall transmit TSP requests based on real-time operational parameters. The following data elements shall be sent to the wayside TSP receivers on a continuing basis, at a minimum rate of (1) update per second:

- Intersection ID
- Route pattern ID
- Timestamp (in ms from an agreed upon base date)
- Distance to intersection. Intersection coordinates, intersection identification and distances shall be SFMTA configurable on the transit route pattern. It shall be the Contractor’s responsibility to develop or contract the development of the necessary accommodations for intersection data to be included in the route pattern data elements of the transit data feed, as received from the Trapeze scheduling system.
- Vehicle speed, with (2) m/s accuracy.
- Estimated travel time to the intersection and subsequent intersections
- Emergency vehicle preemption status

The vehicles shall generate and transmit TSP requests in approach to the next intersection, as well as subsequent intersections. The maximum number of subsequent intersections shall be a SFMTA configurable parameter. This parameter shall either be a global parameter, or configurable as a parameter local to the intersection. The determination of the next and subsequent intersections relative to the vehicle location Addendum No. 11 Page 7 of 16 Contract No. 1240 shall be based on the vehicle routing as dynamically determined by the block logon, and associated trip pattern.

Individual vehicles running in revenue service shall factor the following dynamic real time operational parameters into the TSP requests:

Design-Build Services for the Radio System Replacement

Section 3.0

- Schedule or headway adherence (based on the activation of headway control)
- Real-time passenger load, where vehicles are equipped with Automatic Passenger Counters and the Optional APC interface

The rules for the determination of operational parameters into TSP requests shall be SFMTA configurable. Depending on the proposed method, SFMTA shall be able to assign weighted values to the operational parameters that represent the importance of a particular parameter.

As soon as intersection passage is detected, which shall be less than 30m beyond the intersection stop-bar, a D4-GPS protocol Set Vehicle Data message shall be sent which indicates that the intersection has been passed.

The latency of the data elements sent to the TSP receiver shall not exceed 500ms.

During the Design Phase, the Contractor and SFMTA will analyze the design goal that the traffic signal priority equipment shall utilize the proposed wireless bulk data transfer equipment as required in Appendix Twelve (12), section 3.2.16 “Wireless Data Network”. Dedicated hardware to generate and transmit TSP requests shall not be needed, and the control of the output shall be SFMTA configurable through remote software update through the wireless bulk data transfer infrastructure.

Visual indication that TSP is active for a vehicle shall be provided on the MDT, and also presented on dispatch workstation displays.

Computer Network

The wayside equipment at the six intersections shall utilize the City’s SFgo existing fiber to backhaul to the TSP subsystem’s back end infrastructure and to relay TSP requests if necessary.

The Contractor shall design and build the equipment and local wireless backhuls needed to allow vehicles and their on-board equipment to connect to the wireless network. It is expected that the overall amount of TSP requests received at the wayside

at any time could overwhelm the backhaul fiber network, unless their broadcast throughout the network is prevented. In order to prevent the retransmission of TSP requests throughout the fiber network into segments of the network where they are not needed, the wireless network shall direct TSP requests to the targeted intersections,

Connections between the wireless components on board of the vehicles and the fixed side of the wireless network shall be dynamically associated, connected and maintained as vehicles move within as well as between the coverage areas of the wireless network.

The Contractor shall be responsible for providing the network and computer server equipment that will use the SFgo fiber for TSP functions, including, but not limited to the integration with the MTMS/PSRVN Network Management System.

The local wireless backhaul shall be open to SFMTA for future applications, including, but not limited to the transmission of streaming video feeds received from vehicles that are within the range of the wireless coverage at the intersections.

Design-Build Services for the Radio System Replacement**Section 3.0**

The wayside wireless equipment shall receive the TSP data sent from the vehicles. The exchange of bulk data transfers shall be prevented, as these transfers shall occur at the yards and other suitable locations only.

TSP requests to subsequent intersections shall be relayed to the targeted intersections through the wayside wireless and fiber backhaul network, depending on vehicle association to wireless access point and targeted intersections.

Wayside and Central Functions

Changes to TSP schemes and settings shall be configurable by SFMTA. The computer network shall allow SFMTA to propagate these changes to all intersections such that physical access to wayside equipment for the purpose of updating TSP configurations is not needed. No interruption of service shall be experienced during downloads or updates.

The wayside equipment shall generate the data and logs necessary to feed the following Contractor-provided reports, at a minimum:

- TSP requests received at the wayside from vehicles
- List of intersections that were expected to process TSP requests but failed
- Vehicle approach and passage timing profiles. This report shall present the cumulative times that vehicles spent in approach and passage of a selected intersection, at any distance from the intersection.
- TSP request history of a vehicle, including timestamp, vehicle location of a request made, as well as the values of the data elements included. This report shall include visualization of TSP requests on a base map and a summary of TSP requests sent to each intersection.
- List of vehicles where TSP requests were expected to be received, but which were not received or processed at the wayside. This report shall be based on vehicle locations and the vehicles' dynamic real-time operational parameters.

The data and logs shall be relayed over the computer network to the back end equipment that the Contractor shall provide and install to run reports. SFMTA shall be able to dynamically set the reporting timeframe for each reporting run, and be able to create reports on a per intersection and per vehicle basis, as well as a SFMTA Addendum No. 11 Page 9 of 16 Contract No. 1240 configurable intersection sequence (corridor) basis. A mechanism to create batch reports and to send them to SFMTA email addresses shall be provided via SMTP connection to the City's email servers.

The CCSF's GIS maps shall be used as the source for geospatial data needed for the development and maintenance of basic TSP data, as well as the base data for reports.

Field Performance and Mini Fleet Test Requirements

As part of the Mini Fleet Test, the Contractor shall install the wayside equipment at six intersections on Post Street between Taylor Street and Kearny Street. Connectivity to the City's fiber network is available in the traffic control cabinet at the intersection of

Design-Build Services for the Radio System Replacement**Section 3.0**

Post Street and Stockton Street. Equipment shall be designed, provided and installed to test and demonstrate, at a minimum, the following aspects:

- The wireless backhaul from the six intersections to the City's fiber network and its integration
- The wireless connection and hand-off of vehicles as they move along the corridor
- Wireless coverage for the six intersections that is adequate to support the TSP functions along the corridor. Depending on the coverage needs, the locations of wayside receivers may not coincide with individual intersections. It is the Contractor's responsibility to provide all accommodations necessary to provide the needed coverage.
- The prevention of broadcasts on the City's fiber network
- The logs and reports as required

Additional Field Equipment

The Contractor shall provide additional wayside traffic signal priority equipment, software, and any necessary software licenses to be installed by City staff. The quantity to be provided is specified in Appendix Twenty Eight (28) Cost Proposal Form.

3.3 Optional ITS Components**3.3.1 Automatic Passenger Counting System Interface (option)**

In the response to this RFP, the Qualified Proposers shall include, as an option, an interface to existing Automatic Passenger Counting (APC) equipment. The MTMS shall integrate with the APC onboard subsystem, the data offload of raw passenger counts, the post-processing of APC data, and the APC report module.

Qualified Proposers shall submit a complete description of the Automatic Passenger Counting System Interface. [PRL 12-3-41 Automatic Passenger Counting System Interface Description (option)]

The Contractor shall submit a complete description of the Automatic Passenger Counting System Interface. [CDRL 12-3-27 Automatic Passenger Counting System Interface (option)]

3.3.2 Track Layout and Turnaround Layer (option)

The Contractor shall, as an option, provide a display layer in all relevant displays (e.g. route ladder, map) that shows track layout and tactical trolley route layouts, including switches and turnarounds. Such a layer shall also be provided and displayed on a route-by-route basis. This layer is intended to support dispatchers and train controllers in service recovery decision making. If the relevant data is not available from the SFMTA, the Contractor shall acquire this data, and provide a tool to maintain this data. Changes to track layout and tactical trolley route layouts are rare, and a straightforward ASCII format where changes are made using a text editor could be sufficient. In any case, activation dates for multiple track layout and tactical trolley route layout versions shall be provided.

Qualified Proposers shall submit a complete description of the Track Layout and Turnaround Layer feature. [PRL 12-3-28 Track Layout and Turnaround Layer Description (option)]

The Contractor shall submit a complete description of the Track Layout and Turnaround Layer feature. [CDRL 12-3-28 Track Layout and Turnaround Layer Description (option)]

Design-Build Services for the Radio System Replacement**Section 3.0****3.3.3 Headway Control (option)**

The Contractor shall, as an option, provide a headway control function. Dispatchers and train controllers shall be able to activate headway control on a route by route basis, and for the SFMTA pre-configured corridors which may be shared by multiple routes. When headway control is activated, the headway between vehicles operating on the affected routes shall be calculated in relation to the leading vehicle (headway adherence value), based on a pre-defined adherence value, or as adjusted by a dispatcher or train controller. The MDT on board of the vehicles shall switch to display the headway adherence value in place of the schedule adherence value. This mode shall be indicated on the MDT.

As part of the response to this RFP, the Qualified Proposers shall describe the proposed method for headway control [PRL 12-3-29 Headway Control (option)].

The Contractor shall submit a complete description of the Headway Control feature. [CDRL 12-3-29 Headway Control Description (option)]

3.3.4 "Crush Load" Detection with Wheelchair Priority Pick-up (option)

The Contractor shall, as an option, provide a wheelchair priority pick-up function. This function shall capture situations where wheelchair passengers waiting at a stop or station were passed up by a transit vehicle, due to "crush"-Load status. This function shall alert followers on a route or corridor that a wheelchair passenger was passed up. It is expected that vehicle operator assistance through MDT interaction would be required. At a minimum, this function shall display stop and direction information on follower's MDT.

As part of the response to this RFP, the Qualified Proposers shall describe the proposed method for wheelchair priority pick-up [PRL 12-3-30 Wheelchair Priority Pick-Up (option)].

The Contractor shall submit a complete description of the "Crush Load" detection feature. [CDRL 12-3-30 Wheelchair Priority Pick-Up (option)]

3.3.5 Vehicle Health Monitoring (Option Deleted)**3.3.6 Capture Vehicle Load Using Real-Time Automatic Passenger Count Input (option)**

The Contractor shall, as an option, provide the capability to compute real-time load on board of revenue vehicles that are equipped with Automatic Passenger Counter (APC). This information shall be made available to dispatchers, train controllers and also be available as a factor for traffic signal priority requests

As part of the response to this RFP, the Qualified Proposers shall describe the proposed method of capturing passenger counts in real time, including methods for real time error correction [PRL 12-3-32 Real Time APC (option)].

The Contractor shall submit a complete description how vehicle load is captured using the real time APC interface. [CDRL 12-3-32 Real-Time APC (option)]

3.3.7 Predictive Arrival and Departure Information System (option)

The Contractor shall, as an option, replace the existing traveler information system with a predictive arrival and departure information system. This replacement excludes the surface shelter variable message signs and their supporting infrastructure, as well as the station platform flat panel displays and

Design-Build Services for the Radio System Replacement**Section 3.0**

station platform LED departure signs. The predictive arrival and departure information system shall drive the surface shelter message signs with dynamic departure information in its existing form, and shall have the capacity to accommodate the ongoing expansion of the existing surface shelter message sign infrastructure.

With this option, the Contractor shall provide an arrival and departure information system designed to raise recognition for transit vehicle arrivals and departures at surface stops and underground stations. A traveler facing web site shall also be provided. It shall conform with the SFMTA's existing accessibility accommodations, including the continuing ability for travelers to effectively use web page readers. At the SFMTA's underground stations, large displays shall show vehicle location on a systematic map of the SFMTA's light rail service network, as is the case with the existing system. Existing displays, their mounting and cabling may be reused.

Information provided shall include scheduled and real-time transit vehicle arrival I departure information, text messages, vehicle location, bay assignments, and other multi-media content. Layout tools shall be provided. The predictive arrival and departure information shall allow the design of supporting alternate purposes other than simply transit scheduling notifications, including multimedia capabilities.

A system administrator user interface shall provide diagnostic information, messaging status, setup, configuration, and messaging capabilities for all locations.

The Contractor shall be responsible for any licensing arrangements and fees required for the map data used by the arrival and departure information system. For FDR, the Contractor shall clearly state location and schedule accuracy and precision that the arrival and departure information system will provide [CDRL 12-3-33 Arrival and Departure Information System Schedule (option)]. The cutover from the existing to the replacement traveler information system shall be included in the Contractor's cutover plan. Please refer to Appendix Thirty-One (31), "SFMTA Surface Stop Shelters with NextBus Displays" for a reference list of the SFMTA surface stop shelters and NextBus displays.

As part of the response to this RFP, the Qualified Proposers shall describe the proposed method of implementing the predictive arrival and departure information system [PRL 12-3-33 Predictive Arrival and Departure System Description (option)].

The Contractor shall submit a complete description of the predictive arrival and departure information system. [CDRL 12-3-34 Predictive Arrival and Departure System Description (option)]

3.3.8 Predictive Subsystem and Web Services API (option)

The Contractor shall, as an option, provide an XML based web interface that makes MTMS information available to the public. This interface shall use TriMet's Web Services API format. The format specification can be found on TriMet's web site (<http://developer.trimet.org>), for reference, and either build on the existing, or replacement predictive arrival and departure information system, depending on the implementation of that option.

As part of the response to this RFP, the Qualified Proposers shall describe the proposed method of implementing the predictive subsystem and web services API [PRL 12-3-34 Predictive Subsystem and Web Services (option)].

Design-Build Services for the Radio System Replacement**Section 3.0**

The Contractor shall submit a complete description how vehicle load is captured using the real time APC interface. [CDRL 12-3-35 Real-Time APC (option)]

3.3.9 Mobile Dispatch Computers (option)

The Contractor shall provide, as an option, supervisor mobile workstations that authorized the SFMTA personnel may use to manage the command and control of fleet operations in the field. Thirty (30) mobile computers licensed to run the MTMS software for mobile dispatch capabilities shall be provided. Mounting hardware shall be supplied and installed in the support vehicles used for road supervision. Alternatively, Netbook or tablet style computers may be proposed that are intended to be issued to individual staff rather than being installed in vehicles. The MTMS shall be designed to accommodate up to eighty (80) mobile dispatch computers.

The mobile dispatch computers shall connect to the MTMS via a commercial wireless high speed data network that provides reliable coverage throughout the SFMTA's operating area. The Contractor shall be responsible for contracting, and the recurring cost of the mobile dispatch data communications throughout system implementation, the warranty period as well as any extended maintenance periods.

The mobile dispatch software shall provide similar functionality and response times to that of the dispatcher console including the selective calling of communication systems subscribers such as vehicles, and incident management workflow. The mobile dispatch software shall automatically integrate and coordinate voice and data communications with the central dispatch functions. Terminal emulation shall be acceptable with security enforced through the logon process. Voice communications shall be supported through a portable voice radio interface. Mobile dispatch computers shall be capable of responding to emergency alarms.

In the response to this RFP, the Qualified Proposers shall provide a complete description of their proposed mobile dispatch computer system and describe how the MTMS LAN will be connected to the mobile dispatch computers in a secure fashion [PRL 12-3-35 Mobile Dispatch Computer Description and Integration (option)].

The Contractor shall submit a complete description of the mobile dispatch computer system. [CDRL 12-3-36 Mobile Dispatch Computers (option)] Please refer to Appendix Thirty-six (36) "Supervisor Districts" for a map of SFMTA operations supervisory districts.

3.3.10 Traffic Signal Priority Field Equipment (Option Deleted)**3.3.11 MTMS Development Environment (option)**

During the life of the system, the SFMTA and/or the Contractor will be required to make periodic updates to software on the CAD/AVL system, radio communications system, and other servers. Ideally, these changes should first be implemented and tested in a separate development environment. In this way, application software updates, operating system updates, service packs, patches, etc. are first tested for functionality and/or compatibility before being introduced into the production MTMS environment.

In the response to this RFP, the Qualified Proposers shall include, as an option, an MTMS development environment. The MTMS development environment shall include the minimum subset of production servers able to demonstrate compatibility between different system components and processes that are running. The MTMS development environment will then be placed into operation during off-peak hours

Design-Build Services for the Radio System Replacement**Section 3.0**

to test the end-to-end effect of any proposed software updates and changes. The "bus-in-the-box" units shall be integrated in the MTMS development environment. It is understood that it is not feasible to duplicate certain parts of the system such as the radio base stations, channel banks, etc. and should not be included in this option.

The Qualified Proposers are encouraged to recommend alternative solutions to a dedicated MTMS development environment that would achieve the SFMTA project goals.

As part of the response to this RFP, the Qualified Proposers shall describe the MTMS Development Environment [PRL 12-3-37 MTMS Development Environment (option)].

The Contractor shall submit a complete description of the MTMS Development Environment. [CDRL 12-3-38 MTMS Development Environment (option)]

3.3.12 Yard Management (option)

As an option, the Contractor shall provide a yard management system that automatically locates revenue vehicles in the SFMTA yards. The vehicle locations shall be displayed on a yard map, which may be separate or integrated in other displays. Information about vehicle berth assignments in the yards shall be integrated with the CAD system to allow dispatchers to display the status and location of each vehicle within the yards. The yard map shall display tracks, switches and catenary, as applicable for the individual yards. The location accuracy in the yard shall be sufficient to reliably locate vehicles in relation to the berths, regardless whether vehicle storage is indoors, outdoors, under catenary and any environmental condition found at the SFMTA yards. It is expected that the GPS-based AVL subsystem alone does not provide the required location accuracy.

The yard management system shall provide a function to manually correct vehicle locations in cases where the automatic vehicle location and the correct assignment to a storage berth fails. Such failures shall not be greater than 5% with even distribution over all managed berths. The Contractor shall provide all surveys, data acquisition, vehicle and fixed side equipment, installation and testing required for this option. Vehicle born equipment shall be installed as part of the fleet install of non-option components. A separate round of installation shall not be required. The use of battery powered equipment shall not be necessary, and the vehicle's power supplies shall be used.

The yard management system AVL shall be integrated with the AVL of the MTMS such that vehicle tracking provided by the yard management system is available to the users of the MTMS and its dispatch functions.

In the response to this RFP, the Qualified Proposers shall describe the proposed method of automatic vehicle location using the yard management system along with integration with the wide area AVL system [PRL 12-3-38 Yard Management Automatic Vehicle Location System (option)].

The Contractor shall submit a complete description of the yard management system. [CDRL 12-3-39 Yard Management System (option)]

3.3.13 SFgo CCTV Feeds (Option Deleted)**3.3.14 Geographically Separated MTMS Hot Standby**

The Contractor shall provide a geographically separated hot standby capability for the fixed side MTMS. This capability shall provide an automatic and instantaneous switch between the separated

Design-Build Services for the Radio System Replacement

Section 3.0

equipment and systems in case the fixed side of the MTMS fails at a location. This event shall be recorded and processed by the NMS, The recovery of the failed site shall not require the shutdown and restart of the MTMS.

In the response to this RFP, the Qualified Proposers shall describe how they would implement a geographically separated MTMS Hot Standby [PRL 12-3-40 MTMS Hot Standby Feed).

The Contractor shall submit a complete description of the MTMS Hot Standby. [CDRL 12-3-41 MTMS Hot Standby)

3.4 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

- PRL 12-3-1 Software Licensing Terms
- PRL 12-3-2 Major On-board Equipment Components List
- PRL 12-3-3 Approach to Equipping Articulated Vehicles
- PRL 12-3-4 AVL Subsystem Accuracy
- PRL 12-3-5 On-Board Integration Approach
- PRL 12-3-6 Sequencing Routes Converge
- PRL 12-3-7 Detours and Bus Bridges Monitoring
- PRL 12-3-8 Special Revenue Services
- PRL 12-3-9 Route Adherence
- PRL 12-3-10 User Roles and Access Privileges
- PRL 12-3-11 Communications Network
- PRL 12-3-12 Unit Polling Algorithm
- PRL 12-3-13 Load Analysis
- PRL 12-3-14 Wireless Bulk Data Transfer
- PRL 12-3-15 Data Transfer to Existing Traveler Information System
- PRL 12-3-16 Tracker and ATCS Interface Cutover
- PRL 12-3-17 Trapeze FX Interface
- PRL 12-3-18 Trapeze Ops Interface.
- PRL 12-3-19 Stops geographic Network Bi-Directional Interface
- PRL 12-3-20 Headway Control.
- PRL 12-3-21 Wheelchair Priority Pick-Up.
- PRL 12-3-22 Vehicle Health Monitoring (VHM) Function.

Design-Build Services for the Radio System Replacement

Section 3.0

PRL 12-3-23 Real time APC

PRL 12-3-24 Yard Management Automatic Vehicle Location

PRL 12-3-25 Mobile Dispatch Computer Integration

PRL 12-3-26 Light Rail Vehicle Digital Visual and Announcement System Description and Integration

PRL 12-3-27 Incident Management System Description

PRL 12-3-28 Track Layout and Turnaround Layer Description (option)

PRL 12-3-29 Headway Control (option)

PRL 12-3-30 Wheelchair Priority Pick-Up (option)

PRL 12-3-31 (Deleted)

PRL 12-3-32 Real Time APC (option)

PRL 12-3-33 Predictive Arrival and Departure System Description (option)

PRL 12-3-34 Predictive Subsystem and Web Services(option)

PRL 12-3-35 Mobile Dispatch Computer Description and Integration (option)

PRL 12-3-36 Traffic Signal Priority Interface

PRL 12-3-37 MTMS Development Environment (option)

PRL 12-3-38 Yard Management Automatic Vehicle Location System (option)

PRL 12-3-39 (Deleted)

PRL 12-3-40 MTMS Hot Standby Feed (option)

PRL 12-3-41 Automatic Passenger Counting System Interface Description (option)

3.5 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

CDRL 12-3-1 Pre-inspection Procedure

CDRL 12-3-2 Emergency Alarm Description of Operation

CDRL 12-3-3 Wheelchair Ramp or Lift Test Description of Operation

CDRL 12-3-4 Vehicle Area Network Wireless Router Description

CDRL 12-3-5 Computer Aided Dispatch System Description

CDRL 12-3-6 Service Messaging Description

CDRL 12-3-7 Textual and Tabular Display Description

CDRL 12-3-8 Schedule Adherence System Description

CDRL 12-3-9 Detours and Bus Bridges Monitoring

CDRL 12-3-10 Route Adherence

Design-Build Services for the Radio System Replacement

Section 3.0

- CDRL 12-3-11 Daily Schedules
- CDRL 12-3-12 System Failures Messaging
- CDRL 12-3-13 SFMTA User Groups and Access Privileges
- CDRL 12-3-14 Wide Area Wireless Network System Description
- CDRL 12-3-15 Wireless Bulk Data Transfer System Surveys
- CDRL 12-3-16 On Board Destination and Run Sign Interface Description
- CDRL 12-3-18 Farebox Interface Description
- CDRL 12-3-19 NextBus System Interface Description
- CDRL 12-3-20 MTC 511.org Interface Description
- CDRL 12-3-21 Database Management System Description
- CDRL 12-3-22 Historical Reporting and Playback Feature Description
- CDRL 12-3-23 Data Dictionary, Data Schema
- CDRL 12-3-24 Incident Management System Description
- CDRL 12-3-25 Passenger Facing Service Message System Description
- CDRL 12-3-26 Light Rail Vehicle Digital Visual and Announcement System Description
- CDRL 12-3-27 Automatic Passenger Counting System Interface (option)
- CDRL 12-3-28 Track Layout and Turnaround Layer Description (option)
- CDRL 12-3-29 Headway Control Description (option)
- CDRL 12-3-30 Wheelchair Priority Pick-Up (option)
- CDRL 12-3-31 (Deleted)
- CDRL 12-3-32 Real-Time APC (option)
- CDRL 12-3-33 Arrival and Departure Information System Schedule (option)
- CDRL 12-3-34 Predictive Arrival and Departure System Description (option)
- CDRL 12-3-35 Real-Time APC (option)
- CDRL 12-3-36 Mobile Dispatch Computers (option)
- CDRL 12-3-37 Traffic Signal Priority Interface
- CDRL 12-3-38 MTMS Development Environment (option)
- CDRL 12-3-39 Yard Management System (option)
- CDRL 12-3-40 (Deleted)
- CDRL 12-3-41 MTMS Hot Standby (option)

Design-Build Services for the Radio System Replacement

Section 3.0

The Contractor is advised that the above list does not constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole or by reference as part of the complete package of deliverables and submittals.

4.0 NETWORK REQUIREMENTS

This section describes the current network environment at the SFMTA and City and County of San Francisco (CCSF) sites, the network improvements to be performed by the Contractor, and equipment requirements.

Both the CCSF's Department of Technology and the SFMTA's Information Technology Department operate extensive shared enterprise networks that already connect most of the facilities that will house and support the Public Service Voice Radio Network (PSVRN) and Multimodal Transit Management System (MTMS). These networks include microwave backhaul connecting the above ground communications sites, fiber optic networks, leased circuits, and public cellular data services. With the exception of the microwave backhaul, most other elements of the existing physical networks between and within buildings will not be used by the Contractor. Instead a new gigabit fiber optic network, utilizing existing dark fiber, will be constructed and used in conjunction with the City's existing microwave backhaul to the above-ground antenna sites.

What follows is a description of:

- The existing CCSF and the SFMTA network environment
- Desired network topology and architecture
- The CCSF and the SFMTA network improvements required to accommodate the PSVRN and MTMS network connectivity requirements
- Description of equipment to be provided and work to be performed the Contractor.

4.1 Background

A complete description of the functional requirements for the PSVRN and MTMS can be found in Appendix Twelve (12), Sections Two (2) and Three (3). This section provides a brief synopsis of the system description for the purposes of putting the network requirements into context.

It is the SFMTA's intent to procure a fully integrated system that includes:

- The MTMS including, but not limited to, digital trunked voice and data communications for all transit operations, computer aided dispatch, automatic vehicle location, integrated incident management/reporting, single-point logon for revenue vehicles, and on-board ADA compliant traveler information
- An interoperable Project-25 compliant PSVRN for joint use by the selected SFMTA staff and CCSF public works employees including the Department of Public Works, Port of San Francisco, and Department of Building Inspection (with no public safety users).

Radio communications equipment, computer servers, network equipment, and all necessary software will be installed at above ground radio communications sites, the SFMTA's underground rail tunnels and platforms, the SFMTA's Lenox Way Operations Control Center, the SFMTA's One South Van Ness headquarters, vehicle maintenance facilities, and other CCSF sites. These sites will be interconnected using a combination of the CCSF's existing microwave backhaul, existing fiber optic cable, leased communications circuits, and the public cellular data networks.

Design-Build Services for the Radio System Replacement**Section 4.0**

As part of this Project, the Lenox Way Operations Control Center theatre will be refurbished to accommodate the new dispatch consoles. In order to facilitate the renovation of the Lenox Way Operations Control Center, the existing Line Management Center at the SFMTA's One South Van Ness headquarters will be modified to temporarily accommodate rubber-tire vehicle dispatchers.

This RFP assumes a five (5) site communication (RF) system with two (2) additional Operational Control sites. The communication sites, as illustrated in Appendix Nine (9), "Drawings", include:

- Bernal Heights
- Forest Hill
- One Market Plaza
- South Hill
- Twin Peaks

An additional sixth site at the Clay/Jones building may be retained to house a stand-alone 800 MHz repeater for cable car machinery maintenance operations.

Control sites include:

- Operations Control Center at 131 Lenox Way, San Francisco, CA
- Transit Management Center at 1455 Market St, San Francisco, CA
- Vehicle maintenance facilities, emergency operations center, etc.

4.2 Existing Network Description**4.2.1 City and County of San Francisco Department of Technology Networks****Microwave Backhaul**

The existing microwave backhaul is illustrated in Appendix Nine (9), "Drawings".

The CCSF interconnects eight (8) different radio sites with three (3) loop microwave networks. Two (2) of these loops are used for the Citywide Emergency Radio System (CERS) with radio sites assigned to either a North or South Loop. The third loop is for the Public Works Emergency Radio System (PERS). The eight (8) radio sites include:

- Fort Miley
- Clay/Jones
- One Market Plaza
- Forest Hill
- San Francisco State University
- Bernal Heights
- Central Radio Station (CRS) Twin Peaks
- South Hill

Design-Build Services for the Radio System Replacement**Section 4.0**

The PERS loop has four (4) sites common to CERS. The CERS and PERS microwave networks use loop redundancy for reliability. Each node can select its T-1's to drop from either direction of the loop.

CERS Microwave Loops:

Five (5) sites on the West and North side of the County are considered the CERS North Loop and two (2) sites in the South part of the County are considered the CERS South Loop. Central Radio Station (CRS) at Twin Peaks located in the center of the County serves as the hub for the North and South CERS loops.

All CERS North Loop microwave paths are licensed 18 GHz frequencies and have microwave backhaul capability of 28 T-1's, or DS3. CERS North loop sites include:

- Fort Miley/VA Hospital
- One Market Plaza
- Forest Hill
- San Francisco State University
- Clay/Jones (repeater only)

All CERS South Loop microwave paths are licensed 18 GHz frequencies and have microwave backhaul capability of 28 T-1's, or DS3. CERS South loop sites include South Hills and Bernal Heights.

PERS Loop Sites:

The majority of the PERS sites are interconnected by a licensed 11 GHz Alcatel microwave system at OC3 (155 Mbps) capacity currently configured for 16 T-1's plus Ethernet traffic. The only exception is CRS Twin Peaks which is connected to Fort Miley via fiber only. PERS loop sites include:

- Fort Miley/VA Hospital
- Clay/Jones (repeater only)
- One Market Plaza (OMP)
- South Hill/South City
- CRS Twin Peaks (connected to Fort Miley via FOC only)

The PERS microwave paths are routed in the following manner:

- One Market Plaza (OMP) is connected to Fort Miley via a repeater at Clay/Jones
- One Market Plaza is connected to South Hill
- South Hill is connected to Fort Miley.

Fiber Optic Cable

Fiber Optic Connectivity (FOC) is illustrated in Appendix Nine (9), "Drawings".

With the exception of South Hill, each PERS and CERS site has FOC designed to follow the same routing configuration as the microwave paths to each site. CCSF plans to route FOC to South Hill at a later date. Alcatel switches are installed at each PERS site and are currently configured for 8 T-1's,

Design-Build Services for the Radio System Replacement**Section 4.0**

plus gigabit Ethernet traffic. Contractor may utilize the existing MPLS network of the CCSF. All necessary MPLS configuration changes will be completed by CCSF.

The following sites have FOC with some having dual routes and entrances into the buildings:

- Forest Hill - single route
- One Market Plaza - dual route and entrances
- CRS Twin Peaks - single route
- Bernal Heights - single route

The following the SFMTA vehicle maintenance and storage sites currently have dark fiber available:

- Potrero Division (2500 Mariposa Street)
- Muni Metro East (601 25th Street)
- Presidio Division (949 Presidio Avenue)
- Green Division (425 Geneva Avenue).
- The CCSF plans to provide dark fiber connectivity to the following SFMTA vehicle maintenance and storage sites in the near future:
 - Woods Division (1001 22nd Street)
 - Islais Creek (1301 Cesar Chavez)
 - Marin Division (1399 Marin Street)
 - Flynn Division (1940 Harrison Street)
 - Cable Car Division (1201 Mason Street)
 - Pennsylvania (700 Pennsylvania Avenue)

No FOC exists to the Kirkland Division (151 Beach Street) and the SFMTA plans to cease operations at this facility after Islais Creek opens.

The SFMTA is currently designing the Central Subway Project, a three station 1.7 mile rail line 4th and King Streets to Chinatown. The Central Subway will intersect the Market Street Subway at Powell Street where a network connection is envisioned in the future.

4.2.2 SFMTA Existing Networks

Sufficient fiber exists between 1455 Market and the Van Ness station.

The SFMTA operates extensive in-building networks in each of the facilities. With the exception of One South Van Ness Avenue, the SFMTA vehicle maintenance divisions and 131 Lenox Way already have existing in-building networks whose state or condition is unknown. These existing networks are likely to be unusable for PSVRN and MTMS network connectivity will require the Contractor to-make improvements. The existing physical network in One South Van Ness Avenue is likely usable and can be used to connect from the fiber distribution panel on the third floor to the interim rubber tire dispatch center intended for the eight floor.

Design-Build Services for the Radio System Replacement

Section 4.0

4.3 Network Topology Preliminary Design

The network topology to support the PSVRN and MTMS is shown in Appendix Nine (9), "Drawings". Existing and planned SFMTA Site connectivity along with type is shown in Exhibit 4.3-1.

The Contractor shall submit detailed wide-area network site connection diagrams including patch panel connections and all intermediate connections throughout the City [CDRL 12-4-1 Wide Area Network Diagrams). Contractor may also use any Contractor installed fiber in the tunnels as part of proposed design.

As part of their Proposal, Qualified Proposers shall submit a description of the intended network topology [PRL 12-4-1 Network Topology].

Exhibit 4.3-1: SFMTA Site Connectivity

Connectivity		
Site	Microwave	Fiber
Above Ground Radio Communications		
One Market Plaza	X	X
CRS Twin Peaks	X	X
Forest Hill	X	X
Bernal Heights	X	X
South Hill	X	X
Clay/Jones		X
Control Centers		
131 Lenox Way		
TMC at 1455 Market Street to Van Ness Station	X	
Maintenance Divisions		
Potrero Division		X
Muni Metro East		X
Presidio Division		X
Green Division		X
Woods Division		X
Islais Creek		Planned
Flynn Division		Planned
Cable Car Division		Planned

Design-Build Services for the Radio System Replacement**Section 4.0****4.4 Network Architecture Preliminary Design**

The Network Architecture preliminary design is illustrated in Appendix Nine (9), "Drawings". The design includes the following elements:

- Radio communications prime site, and primary network core switch at Bernal Heights
- Backup network core switch at CRS Twin Peaks
- Primary Operations Control Center and Centralized MTMS servers at 131 Lenox Way
- Interim rubber-tire dispatch center at One South Van Ness Avenue
- Above-ground communications sites:
 - Bernal Heights
 - Forest Hill
 - One Market Plaza
 - CRS Twin Peaks
 - South Hill
- Clay/Jones (stand-alone, remote monitoring via fiber only)
- Below-ground communications sites (remote monitoring only)
- MTMS data and voice radio communications at multiple SFMTA vehicle maintenance facilities:
 - Potrero Division
 - Muni Metro East
 - Presidio Division
 - Green Division
 - Woods Division
 - Flynn Division
 - Islais Creek
 - Cable Car Division
- Other base ITS components connections
- Internet connection to MTC's 511.org
- Connection to the SFMTA's Trapeze data
- Public cellular data connections to cable cars.

The Contractor shall submit detailed local-area network diagrams including patch panel connections and all intermediate connections throughout each facility [CDRL 12-4-2 Local Area Network Diagrams].

Design-Build Services for the Radio System Replacement**Section 4.0****4.5 Network Security****4.5.1 General Network Security Considerations**

In order to minimize the failure of anyone security device, the Contractor shall employ a multi-layer strategy involving two (or more) different overlapping security mechanisms, including the use of firewalls, demilitarization zones (DMZ), intrusion detection, and security policy enforcement. The Contractor's network security design shall follow guidelines established in NIST-800-82 Guide to Industrial Control System Security, considering such threats as:

- Backdoors and holes in the network perimeter
- Vulnerabilities in common protocols
- Attacks on field devices
- Database attacks
- Communications hijacking and 'man-in-the-middle' attacks.

There shall be no direct connection between either the SFMTA, CCSF, or PSVRN/MTMS networks, except through one of the above methods such as firewall and/or DMZ.

The Contractor shall submit a Network System Security Plan providing an overview of the security requirements along with describing the specific security controls that will be provided to meet those requirements [CDRL 12-4-3 Network System Security Plan]. The security controls that fall within the NIST SP 800-53 Planning (PL) family shall provide the basis for developing the security plan. These controls also address maintenance issues for periodically updating a security plan.

Throughout this process, the Contractor shall work with the SFMTA and CCSF information technology staff to implement the network and all aspects of network security functions and features.

As part of their proposals, Qualified Proposers shall submit a description of network security requirements and how those requirements will be met [PRL 12-4-2 Network Security Description].

4.5.2 Network Configuration Management

In conjunction with the Network Management System specified in Section 4.6, the Contractor shall provide a utility for the SFMTA and CCSF staff to remotely monitor and manage the configuration of the PSVRN/MTMS network. The software utility shall include the ability to remotely monitor and audit changes to network configuration(s), along with providing the ability to remotely configure, secure, and update any devices on the PSVRN/MTMS network. The network configuration management utility shall be capable of providing regular reports and alert notifications (via email or SMS) of all network changes, both authorized and unauthorized.

4.5.3 Network Intrusion Detection System

In an attempt to identify an intruder breaking into or attempting to break into the PSVRN/MTMS network, the Contractor shall provide an Intrusion Detection Systems (IDS) to monitor events on the network, including, but limited to traffic patterns, log entries, and file accesses. The IDS shall provide regular reports and alert notifications for unusual activity such as new open ports, unusual traffic patterns, or changes to critical operating system files. The IDS shall include both host-based and

Design-Build Services for the Radio System Replacement**Section 4.0**

network-based components and be capable of being configured to filter false alarms related to normal network activity.

4.6 Network Management**4.6.1 General Requirements**

All subsystems shall be under control of a single network management scheme. The scope of the single network management scheme includes the five basic elements of network management:

- Configuration management
- Fault management
- Security management
- Performance management
- Accounting management.

Network Management System (NMS) general requirements include:

- Use of open system standards - The NMS shall be developed using Open Systems Standards to gain maximum flexibility and scalability of the NMS. This functionality will also allow for easier enhancements from other software/hardware providers.
- Use of client server architecture - The Contractor shall provide for a true multi-user, multitasking system, following a client server architecture and be capable of supporting 10 Mbps and 100 Mbps LAN and Gigabit Ethernet connectivity. The operating system will allow for compatibility across many hardware platforms. The hardware architecture shall provide multiple levels of computing power based on the size of the network. Qualified Proposers shall define the operating system programming language and platforms that will be used to develop the offered NMS.
- Provide expandable processing power
- Accessible by authorized users from anywhere on the network
- Be user friendly - The NMS shall be developed in a logical manner so that the user can understand the conceptual layout of the application software as related to the overall network. The design shall allow for on-screen help menus and user-understood prompts that provide direction and assistance through the learning process. These learning tools shall be able to be placed in the background after user efficiency is achieved. Training and user manuals shall contain the same information provided on help screens and prompts.
- Employ use of modular software
- Use a powerful operating system
- Use a relational database - The NMS shall be supplied with an industry-standard relational database management system such as SQL Server or Oracle. In the response to this RFP, the Qualified Proposers shall indicate manufacturer and version

Design-Build Services for the Radio System Replacement**Section 4.0**

of the relational database as part of their response to this RFP. Additional relational database requirements include:

- All database entries shall be user restricted and password protected, and all transactions shall be logged and tagged and traceable to the user names.
- Redundancy and fault tolerant design as necessary to meet system availability requirement.
- Security and user partitioning (Contractor to specify number and capabilities of partitions)
- Capable of interfacing with other Contractor NMS'.
- The database and software must be able to store objects and their relationships
- Software tools shall be provided to update both database and the graphical network depiction as the network expands or is being modified.
- All user terminal positions shall have access to printers to output activity reports or other output produced by the NMS.
- The NMS shall incorporate a graphical user interface (GUI) system manager/information management system to set selected parameters and allow the supervisory personnel to control and analyze NMS operation.

The Contractor shall submit a complete description of the Network Management System, including all subordinate network management systems and interfaces for individual subsystems [CDRL 12-4-4 Network Management System Description].

4.6.2 Alerts and Notifications

A programmable, audible alert for critical alarms shall be provided at the Operations Control Center. Critical failures should be automatically displayed to alert appropriate radio maintenance personnel. If positive acknowledgement is not received within 30 minutes, the NMS shall contact maintenance personnel by alternate means (i.e. telephone, pager, e-mail).

The NMS shall monitor fire, intrusion, station batteries power supply or UPS.

The NMS shall provide alarm conditions down to board level failures of all-network elements or as provided in commercial off the shelf (COTS) products.

All reported network problems shall be entered into NMS trouble tracking system, and problem history records shall be stored for each user.

The NMS shall also incorporate a feature that graphically illustrates network trends and statistics.

4.6.3 Remote Access

The SFMTA requires the capability of monitoring the integrated radio network using a VPN connection from remote locations via the Internet. The SFMTA's system managers, technicians, and other types of personnel shall be able to perform monitoring and obtain access to the network through such remote connections.

Design-Build Services for the Radio System Replacement**Section 4.0**

These remote monitoring and control functions shall comprehensively cover all monitoring and control functions, such that system management can be conducted in case government orders in response to pandemics, earthquakes or other events are in place.

The NMS shall be capable of supporting remote access using a System Manager user terminal without degradation of terminal performance. A remote user terminal shall be capable of performing/accessing all the same functions/information that a local terminal can.

The speed at which the remote terminal connecting from within the MTMS network operates shall be equivalent to that of a local terminal and the accessing of information shall not be noticeably different in physical appearance or access time.

A minimum of two remote terminals shall be provided. The Contractor shall provide the necessary connectivity to remote terminals.

The remote terminals should enable a user to have access to required NMS manager capabilities. These capabilities shall include:

- NMS configuration-shall be able to control all of the programmable features of the trunking controller and radio infrastructure
- Subscriber management-shall allow an operator to view, set, or modify the talk group IDs, and the unique 10 profiles.

4.6.4 Security and User Partitioning

The NMS shall support multiple levels of access that are protected in a manner that will allow users to control, monitor, and use software applications that have been partitioned for specific use by the end-user.

In the response to this RFP, the Qualified Proposers shall provide a detailed description of this capability by defining the levels of partitioning and security, total number of end-users, the total number of simultaneous users with independent views, and the method used to achieve this requirement.

End-users will be at different locations, such as dispatch centers, offices, maintenance facilities, and other remote sites. Therefore, this feature shall be provided to remote locations to allow restricted access to the overall radio network.

4.6.5 Redundancy and Fault Tolerant Design

The NMS shall ensure uninterrupted network monitoring (redundancy) by supporting multiple redundant network management stations through remote background processing communications. This enables each network management station to operate as a full backup in the event of equipment failure.

The NMS shall be supplied with a backup server and associated equipment to support a failed main server or any component of the server that will cause a failure.

In the response to this RFP, the Qualified Proposers shall describe this backup configuration offering and any fault tolerant equipment offered as a response to the specifications.

Design-Build Services for the Radio System Replacement**Section 4.0****4.6.6 Monitoring and Control of Other Components**

The NMS shall be capable of controlling each and every system that is part of the integrated radio system. These systems shall include, but not be limited to, the items listed below. A list of elements and alarms is provided as a starting point in the development of the NMS.

- Power supply systems
- Tower lights
- Shelter
- Emergency generator
- Automatic transfer switch
- HVAC units
- Door
- Fire and smoke monitors
- Radio communications system (i.e., power, VSWR, diagnostics, and reflected power)
- Temperature.

Each of these items and components shall be monitored and controlled for specific management and diagnostic reasons.

The monitoring and controlling operations shall be performed by network elements, RTUs, and SCADA elements, as required.

4.7 Statement of Work**4.7.1 Work Done By Others**

This section describes work to be performed by others in preparation for the Contractor's installation of the MTMS and PSVRN.

Although it is the SFMTA's intent to have this work completed in advance of the Contractor's need for network connectivity, the SFMTA reserves the right to issue a contract change notice to the Contractor to perform any necessary remaining work. In such case, the SFMTA will make a best effort to notify and negotiate this work with the Contractor well in advance of the need for network connectivity.

The contractor should interface with the Microwave vendor for the complete design and construction phases, and the design build contractor is responsible for the completion performance (99.999%) of the Radio system include the microwave system.

Microwave Backhaul Improvements

The SFMTA and CCSF believe there is sufficient capacity available on the PERS Microwave loop and that only the One Market Plaza to South Hill path would be used for the PSVRN and MTMS with no improvements required.

The remaining PSVRN/MTMS sites (see Appendix Nine (9), "Drawings") shall be connected as follows with indicated capacity:

Design-Build Services for the Radio System Replacement**Section 4.0**

- South Hill to Bernal Heights via CERS South Loop - Licensed 18 GHz Harris equipment with 45 Mbps capacity, with approximately 50% available capacity.
- Bernal Heights to Twin Peaks via CERS South Loop - Licensed 18 GHz Harris Equipment with 45 Mbps capacity, with approximately 50% available capacity.
- Twin Peaks to South Hill via CERS South Loop - Licensed 18 GHz Harris equipment with 45 Mbps capacity, with approximately 50% available capacity
- Twin Peaks to Forest Hills and One Market Plaza via CERS North Loop - Licensed 18 GHz Harris equipment with 45 Mbps capacity, with one T1 worth of capacity available for the contractor.

As part of their Proposal, Qualified Proposers shall indicate their capacity their back haul requirements for the combined PSVRN and MTMS, with spare capacity for future growth [PRL 12-4-3 Backhaul Requirements for Combined PSVRN and MTMS).

Dark Fiber

With the exception of those sites listed above, the SFMTA believes there is existing or planned dark fiber capacity to each site housing the PSVRN and MTMS equipment. The SFMTA will provide dark fiber from the Van Ness station to 1455 Market St.

4.7.2 Work to Be Performed By The Contractor**Network Design**

The Contractor shall consider the network architecture and topology described above to design a network to accommodate all needs of the PSVRN and MTMS. The design shall consider existing CCSF and the SFMTA provided microwave backhaul, FOC, and in-building cabling. The Contractor's design shall include specification, selection, and configuration of all necessary core and edge equipment to accommodate the needs of the PSVRN and MTMS.

The network shall be designed to provide, with improvements, sufficient capacity for future growth beyond existing projected air-time measurements listed in Appendix Nineteen (19) and fleet growth.

The network design shall include hardware and software to provide all security features listed above.

The Contractor's design shall consider all inherent latencies and delays to be anticipated traversing the CCSF and the SFMTA microwave and dark fiber infrastructure and include all equipment with flexibility to minimize the effects of such latency in implementing the PSVRN and MTMS.

Network Interface Criteria

The Contractor shall identify all electrical, mechanical, and physical interfaces associated with the network equipment installation and as shown on the Contract Drawings. These shall include, but not limited to, the following network interfaces:

- Between the various systems, subsystems, equipment, and materials included in these documents.
- Between the systems, subsystem, equipment, and materials included in these documents and existing systems, subsystems, and equipment.

Design-Build Services for the Radio System Replacement

Section 4.0

The Contractor-provided system, subsystem, equipment, and materials shall be designed to have the characteristics required to ensure that electrical, mechanical, and physical interfaces achieve the specified grade of service and performance levels on a non-interfering basis with existing system and equipment functions.

The Contractor shall be fully responsible for the correct interfacing of the systems, facilities, and equipment that are provided under this Contract with the existing SFMTA and CCSF systems, subsystem, equipment, and facilities. If any incompatibility is discovered, the Contractor shall correct the incompatibility by modifying the additional required equipment and material and correcting the manuals and drawings. Unless otherwise specified, modifications to the equipment of existing systems, subsystems, and facilities will not be permitted.

On-site technical assistance from the Contractor shall be provided for system installation and testing when interfacing with the SFMTA or City and County of San Francisco provided network equipment per the agree upon level of service..

Equipment Installation and Configuration

The Contractor shall be responsible for installation, configuration, testing of all network core and edge equipment from the connection to the SFMTA and CCSF provided demarcation points at each location throughout the system.

The Contractor shall immediately notify the SFMTA of any problems or deficiencies with network connectivity between any sites. The SFMTA and/or CCSF staff will make immediate attempt to correct the situation, or at its discretion, request that the Contractor make necessary repairs to reimbursed on a time and material basis.

Addition of Microwave Link between 1455 Market and CRS

Contractor shall install a new microwave link between CRS Twin Peaks and 1455 Market. This shall be used to support communications between the two locations. The Contractor shall submit a complete description including features, installation details, and interface description for the point-to-point microwave connection between CRS Twin peaks and 1455 market [CDRL 12-4-5 Point-to-Point Microwave Description Between CRS Twin Peaks and 1455 Market]. Contractor shall also provide network equipment to tie 1455 Market St. to MPLS network if MPLS FOC backup is needed in the proposed network design.

Woods Division Point-to-Point Wireless Bridges

At the Woods Division, the Vehicle Maintenance Building and Meet and Greet are separated by Indiana Street with no spare fiber connectivity between the three buildings. As an alternative to laying fiber below Indiana Street, the Contractor shall provide, install, and test wireless point-to-point bridges between the Vehicle Maintenance Building and Meet and Greet. The wireless bridges (or equivalent) shall permit secure and encrypted connections between the network in the Vehicle Maintenance Building and the networked equipment in the dispatch office, operator area, and Meet and Greet. The wireless bridge shall provide sufficient bandwidth to accommodate worst-case network traffic conditions including voice communications from Dispatch, voice communications from the Meet and Greet, and wireless data communications with vehicles in the bus yard. The Contractor may propose to SFMTA an alternative design that meets the same requirements.

Design-Build Services for the Radio System Replacement**Section 4.0****4.8 Network Equipment Requirements****4.8.1 Equipment Availability and Serviceability**

All network equipment shall be commercially available through multiple sellers or distributors.

4.8.2 Equipment Management

Management protocols supported shall include SNMP, RMON, and Telnet. Management Information Bases shall be available from the equipment vendor(s) to be used by the Contractor in the implementation of the Network Management System. The switches shall have embedded web-based management software with the ability to manage up to 16 switches at once.

4.8.3 Equipment Features

The network equipment shall be rack-mountable.

All switches shall auto-detect full and half-duplex operation on all ports.

All switches shall support VLAN (IEEE 802.1 Q) and Spanning Tree Algorithm protocols (IEEE 802.1d).

4.8.4 Design Submittals

The Contractor's Network Design Document [CDRL 12-4-6 Network Design Document] shall include, as a minimum:

- A network diagram of the system including all interfaces and devices
- Specification sheets for all proposed network components
- IP addressing scheme that is consistent with the SFMTA and CCSF IT Department assignment conventions
- A network list for all devices, showing proposed network addresses, subnets, gateways, mask assignments and terminal address of each device
- Equipment final layout diagrams showing equipment in each rack and/or cabinet
- Bills of materials for all network equipment and accessories.

4.9 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

PRL 12-4-1 Network Topology

PRL 12-4-2 Network Security Description

PRL 12-4-3 Backhaul Requirements for Combined PSVRN and MTMS.

4.10 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

CDRL 12-4-1 Wide Area Network Diagrams

CDRL 12-4-2 Local Area Network Diagrams

Design-Build Services for the Radio System Replacement

Section 4.0

CDRL 12-4-3 Network System Security Plan

CDRL 12-4-4 Network Management System Description

CDRL 12-4-5 Point-to-Point Microwave Description Between CRS Twin Peaks and Forest Hill

CDRL 12-4-6 Network Design Document.

The Contractor is advised that the above list does not necessarily constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole, or by reference, as part of the complete package of deliverables and submittals. Any additional CDRLs required will be mutually agreed during the Design Phase.

5.0 SYSTEM INSTALLATION AND CUTOVER

This system describes the work to be performed by the Contractor to install and cutover the Public Service Voice Radio Network (PSVRN) and Multimodal Transit Management System (MTMS). Detailed requirements for the system test program are described in Appendix Twelve (12), Section Seven (7).

A complete description of the functional requirements for the PSVRN and MTMS can be found in Appendix Twelve (12), Sections Two (2) and Three (3). What follows is a brief synopsis of the system description for the purposes of putting the site installation requirements into context.

It is the SFMTA's intent to procure, via a design-build project, a fully integrated system that includes:

- The MTMS including, but not limited to, digital trunked voice and data communications for all transit operations, computer aided dispatch, automatic vehicle location, integrated incident management/reporting, single-point logon for revenue vehicles, and on-board ADA compliant traveler information
- An interoperable Project-25 compliant PSVRN for joint use by selected the SFMTA staff and City and County of San Francisco (CCSF) public works employees including the Department of Public Works, Port of San Francisco, and Department of Building Inspection (with no public safety users).

Radio communications equipment, computer servers, network equipment, and all necessary software will be installed at above ground radio communications sites, the SFMTA's underground rail tunnels and platforms, the SFM A's Lenox Way Operations Control Center, the SFMTA's One South Van Ness headquarters, vehicle maintenance facilities, and other CCSF sites. These sites will be interconnected using a combination of the CCSF's existing microwave communications system, existing fiber optic cable, leased communications circuits, and the public cellular data networks.

As part of this Design/Build project, the Lenox Way Operations Control Center theatre will be refurbished to accommodate the new dispatch consoles. In order to facilitate the renovation of the Lenox Way Operations Control Center, the existing Line Management Center at the SFMTA's One South Van Ness headquarters will be modified to accommodate rubber-tire vehicle dispatchers.

This RFP assumes a (5) five site communication (RF) system with (2) two additional central control sites. The communication sites, as illustrated in Appendix Nine (9), "Drawings", include:

- Bernal Heights
- Forest Hill
- One Market Plaza
- South Hill
- Twin Peaks.

An additional site at the Clay/Jones building will likely be retained to house a stand-alone 800 MHz repeater for cable car machinery maintenance operations.

Control sites include:

- Operations Control Center at 131 Lenox Way, San Francisco

Design-Build Services for the Radio System Replacement**Section 5.0**

- An interim rubber-tire dispatch center at the SFMTA headquarters at One South Van Ness Avenue, San Francisco, to facilitate renovation of the Operations Control Center at 131 Lenox Way
- Vehicle maintenance facilities, emergency operations center, etc.

5.1 System Installation General Requirements

On a site-by-site basis, the Contractor shall perform work required to prepare sites for the installation of all MTMS and PSVRN system components.

The Contractor shall submit all designs, specifications, drawings, and plans to the SFMTA for acceptance before proceeding with any work. The final drawings shall provide adequate direction to the construction forces on the execution of the site specific Infrastructure work. The drawings shall be a complete representation of the work to be done. The drawings shall permit the SFMTA to have a clear understanding of all of the work to be accomplished. The drawings shall permit the SFMTA to review the planned work and to facilitate approval.

The Contractor shall perform all necessary site modifications, including material and labor. The Contractor shall also perform all modifications that are deemed temporary in order to facilitate installation and testing of the system components.

If the Contractor fails to mention or identify necessary improvements or neglects to specify all facility requirements, the Contractor shall remedy the problems that arise at its own expense.

Proposers, as part of their proposals, shall describe in detail any environment requirements which include but are not limited to, all grounding, electrical power specifications, humidity, temperature requirements for facilities and vehicles that will house the equipment [PRL 12-5-1 Environment Requirements]. Proposers, as part of their proposals, shall also describe the required installation space, bays and the expected installation duration as impact to the SFMTA (down time) [PRL 12-5-2 Required Equipment Space]. Proposals shall address the following areas of work:

- Vehicles, for each individual vehicle type
- Backhaul infrastructure
- Base station sites
- Controller and server sites
- Underground structures, including cable car below grade structures, if applicable
- Control Center
- Divisions (yards) including but not limited to wireless LAN coverage areas, dispatch positions and Meet-and-Greet.

5.1.1 Summary of Site Work**5.1.2 Documentation Requirements**

The final design documents shall include specifications for the following products, as minimum:

- Lighting (for Lenox Way)

Design-Build Services for the Radio System Replacement

Section 5.0

- Transformers (120 Volts and up)
- Towers or tower components
- Shelters
- Generators
- Automatic Transfer Switches
- UPSs (above 6 KW)
- Battery Chargers above 6 KW
- Stationary Batteries
- Electrical Distribution Panels
- Pre-Action Gas based Fire Suppression Systems
- FM200 Fire Suppression Systems
- Fire detection and remote alarm systems
- Air Handlers using externally provided chilled water
- And other equipment and systems that the SFMTA deems appropriate.

The services provided by the Contractor shall include but shall not be limited to the following:

- **Product Description:** The Contractor shall provide a complete description of the product or system to be delivered. This description shall be associated with the purchase process of the product or system. The description shall be that of a product that meets all of the requirements of the associated specification. This description shall be provided to the SFMTA prior to delivery of the product or system to the Contractor.
- **Shop Drawings:** The Contractor shall provide a complete shop drawings of the product or system to be delivered. This shop drawings shall be associated with the purchase process of the product or system. The shop drawings shall be compatible with the Contractor's produced design drawings. The shop drawings shall provide a complete description of the size, shape, configuration, interface, operation, capacity of the product or system. This shop drawing package shall be provided to the SFMTA prior to delivery of the product or system to the Contractor.
- **Shop Test Reports:** The Contractor shall provide complete test reports on the product or system as required by the specification. This shop tests shall be referred to in the purchase process of the product or system. The shop tests shall demonstrate that the product or system meets the requirements of the associated specification. These test results shall be provided to the SFMTA prior to delivery of the product or system to the Contractor.
- **Shop Visits:** The Contractor shall permit visits to the factory. by the SFMTA, during the time when the product or system that was sold for the SFMTA use is being: manufactured, assembled or tested. The factory visits shall be coordinated by the

Design-Build Services for the Radio System Replacement

Section 5.0

Contractor. The visit details of time, place, etc. shall be at the mutual agreement of all parties. The Contractor shall inform the SFMTA in a timely manner when manufacture, assembly or testing is expected to occur.

- Shop Test Witnessed: In specific cases the Contractor shall permit the SFMTA (or a representative) to be present for factory tests of the product or system being supplied. The arrangements for attendance at the tests shall be made by the Contractor. The timing and procedure for the test shall be the result of mutual agreement between all parties. The SFMTA shall be notified of the test schedule well in advance.

The following documentation is required for the specifications listed below. This list of documentation requirements is not to be taken as complete or prescriptive. The requirements in the final specifications shall conform the needs of the evolving design.

- Lighting (for Lenox Way) Product Description Required:

Shop Drawings Required: Yes

Shop Test Reports: No

Shop Visits Required: No

Shop Test Witnessed: No

- Transformers (120 Volts and up)

Shop Drawings Required: Yes

Shop Test Reports: No

Shop Visits Required: No

Shop Test Witnessed: No

- Towers or tower components

Shop Drawings Required: Yes

Structural Analysis: Yes

Shop Test Reports: No

Shop Visits Required: No

Shop Test Witnessed: No

- Shelters (permanent)

Shop Drawings Required: Yes

Permit Drawings: Yes

Structural Analysis: Yes

Shop Test Reports: Yes

Shop Visits Required: Yes

Shop Test Witnessed: No

- Shelters (interim)
 - Shop Drawings Required: Yes
 - Permit Drawings: Yes
 - Structural Analysis: Yes
 - Shop Test Reports: Yes
 - Shop Visits Required: No
 - Shop Test Witnessed: No
- Generators
 - Shop Drawings Required: Yes
 - Permit Application Documents: Yes
 - Shop Test Reports: Yes
 - Shop Visits Required: No
 - Shop Test Witnessed: Yes
- Automatic Transfer Switches
 - Shop Drawings Required: Yes
 - Shop Test Reports: Yes
 - Shop Visits Required: No
 - Shop Test Witnessed: No
- UPSs (above 6 KW)
 - Shop Drawings Required: Yes
 - Shop Test Reports: Yes
 - Shop Visits Required: No
 - Shop Test Witnessed: No
- Battery Chargers above 6 KW
 - Shop Drawings Required: Yes
 - Shop Test Reports: Yes
 - Shop Visits Required: No
 - Shop Test Witnessed: No
- Stationary Batteries
 - Shop Drawings Required: Yes

- Shop Test Reports: No
- Shop Visits Required: No
- Shop Test Witnessed: No
- Electrical Distribution Panels
 - Shop Drawings Required: Yes
 - Shop Test Reports: No
 - Shop Visits Required: No
 - Shop Test Witnessed: No
- Fire Alarm Systems
 - Shop Drawings Required: Yes
 - Permit Application Documents: Yes
 - Shop Test Reports: Yes
 - Shop Visits Required: No
 - Shop Test Witnessed: No
- Pre-Action Gas based Fire Suppression Systems
 - Shop Drawings Required: Yes
 - Permit Application Documents: Yes
 - Shop Test Reports: Yes
 - Shop Visits Required: No
 - Shop Test Witnessed: Yes
- FM200 Fire Suppression Systems
 - Shop Drawings Required: Yes
 - Permit Application Documents: Yes
 - Shop Test Reports: No
 - Shop Visits Required: No
 - Shop Test Witnessed: No
- Air Handlers using externally provided chilled water
 - Shop Drawings Required: Yes
 - Shop Test Reports: Yes
 - Shop Visits Required: No
 - Shop Test Witnessed: No

Design-Build Services for the Radio System Replacement

Section 5.0

5.1.3 Site Cleanup Summary:

A summary of cleanup work to be performed by the Contractor at each site follows:

EXISTING	NEW	SITE	CLEANUP
X	X	Lenox Way	Remove and dispose of all old consoles, radio equipment, carpeting, wiring, lighting, furniture, all other decommissioned equipment.
	X	One Market Plaza	N/A
	X	Bernal Heights	N/A
X		Bank of America	Remove and dispose of decommissioned equipment, including antenna.
	X	CRS Twin Peaks	N/A
	X	South Hill	N/A
X	X	Forest Hill	Remove and dispose of decommissioned racks, etc. from existing building and eventually temporary facility. Remove existing antenna.
X		McLaren Park	Remove and dispose of all decommissioned equipment, antennas, etc.(Option)
X	X	Clay Jones	N/A
X	X	Underground	Remove and dispose of all equipment Equipment including but not limited to Rooms decommissioned repeaters, combiners, batteries, donor antennas, with the exception of the tunnel radiax cable which shall remain in place and be labeled for removal at future date.
X	X	Maintenance	Cleanup of any obsolete equipment or Facilities equipment as necessary.
X	X	Vehicles	Remove and dispose of all decommissioned equipment.

5.2 Structural Design Requirements

As part of the Contractor's structural design, the contractor shall be required to:

- Verify the structural adequacy of existing antenna towers, their foundations and/or support systems for the new radio communications system installation
- Design modifications to the existing structures as required.
- Design anchorage and support for lateral loads of radio antennae, equipment, brackets, and other components.
- Modify existing structures to accommodate the installation of ancillary components such as equipment racks, air conditioning and duct systems, electrical raceways etc.

Design-Build Services for the Radio System Replacement**Section 5.0**

Structural design shall conform to 2007 California Building Code (CBC) and 2007 San Francisco Building Code, and shall be based on the specific design criteria cited below.

Existing tower structural and geotechnical reports for the Forest Hill, South Hill, and CRS Twin Peaks sites are contained in Appendix Forty (40) Existing Tower Site Structural and Geotechnical Reports.

Tower structural reports for the Forest Hill and South Hill sites to accommodate the 35% Preliminary Design are contained in Appendix Forty One (41) Tower Structural and Geotechnical Reports.

5.2.1 Seismic Design Criteria

Seismic Design Criteria are listed below:

- American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) Standard reference number 7-05 titled "Minimum Design Loads for Buildings and Other Structures" including supplement NO.1.
- ASCE/SEI 7-05 is referenced in the 2007 California Building Code (CBC) section 1613 and Chapter 35.

Applicable portions in ASCE/SEI 7-05 shall include but are not limited to the following chapters:

- Chapter 2 - Combination of loads
- Chapter 3 - Dead loads, soil loads, and hydrostatic pressure
- Chapter 11 - Seismic design criteria
- Chapter 13 - Seismic design requirements for non-structural components.

In addition, the load combinations in CBC section 1605 shall also apply.

The seismic demand on the equipment and other nonstructural components that are permanently attached to the structures and for their supports and attachments shall be based on ASCE/SEI 7-05 equation 13.3-1 for calculating the seismic design force (F_p). The component importance factor (I_p) shall be taken as 1.5; the radio antennae and equipment are required to function after an earthquake (ASCE/SEI 7-05 13.1.3).

Equipment racks and cabinets shall be positively anchored to floor at the base, and be supported laterally with opposite pair of braces in no less than two directions.

5.2.2 Wind Design Criteria

Wind design criteria are listed below:

- American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) Standard reference number 7-05 titled "Minimum Design Loads for Buildings and Other Structures" including supplement No.1.
- ASCE/SEI 7-05 is referenced in the 2007 California Building Code (CBC) section 1609 and Chapter 35.
- American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) Standard reference number 7-05 titled "Minimum Design Loads for Buildings and

Design-Build Services for the Radio System Replacement

Section 5.0

Other Structures" including supplement NO.1. ASCE/SEI 7-05 is referenced in the 2007 California Building Code (CBC) section 1609 and Chapter 35.

- Chapter 2 - Combination of loads
- Chapter 3 - Dead loads, soil loads, and hydrostatic pressure
- Chapter 4 - Live loads
- Chapter 6 - Wind loads.

In addition, the load combinations in CBC section 1605 shall also apply. The wind loading on the exterior equipment and other components (e.g. antennae connections) shall be based on ASCE/SEI 7-05 chapter 6. The following methods can be used:

- Method 1 - Simplified procedure for components and cladding: Equation 6-2 (section 6.4.2.2) if the conditions in section 6.4.1.2 are met.
- Method 2 - Analytical procedure for components and cladding
- Equation 6-22 (section 6.5.12.4.1) for low-rise buildings/structures with height less than or equal to 60'
- Equation 6-23 (section 6.5.12.4.2) for buildings/structures with height greater than 60'
- The conditions in section 6.5.1 of CBC shall be met.

The following methods can be used for the wind loading on the supporting elements, defined as the main wind-force resisting system (MWFRS) in section 6.2:

- Method 1 - Simplified procedure for MWFRS: Equation 6-1 (section 6.4.2.1) if the conditions in section 6.4.1.1 are met.
 - Method 2 - Analytical procedure for MWFRS
- i. Equation 6-17 (section 6.5.12.2.1) for rigid buildings/structures with height less than or equal to 60'
 - ii. Equation 6-19 (section 6.5.12.2.3) for flexible buildings/structures
 - iii. As an alternative to equation 6-17, equation 6-18 (section 6.5.12.2.2) for low-rise buildings/structures with height less than or equal to 60'

The wind design criteria for EIA/TIA 222 Rev. G shall also apply.

5.2.3 Foundation Design Criteria

Foundation criteria are listed below:

- i. Foundations shall be designed in accordance with the recommendations in the geotechnical report and/or Chapter 18 (soils and foundation) of the 2007 California Building Code.
- ii. The SFMTA will provide, upon request, geotechnical reports on South Hill and Forest Hill for information on site conditions, foundation recommendations and other requirements.

Design-Build Services for the Radio System Replacement

Section 5.0

- iii. Foundation plans and details shall be reviewed by the geotechnical engineer of record to verify conformance with the recommendations in the geotechnical report. The geotechnical engineer of record shall issue a letter of conformance subsequent to the review of the plans; any recommendations shall be incorporated into the plans.

Foundation design criteria, based on available geotechnical reports, for the South Hill and Forest Hill sites are summarized in the table below.

Foundation Site Design Criteria Summary

SITE	FOUNDATION OPTIONS	ALLOWABLE DESIGN VALUES
SOUTH HILL (Option 1)	SHALLOW-SPREAD FOOTING OR MAT FOUNDATION	5000 psf BEARING PRESSURE (DEAD PLUS LIVE LOADS) 6650 psf BEARING PRESSURE (TOTAL LOADS)
SOUTH HILL (Option 2)	DEEP-CAST IN PLACE OR DRILLED PIER FOUNDATION	1000 psf SKIN FRICTION DOWNWARD (DEAD PLUS LIVE LOADS) 1330 psf SKIN FRICTION (TOTAL LOADS DOWNWARD) 665 psf SKIN FRICTION UPLIFT (TOTAL LOADS) 1500 psf PASSIVE PRESSURE
FOREST HILL	DEEP DRILLED CAISSONS	500 psf SKIN FRICTION DOWNWARD (DEAD PLUS LIVE LOADS) 665 psf SKIN FRICTION DOWNWARD (TOTAL LOADS) 300 psf SKIN FRICTION UPLIFT (TOTAL LOADS)

A summary of each site's shelter requirements and soils report availability is shown below:

SITE	REQUIRE NEW PREFABRICATED SHELTER	SHELTER SIZE (Approx.)	AVAILABLE SOIL REPORT
Forest Hill	Yes	11'X11'***	Yes
One Market Plaza	No*		No
South Hill	Yes	10'X10'***	Yes
Twin Peaks	No*		Yes
Bernal Heights	No*		No

*USE EXISTING SHELTER/FACILITY.

**SHELTER SIZES ARE APPROXIMATE.

Design-Build Services for the Radio System Replacement**Section 5.0****5.3 Electrical and Grounding System Design Requirements**

Electrical Systems shall be designed to conform to the standards and requirements described in this Section. The Contractor shall be responsible for all site development.

5.3.1 Primary Power

Contractor shall ensure that all modified electrical panels will meet NEC requirement and notify SFMTA if any code deficiencies are identified beyond the modified panel.

The electrical design and installation work shall be carried out by Contractor in accordance with the current edition of the National Electric Code (NEC), the relevant sections of the Uniform Building Code (USC) for the City and County of San Francisco and/or other applicable codes.

The initial incoming power service feeder, to be run by the electrical utility company, shall be sized for the full capacity of the facility. Future expansion shall also be considered when determining the feeder size. The power transformer shall be placed as close as possible to the facility to improve protection in the event a lightning strike or power surge occurs further down the line.

The Contractor shall conduct a site survey and evaluate the capacity of the existing regular power and existing back-up power. The Contractor shall be responsible to notify the local utility to increase the incoming power to meet the new electrical power requirements. The Contractor shall notify the local utility before engaging in work which requires the presence of an inspector.

Electrical surge and transient protection shall be provided on incoming power lines at all sites. Current City and County of San Francisco sites already have surge and transient protection. Dual-redundant protection is required for AC utility circuits. If the primary protection device self-sacrifices due to a lightning strike, the secondary protection will protect the site until the primary can be replaced.

All suppression devices will utilize Normal Mode (Line-Neutral) protection. The use of MOV protection as the primary and only protection for the incoming power feeder is not permitted.

Common Mode suppressors are not acceptable. The AC neutral shall be bonded to ground ONLY at the main AC service panel.

Main AC panel protectors shall be installed at every site. Regardless of the method of protection chosen, lead lengths from the protection devices(s) shall be made as short as possible. All panel protectors must be wired through a circuit breaker used as a disconnect to the protection, allowing servicing without disturbing site power. Protectors will provide a minimum of 250 Joules of Silicon Avalanche Diode (SAD) protection in combination with a minimum of 5000 Joules of secondary Metal Oxide Varistor (MOV) protection. The secondary protection is necessary if the surge is sufficient to cause the Primary (SAD) device to self-sacrifice. Relay closures must be provided for all primary failure alarms.

5.3.2 Grounding Systems

All equipment shall be electrically bonded and grounded. These include but shall not be limited to cabinet, metal conduits, cable tray, equipment racks, battery racks, chassis, shelves, antennas, and transmission lines.

The contractor shall verify the condition of grounding at all existing sites. Upgrading deficiencies in grounding at existing sites shall be the Contractor's responsibility. The Contractor shall furnish and

Design-Build Services for the Radio System Replacement**Section 5.0**

install all grounding and bonding conductors and make connections to and improve the condition of the grounding at existing sites. The contractor shall furnish grounding at new sites. Any deficiencies in grounding at One Market Plaza and Maintenance Facility Yards shall be reviewed during the design phase to identify a mutually agreeable solution.

Single point ground systems installed within equipment shelters or rooms shall be connected to the exterior building/tower ground system.

A suitably-sized ground window shall be installed at the point where antenna transmission lines enter the shelter, with a building connection and any external ground system using a #2 AWG or larger solid or stranded green jacketed copper conductor. If this conductor extends below the earth's surface, the conductor shall be tinned and any splices shall be made with the exothermic process (Cadweld or equivalent). For equipment located within a building and with antennas located on or within the building, the ground must however be connected to any facility grounds as identified in Section 800-40, NEC. If a tower or other antenna support structure is installed, the ground window shall be bonded to the support structure ground system as well as the building ground system.

Where the shelter, building, or room contains more than one communications system, multiple ground windows shall be used for each system. Each ground window would then be connected with a #2 AWG or larger solid or stranded green jacketed copper conductor to the main, single-point ground window.

Interior halo ground rings shall be installed in shelters, buildings, or rooms specifically designed or designated for communications equipment. They shall also be installed in areas where there is a need to bond system or equipment support apparatus to the ground window. Examples include battery racks, HVAC equipment, doors and door frames, electrical panels and transfer switches. An interior halo ground ring is not required in rooms or areas that are within another larger building where support apparatus, such as items listed above, are not present and the doors or door frames are not metallic or can be grounded via a #6 AWG stranded copper green jacketed conductor run directly to the single point ground. When the internal halo grounding ring is installed, it shall encircle the interior of the shelter, building, or room where the equipment is installed, with opposite ends of the halo conductor connecting to the interior single point ground window.

Upon entering the building, all RF transmission lines, including unused spares, must contain a surge suppresser. The surge suppresser shall be connected to the single point ground window. The suppresser shall be spaced a minimum of two inches from any ancillary equipment, such as cable trays, to prevent flashover in the event of a lightning strike. The surge suppresser must be placed within two feet of the building service entrance.

RF transmission lines from the antenna, down the tower, and into the building shall be grounded as described below.

5.3.3 Ground Bus

In situations where it is necessary to minimize the number of ground conductors connected to the ground window, a ground bus shall be used. Each single row of equipment shall have a separate ground bus consisting of an AWG #2 or larger solid or stranded green jacketed copper conductor. Each bus shall be connected to the single row may be connected to the ground bus. The equipment connection shall be made with AWG #6 or larger solid or stranded green jacketed copper conductors.

Design-Build Services for the Radio System Replacement**Section 5.0****5.3.4 Equipment Grounding Connections**

Installation of any single cabinet, rack, or enclosure and any transmission line or circuit protection devices associated with this single cabinet, rack, or enclosure shall have an equipment grounding conductor bonding all components to a single point ground bus located near the equipment installation. This single point ground bus consisting of AWG #2 or larger solid or stranded green jacketed copper conductor shall be extended to the single point ground connection or directly to an exterior ground system which is bonded to the electrical service ground.

Installation of multiple cabinets, racks, or enclosures, and any transmission line or circuit protection devices associated with these multiple items that are installed in an area not solely dedicated to the installation of communications equipment shall be connected by the designated size and type of grounding conductors to a single point ground window located near the equipment installation within the same equipment shelter, building, room, or area. This single point ground window shall be connected with AWG #2 or larger solid or stranded green jacketed copper conductor extending to a suitable building ground connection or to an exterior ground system which is bonded to the electrical service ground.

5.3.5 Ground Conductor Length

All grounding conductors shall be kept as short as possible to reduce the radio frequency impedance to ground. The shortest practical ground route with the least number of bends shall be chosen provided the chosen route does not interfere with the equipment or create a safety hazard.

5.3.6 External Grounding Systems

The external grounding system shall establish a 5 ohm or less reading, as measured by the "fall of potential" testing procedure. Due to varying soil resistances caused by geographic composition, modifications to this standard may be accepted. In no case shall a final resistance value greater than 5 ohms be accepted.

The external grounding system shall consist of a buried perimeter ring encircling the shelter foundation, generator foundation, and tower support foundation. In the event these foundations are not located immediately adjacent to one another, individual perimeter loops shall be provided for each system. These loops shall be interconnected by tying two points of each loop to two points of each adjacent loop.

The external ground conductor shall be installed 30 inches below final grade, or inches below the local frost line. It shall be placed a minimum of 24 inches off the concrete foundations, with a minimal bending radius of 12 inches. All buried connections shall be of the exothermically welded type.

From the ground loops, lateral runs shall extend to all above ground fuel tanks, electrical service and generator frame. A minimum of two connections shall be made to the fence. The ground loops and laterals shall be a minimum of #2 solid bare soft drawn tinned copper conductors. Ground rods of 5/8 inch X 8 foot tinned copper clad steel shall be installed at the following locations:

1. Each corner of the perimeter loop encircling the shelter.
2. At intervals between the corner rods, spacing to be no greater than 16 feet or less than 8 feet.

Design-Build Services for the Radio System Replacement**Section 5.0**

3. Monopoles shall be grounded with a minimum of 4 ground rods. A lateral shall be brought from each rod and connected to the monopole base via an exothermic weld.

4. Self supported and guyed lattice towers shall be grounded with a ground rod adjacent to each tower leg. A lateral shall be brought from each rod and connected to the leg base via an exothermic weld.

The SFMTA may accept suitable alternatives. Alternative methods such as radial copper wire patterns, soil enhancements, or chemical ground rods may be considered on a case by case basis.

5.3.7 Power Back-up Systems

To meet the specified availability requirements in Appendix Twelve (12), Section One (1), the Contractor shall utilize back-up power systems for all critical subsystems and system components.

Remote site equipment is broken down into two categories: Critical and non-critical. Critical equipment includes equipment which, if "down", would result in an unacceptable drop in the grade of service to the combined MTMS and PSVRN. Examples of "Unacceptable" include:

- A reduction of 10% in the capability of the combined MTMS and PSVRN radio to carry traffic due to trunked channels becoming unavailable.
- Coverage dropping below 90% (on-street level)
- The MTMS and/or PSVRN going into failsoft (loss of trunked operation).

Back-up power sources at existing sites may be used, if the added load of the Contractor provided equipment plus the present connected loads, does not exceed 75% of the designed capacity of the existing back-up system. The Contractor is encouraged to recommend the optimum configuration for remote sites and other constituent systems. This recommendation shall be based on the load analysis, and the power back-up availability at some of the existing remote sites. The Contractor must conduct a site survey and evaluate the capacity of the existing back-up power.

During Intermediate and Final Design the Contractor shall perform fall-back and criticality analysis and identify critical equipment.

5.3.8 Generators

The standby generator system shall be designed to use diesel fuel and supply adequate power for the duration of the outage. Fuel capacity shall provide for no less than 48 hours of continuous backup power at full load. The standby generator system shall be designed considering maintenance and type of operation.

The Contractor shall be responsible to do a load study based on existing conditions and new equipment loads to evaluate the existing diesel generator and determine if an upgrade is required. Additionally, the generator shall be sized for 25% growth.

The standby generator system shall include the following features:

1. Transfer switches for two (2) modes of back-up operation:
 - Mode 1: Automatic backup if primary power fails
 - Mode 2: Manual switch over to connect a portable generator in the event the primary generator fails to the site power through a connector similar to an Appleton connector.

Design-Build Services for the Radio System Replacement

Section 5.0

- 2. An Automatic Transfer Switch that shall at a minimum:
 - Provide adjustable voltage sensors and time-delay monitors.
 - Be capable of sending the following alarms to the Network Management System:
 - Low power
 - Low fuel
 - No start-up

5.3.9 Uninterruptible Power Supplies (UPS) (Section Deleted)

5.3.10 Lighting

All equipment room lighting shall be 100 foot-candle with lighting placed over the space between the racks. The Contractor shall provide a dual 40 w Fluorescent fixture in each 8 ft aisle near the blind end with additional fixtures along the aisle at the end of the rows.

The Lenox Way Central Control theater lighting shall be 50 foot-candle.

Operator console task lighting at the Lenox Way Central Control facility shall be 100 foot-candle.

Emergency operating lighting is 20 foot-candle.

5.3.11 Remote Site -48 VDC Power System

- 1. Each remote site shall have installed a -48 VDC Power System that supplies power to all critical components such as, but not limited to, base stations, core routers, core switches, microwave, multiplex, SCADA, GPS, etc. If a critical component is only available with 120 VAC, it shall be powered via a converter connected to the -48 VDC battery plant. All power equipment installations shall meet Seismic Zone 4 regulations and practices.
- 2. Each -48 VDC Power System shall consist of the following:
 - a. Power Bay (19 or 23 inch rack) with the following installed:
 - i. Rectifier Shelf
 - ii. Rectifiers (n+1 configuration)
 - iii. DC Distribution
 - iv. Fuse Panel(s)
 - v. Metering Panel
 - vi. Ground Bar
 - b. Battery Plant (-48 VDC) including the following:
 - i. Modules/cells (Quantity as specified herein)
 - ii. Module frames and hardware
 - iii. I-beam supports
 - iv. Racks rated for Seismic Zone 4

Design-Build Services for the Radio System Replacement

Section 5.0

- v. Inter-cell connectors
- vi. Inter-module connectors
- vii. Input/output terminal plates
- viii. Protective covers
- ix. Cell numerals
- x. Lifting straps
- xi. Miscellaneous hardware
- c. Grounding system

3. The rectifiers shall conform to the following:

- a. The input voltage shall be 208 VAC or 240 volts AC single phase – rectifiers shall have a wide mouth to accommodate voltage variations of up to $\pm 20\%$ and still maintain output capacity over the temperature range -20°C to $+65^{\circ}\text{C}$ (-4°F to $+149^{\circ}\text{F}$)
- b. Steady state output voltage shall remain within $\pm 0.5\%$ of its set point for at least one year within the range of 46.0 to 58.0 volts DC for any combination of frequency, input voltage, and load from no load to full load over the temperature range of -20°C to $+65^{\circ}\text{C}$ (-4°F to $+149^{\circ}\text{F}$)
- c. The rectifier system shall be modular in that equipment shelves shall accommodate standard plug-in modules creating a N+1 configuration
- d. There shall be a minimum of 3 rectifiers with a preference for 4 or 5
- e. The rectifier modules shall automatically load share without any manual adjustments
- f. Each rectifier module shall have DC output short circuit protection in the form of a DC output circuit breaker located in the negative output lead. The AC input breaker shall be synchronized to the DC breaker.
- g. Each rectifier module shall have a current limiting circuit adjustable from 75% to 105% of rated full load and factory set at 100 %.
- h. Each module shall have high voltage shutdown. If the rectifier module output voltage exceeds an adjustable preset value, the module will shut down. Only the module causing the high voltage condition shall shut down
- i. The high voltage shutdown circuit shall be adjustable through the range of 50 to 60 VDC and factory set at 58.8 VDC.
- j. Total system rectifier capacity shall be equal to full site load + recharge current (12 hour rate) + 25 % spare
- k. The rectifier plug-in module quantity and size shall be such that under normal load conditions (no modules failed); each rectifier module is loaded in the 65 % to 85 % range. The failure of one module shall not cause any rectifier module to exceed its 100 % rating.
- l. Remote alarm indication - One set of Form "C" contacts for connection to remote customer alarm circuits shall be provided for each of the following:

Design-Build Services for the Radio System Replacement

Section 5.0

- i. Minor Rectifier Failure
- ii. Major Rectifier Failure
- iii. High DC Voltage Alarm
- iv. Low DC Voltage Alarm
- v. Distribution Fuse/Breaker Trip
- m. Efficiency shall be greater than 90 % at 100 % load
- 4. The - 48 VDC Battery Plant shall conform to the following:
 - a. Battery type shall be valve regulated lead acid (VRLA)
 - b. The -48VDC Battery Plant shall consist of 24 cells at a nominal 2 volts
 - c. Battery Plant capacity shall be sized based on 4 hour rate (2 hour rate at One Market Plaza) of discharge at 25° C (77°F) supplying the full -48 VDC site load + 25 % spare to an end cell voltage of 1.84 volts/cell and calculated at end of battery life
 - d. Cells shall be designed for a float voltage between 2.23 and 2.27 volts per cell at 25°C (77°F)
 - e. The -48VDC Battery Plant float voltage shall nominally be 54 VDC (24 cells at 2.25 volts/cell).
 - f. The -48VDC Battery Plant shall have the positive terminal grounded
 - g. Battery cell construction shall be rated explosion proof and UL listed
 - h. The battery plant shall be essentially maintenance free in that no water additions or scheduled equalization charges are required
 - i. The battery plant shall not require any special ventilation
 - j. Cell shall have 20 year life and the manufacturer shall provide a written guarantee of the 20 year performance of the battery plant based on a pro rata replacement of any cell or cells
- 5. DC Distribution and Fuse Panels
 - a. The power bay shall contain both low current (1 to 10 amps) self-indicating fuses of the GMT type and high current breakers or fuses in the 10 to 30 Ampere range
 - b. There shall be 25 % spare fuse positions for both the low current and high current types
 - c. The power bay shall contain a solid copper ¼ inch thick ground bar full width of the rack and at least 3 inches wide with a minimum of 24 sets of 9/32 inch holes
- 6. Metering Panel
 - a. The power bay shall contain a metering panel with both a DC voltmeter and DC ammeter
 - b. The ammeter shall be fed from a high accuracy DC shunt located on the power bay
- 7. Grounding and Installation

Design-Build Services for the Radio System Replacement**Section 5.0**

- a. The ground bar on the power bay shall be connected to the site primary ground with a #2/0 green covered copper conductor
- b. The primary ground connection to the ground bus bar and connections to the battery bank shall use two hole lugs with double crimp and stainless steel or silicon bronze hardware”

5.4 Lenox Way Operations Control Center (Option)**5.4.1 General Notes**

The Contractor shall reconfigure the existing Lenox Way Operations Control Center as shown in **Appendix Nine (9)**. This section of the scope of work should only be completed after successful transition to the new control center such that the Lenox Way Operations Control Center is no longer in active use.

This Option may be executed on its own and/or in conjunction with the Option to construct the primary Operations Control Center at 1455 Market Street (see below).

5.4.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site.
- Prepare a detailed review of the site and document existing conditions in detail.
- Prepare a detailed plan for the renovation work
- Work shall not start until the SFMTA is satisfied with the proposed renovation..
- Perform a load study of the AC and DC power system at Lenox Way that includes the new consoles/radio equipment and that includes the equipment resident on the system at each phase in the renovation plan.
- Perform a HVAC study of the Lenox Way site that includes all of the existing equipment and people and the new consoles/radio equipment and that includes the equipment resident at the site at each phase in the renovation plan.
- During construction deactivate the gas based fire suppression system.

Remove old wiring, cables, tray, etc from below the floor.

- Remove the ceiling tiles and floor tiles.
- Re-outfit the room with new floor, ceiling, lighting, HVAC ducts, consoles, electronics and displays.
- Install new flat displays as required for coordinated operations.
- Reactivate the gas based fire suppression system.
- Start-Up all systems using vendor help as appropriate. Prepare a detailed test procedure for The SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA. (The gas based fire suppression shall be tested without actual agent discharge.)

Design-Build Services for the Radio System Replacement**Section 5.0**

The Contractor shall provide the following calculations and plans, to be developed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. [CDRL 12-5-1 Lenox Way Site Calculations and Reports].

Electrical:

- Detailed Electrical Load Study including the entire complex
- HVAC load Calculation including the entire complex

Provide a detailed plan for the renovation of the Control Room that includes consideration of:

- Relocation of people and equipment
- Isolation of operating personnel from construction activity
- Protection of vital circuits, HVAC, lighting and power during construction.
- Protection of systems that will not be replaced such as the gas fire suppression system.
- Removal and replacement of control room infrastructure.
- Inspection of the FM200 gas fire suppression system and an assessment of its effectiveness.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings [CDRL 12-5-2 Lenox Way Completed Construction Drawings]
- Completed Materials Specifications [CDRL 12-5-3 Lenox Way Completed Materials Specifications]

5.4.3 Civil/Architectural

Console furniture shall be provided to accommodate the dispatch workstations and their use by dispatchers and train controllers. It shall be of modular, ergonomic design, and provide the following features:

- MTMS and PSVRN Workstation storage
- Convenient height-adjustable writing surface
- Drawers and storage space
- Power outlet strips
- Design for neat and safe cable runs and connections such as internal cable guides and covered knockouts
- Design for headset jacks
- Comply with ADA regulations
- Comply with state and local seismic bracing requirements.

Design-Build Services for the Radio System Replacement**Section 5.0**

The Contractor shall be responsible for any Civil/Architectural improvements required to accommodate newly installed equipment.

Architectural drawings for Lenox Way Operations Control Center are contained in Appendix Nine (9).

5.4.4 Electrical and Grounding

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment. Contractor shall ensure that any modified electrical panels will meet NEC requirement and notify SFMTA if any code deficiencies are identified beyond the modified panel.

As part of the reconfiguration effort at Lenox Way, the Contractor shall remove all unused wire and cable beneath the control center theatre floor.

Electrical and Grounding drawings are contained in Appendix Nine (9). Network connectivity drawings are also contained in Appendix Nine (9).

5.4.5 Mechanical

The Contractor shall be responsible for any mechanical improvements required to accommodate all newly installed equipment.

5.6 Bernal Heights Communications Facility**5.6.1 General Notes**

The Bernal Heights Communications Facility houses existing City and County of San Francisco (CCSF) equipment. The SFMTA wishes to co-locate MTMS and PSVRN equipment at this site with the CCSF equipment. For the SFMTA, The Bernal Heights Communications Facility shall serve two purposes:

- Above ground radio communications facility for the MTMS and PSVRN systems
- Equipment room facility for MTMS and PSVRN central site equipment, servers, combiners, network core, etc.

The Contractor shall verify whether the existing tower structure can accommodate the new MTMS and PSVRN antennas and feed lines.

5.6.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site.
- Provide a minimum of four (4) fire extinguishers, carbon dioxide, 20 pounds, rated 10-B:C, rechargeable
- Install a revised power system to provide sufficient power for the existing and the new radio equipment in the room.
- Provide a detailed heat load study to determine if the existing HVAC system will accommodate the additional SFMTA radio equipment. Provide a revised design if required.

Design-Build Services for the Radio System Replacement**Section 5.0**

- Install supporting infrastructure for the new radio equipment including but not limited to: grounding, power distribution and cable ladders.
- Install antenna mounting appliances on the existing tower to support the new antennas.
- Provide a structural analysis of the new hardware and a copy of a structural analysis of the tower subsequent to the addition of the antennas. The analysis shall conform to the requirements of ANSI/TIA-222-G.
- Install a means to structurally restrain all hardware including: racks, pipes, cable ladders and tanks, in a manner that satisfies local seismic requirements and that permits the SFMTA facility to survive a seismic event.
- Start-Up all systems using vendor help as appropriate. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA. (The gas based fire suppression shall be tested without actual agent discharge.)

The Contractor shall provide the following calculations, to be performed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. [CDRL 12-5-4 Bernal Heights Site Calculations).

Electrical:

- Detailed Electrical Load Study including the City Radio equipment.
- HVAC load Calculation based on new and existing loads and existing HVAC equipment.
- Generator Loading Study

Structural Calculations (to be stamped and signed by a Registered Structural Engineer licensed in California):

- Tower structural analysis based on ANSI/TIA-222-G.
- Structural Analyses of the existing tower without and with the new antennas. (The tower is owned by American Tower and is a unique AT&T design.)

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings [CDRL 12-5-5 Bernal Heights Completed Construction Drawings]
- Completed Materials Specifications [CDRL 12-5-6 Bernal Heights Completed Materials Specifications].

5.6.3 Civil/Architectural

The Contractor shall perform any required Civil/Architectural work at this site required to accommodate the MTMS and PSVRN equipment.

Design-Build Services for the Radio System Replacement**Section 5.0****5.6.4 Electrical and Grounding**

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment. Contractor shall ensure that any modified electrical panels will meet NEC requirement and notify SFMTA if any code deficiencies are identified beyond the modified panel.

Electrical and Grounding drawings are contained in Appendix Nine (9). Network connectivity drawings are also contained in Appendix Nine (9).

Existing conditions are provided here for reference only and should be verified prior to any design or construction activity:

- PG&E meter #86R904
- Diesel Generator: 40 kW, 120/208V, 3 phase, 4 wire.
- UPS is 850VA
- Incoming for House Service Panel: 1000A breaker
- Fail soft mode, the phase current is 38A, 48A, 48A (with two AC on at the same time).

5.6.5 Mechanical

The Contractor shall perform any required mechanical work at this site required to accommodate the MTMS and PSVRN equipment.

Mechanical drawings are contained in Appendix Nine (9).

5.7 Central Radio Station Twin Peaks Communications Facility**5.7.1 General Notes**

The Central Radio Station (CRS) Twin Peaks Communications Facility houses existing City and County of San Francisco (CCSF) equipment. The SFMTA wishes to co-locate MTMS and PSVRN equipment at this site with the CCSF equipment. For the SFMTA, The CRS Twin Peaks Communications Facility shall serve two purposes:

- Above ground radio communications facility for the MTMS and PSVRN systems
- Equipment room facility for backup network core equipment.

The Contractor shall verify whether the existing tower structure can accommodate the new MTMS and PSVRN antennas and feed lines.

5.7.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site.
- Confirm that the existing site HVAC equipment will be sufficient to support the new SFMTA radio equipment heat load.

Design-Build Services for the Radio System Replacement

Section 5.0

- Install at least four wall hung, 10 pound CO2 portable fire extinguishers in the area of the SFMTA equipment”
- Install a supervised fire alarm system covering the MT A occupied radio room. This alarm panel shall be supervised by a MTA, 3rd party contract remote fire alarm monitoring company.
- Install supporting infrastructure for the new radio equipment including but not limited to: grounding, ground bar and power distribution.
- Provide a structural analysis of the tower after the installation of the new SFMTA antennas. The analysis shall conform to the requirements of ANSI/TIA-222-G.
- Install a means to structurally restrain all hardware including: racks and cable ladders, in a manner that satisfies local seismic requirements and that permits the SFMTA facility to survive a seismic event.
- Start-Up all new systems. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA.

The Contractor shall provide the following calculations, to be performed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. [CDRL 12-5-7 CRS Twin Peaks Site Calculations].

Electrical:

- Detailed Electrical Load Study including the City Radio Room
- HVAC load Calculation.

Structural Calculations (to be stamped and signed by a Registered Structural Engineer licensed in California):

- Tower structural analysis based on ANSI/TIA-222-G.
- Structural analyses of the existing tower without and with the new antennas.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings [CDRL 12-5-8 CRS Twin Peaks Completed Construction Drawings]
- Completed Materials Specifications [CDRL 12-5-9 CRS Twin Peaks Completed Materials Specifications].

5.7.3 Civil/Architectural

The Contractor shall perform any required Civil/Architectural work at this site required to accommodate the MTMS and PSVRN equipment.

Design-Build Services for the Radio System Replacement**Section 5.0****5.7.4 Electrical and Grounding**

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment. Contractor shall ensure that any modified electrical panels will meet NEC requirement and notify SFMTA if any code deficiencies are identified beyond the modified panel.

Electrical and Grounding drawings are contained in Appendix Nine (9). Network connectivity drawings are also contained in Appendix Nine (9).

Existing conditions are provided here for reference only and should be verified prior to any design or construction activity:

- PG&E meter: #9752R2
- Department of Emergency Management's new load requirements, to be added as part of a CERS system upgrade are approximately 3.854KW
- "UPS #1" has two 40KVA UPS. Under normal conditions, each UPS carry half load, or approximately 15% load capacity. When one fails, the other one will carry the full load. (about 30% load capacity).
- "UPS #2" is a 60KVA, GE LP 33 Series, 288V, 117.37 Amps, at 23% average load capacity.

5.7.5 Mechanical

The Contractor shall perform any required mechanical work at this site required to accommodate the MTMS and PSVRN equipment.

Mechanical drawings are contained in Appendix Nine (9).

5.8 Forest Hill (Mendosa Avenue) Communications Facility**5.8.1 General Notes**

The Forest Hill Communications Facility houses existing City and County of San Francisco (CCSF) equipment (not to be confused with the SFMTA Forest Hill Muni Metro station). The SFMTA wishes to co-locate MTMS and PSVRN equipment at this site with the CCSF equipment. For the SFMTA, The Forest Hill Communications Facility shall house above ground radio communications facility for the MTMS and PSVRN systems.

SFMTA to provide technical assistance for the relocation for of existing equipment.

The Contractor shall verify whether the existing tower structure can accommodate the new MTMS and PSVRN antennas and feed lines.

5.8.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site.

Design-Build Services for the Radio System Replacement**Section 5.0**

- Provide a detailed heat load study to determine if the existing HVAC system will accommodate the additional SFMTA radio equipment. Provide a revised design if required.
- Provide a detailed electrical load study to determine that the existing shelter power system has sufficient capacity to support the new SFMTA radio equipment.
- Provide a detailed electrical load study to determine that the existing shelter power system has sufficient capacity to support the new SFMTA radio equipment and the existing SFMTA radio equipment. If there is not sufficient power capacity, provide a design to upgrade the service.
- Install supporting infrastructure for the new radio equipment including but not limited to: grounding, power distribution and cable ladders.
- Install antenna mounting fixture appliances on the existing tower to support the new antennas. Provide a structural analysis of the new hardware and a copy of a structural analysis of the tower subsequent to the addition of the antennas. The analysis shall conform to the requirements of ANSI/TIA-222-G. The analysis shall include the consideration of having both the existing SFMTA antennas and the new SFMTA antennas on the tower at the same time.
- Install a means to structurally restrain all hardware including: racks, pipes, cable ladders and tanks, in a manner that satisfies local seismic requirements and that permits the SFMTA facility to survive a seismic event.
- Prepare a detailed plan for the relocation of the existing SFMTA radio equipment. The plan shall include consideration of the following factors: the impact on the SFMTA communications system when the Forest Hill site is incapacitated; The potential for operational compensations for the temporary loss of the Forest Hill site; the time and day when the loss of the Forest Hill radio equipment will have the least impact; the process required for re-starting the radio equipment after relocation.
- Start-Up all new systems using vendor resources as appropriate. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA.
- Install a new fire alarm system that will notify SFMTA Operations Control Center, City staff at CRS Twin Peaks, and the third party monitoring company listed as Central Station, Proprietary, or Remote Station by a nationally recognized listing agency
- Install a City approved pre-action, dry pipe (FM-200 or equivalent) fire suppression system that is connected to the fire alarm system.
- Provide a minimum of four (4) fire extinguishers, carbon dioxide, 20 pounds, rated 10-B:C, rechargeable
- Install a new security alarm system that will notify SFMTA Operations Control Center, City staff at CRS Twin Peaks, and the third party monitoring company listed as Central Station, Proprietary, or Remote Station by a nationally recognized listing agency

Design-Build Services for the Radio System Replacement**Section 5.0**

The Contractor shall provide the following calculations, to be performed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. [CDRL 12-5-10 Forest Hill Calculations].

Electrical Calculations:

- A detailed Electrical Load Study including the current load, the interim load and the final load.
- HVAC load Calculation.

Structural Calculations (to be stamped and signed by a Registered Structural Engineer licensed in California):

- The tower structural analysis shall be based on ANSI/TIA-222-G.
- Structural analyses of the existing monopole without and with the new antennas.

A preliminary structural report for the existing tower with anticipated new loads is contained in Appendix Forty One (41) Tower Structural Analysis.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings [CDRL 12-5-11 Forest Hill Completed Construction Drawings]
- Completed Materials Specifications [CDRL 12-5-12 Forest Hill Completed Materials Specifications].

5.8.3 Civil/Architectural

The Contractor shall perform any required Civil/Architectural work at this site required to accommodate the MTMS and PSVRN equipment.

5.8.4 Electrical and Grounding

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment. Contractor shall ensure that any modified electrical panels will meet NEC requirement and notify SFMTA if any code deficiencies are identified beyond the modified panel.

Electrical and Grounding drawings are contained in Appendix Nine (9). Network connectivity drawings are also contained in Appendix Nine (9).

Existing conditions are provided here for reference only and should be verified prior to any design or construction activity:

- PG&E meter X01869.
- Last year, PG&E reported a peak value of 26KW
- UPS is 850VA
- Diesel Generator is 100kW/125kVA. 120/208V. 30, 4W

Design-Build Services for the Radio System Replacement**Section 5.0**

- Department of Emergency Management's new load requirements, to be added as part of a CERS system upgrade are approximately 3.56KW.

5.8.5 Mechanical

The Contractor shall perform any required mechanical work at this site required to accommodate the MTMS and PSVRN equipment.

Mechanical drawings are contained in Appendix Nine (9). The Contractor shall be responsible for performing any mechanical or HVAC upgrades required to accommodate the MTMS and PSVRN equipment to be installed.

5.9 One Market Plaza Communications Facility**5.9.1 General Notes**

The SFMTA is currently investigating the feasibility of leasing additional space at One Market Plaza to accommodate the MTMS and PSVRN equipment.

The Contractor is advised that all electrical, mechanical, and civil/architectural work performed at this site shall be performed by the building management association's approved contractor(s). In such case, the Contractor shall be required to execute a subcontract with the approved contractor(s) to perform any necessary work at this site. Qualified Proposers may request the list of building management association's approved contractor(s) from the SFMTA.

The Contractor shall verify whether the existing building structure can accommodate the new MTMS and PSVRN antennas and feed lines.

5.9.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site.
- Renovate the designated room and prepare it for re-construction
- Install a City approved pre-action, dry pipe (FM-200 or equivalent) fire suppression system that is connected to the existing building fire alarm system.
- Install a sprinkler system in accordance with the California Building Code
- Install a new fire alarm system that will notify SFMTA Operations Control Center, City staff at CRS Twin Peaks, and the third party monitoring company listed as Central Station, Proprietary, or Remote Station by a nationally recognized listing agency
- Install a new security alarm system that will notify SFMTA Operations Control Center, City staff at CRS Twin Peaks, and the third party monitoring company listed as Central Station, Proprietary, or Remote Station by a nationally recognized listing agency
- Provide a minimum of four (4) fire extinguishers, carbon dioxide, 20 pounds, rated 10-B:C, rechargeable
- Install a new emergency power system with the basement located emergency generator. This power system shall support both the SFMTA equipment room and the City Radio

Design-Build Services for the Radio System Replacement**Section 5.0**

Equipment room. A complete and detailed load study shall be completed. The drawings indicate the anticipated result of this task and are not prescriptive. The emergency generator shall be cooled by the existing building chilled water system.

- Install a dual, redundant room cooling system that will maintain a 70 degree F atmosphere for all of the anticipated radio equipment and an additional 50% of the anticipated cooling load. This system shall use existing building chilled water and shall be supported by the emergency generator.
- Install a room grounding system that is connected to both the building steel frame and to the building electrical ground system.
- Install room support systems including but not limited to: lighting, cable ladder, racks, power distribution, etc.
- Install antenna mounting fixtures that are attached to the building steel frame and that comply with all applicable codes including ANSI/TIA-222-G.
- Install necessary means so that antenna cables shall not be visible from outside the building.
- Install a means to structurally restrain all hardware including: racks, pipes, cable ladders and tanks, in a manner that satisfies local seismic requirements and that permits the facility to survive a seismic event.
- Start-Up all systems using vendor guidance as appropriate. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA. (The gas based fire suppression shall be tested without actual agent discharge.)

The Contractor shall provide the following calculations, to be performed by qualified personnel. Results shall be provided in report format. stamped and signed by a Registered Engineer licensed in California. [CDRL 12-5-13 One Market Plaza Site Calculations].

Electrical Calculations:

- Detailed Electrical Load Study including the City Radio Room
- HVAC load Calculation
- Generator Loading Study.

Structural Calculations (to be stamped and signed by a Registered Structural Engineer licensed in California):

- Tower structural analysis based on ANSI/TIA-222-G.
- Analysis of the capacity of the penthouse to support additional antennas.
- Analysis of the proposed antenna mounting hardware and attachment methods.
- Floor loading.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

Design-Build Services for the Radio System Replacement**Section 5.0**

- Completed Construction Drawings [CDRL 12-5-14 One Market Plaza Completed Construction Drawings]
- Completed Materials Specifications [CDRL 12-5-15 One Market Plaza Completed Materials Specifications].

5.9.3 Civil/Architectural

The Contractor shall perform any required Civil/Architectural work at this site required to accommodate the MTMS and PSVRN equipment.

5.9.4 Electrical and Grounding

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment. Contractor shall ensure that any modified electrical panels will meet NEC requirement and notify SFMTA if any code deficiencies are identified beyond the modified panel.

Electrical and Grounding drawings are contained in Appendix Nine (9). Network connectivity drawings are also contained in Appendix Nine (9).

Existing conditions are provided here for reference only and should be verified prior to any design or construction activity:

- Transformer: 45KVA
- Diesel Generator: 600KW/750KVA, PF 0.8
- UPS: 850VA
- Lighting load: 640W
- Department of Emergency Management's new load requirements, to be added as part of a CERS system upgrade are approximately 3.56KW.

5.9.5 Mechanical

The Contractor shall perform any required mechanical work at this site required to accommodate the MTMS and PSVRN equipment.

Mechanical drawings are contained in Appendix Nine (9). The Contractor shall be responsible for performing any mechanical or HVAC upgrades required to accommodate the MTMS and PSVRN equipment to be installed.

HVAC control sequence of operation is listed below (see reference drawing in Appendix Nine (9)):

- ACU-1 AND ACU-2, In conjunction with a DOC programmable controller, shall be programmed to run one (1) ACU continuously. The second unit shall operate as a stand-by unit and shall be programmed to start whenever the lead unit fails. ACU-1 and ACU-2 shall be alternately selected to function as the stand-by unit for a period of one month.
- The fan corresponding to selected unit shall run continuously.

Design-Build Services for the Radio System Replacement

Section 5.0

- Thermostats T-1 and T-2 corresponding to ACU-1 and ACU-2, respectively shall control the cooling functions of their corresponding ACU unit to maintain space temperature at 75° F.
- Humidity sensor H-1 and H-2 corresponding to ACU-1 and ACU-2 respectively shall control their corresponding humidifier to maintain room humidity at 50% relative humidity.
- Detection of smoke by smoke detectors SD-1, SD-2 (LOCATED RESPECTIVELY IN ACU-1 and ACU-2) or an area smoke detector in conjunction with the fire control panel, shall shut down air conditioning units with ACU-1 and ACU-2, and disable EF-1.
- Detection of smoke shall also cause the fire control panel to close new supply and return dampers connected to radio room air ducts (if applicable-See <3>; and emergency air damper connected t outside air louver.
- Condenser water pump CWP-1 or CWP-2 in conjunction with the DOC programmable controller shall be programmed to run continuously. Condenser water pump CWP-1 and CWP-2 shall be alternately selected to functions as the lead pump for a period of (1) one month.
- The DOC programmable controller in conjunction with flow switch FS-1 or FS-2, respectively located at CWP-1 and CWP-2, shall sense failure of the lead pump CWP-1 or CWP-2 and start the lag pump.
- When temperature sensor TS-1 detects a room temperature rise to 90° F, the stand-by ACU and stand-by CWP shall be programmed to operate. Both ACU-1 and ACU-2 will operate simultaneously until the room temperature falls to 75° F.
- When both ACU-1 and ACU-2 fails, the emergency outside air damper shall be programmed to open and EF-1 shall be programmed to start.
- When the remote indicators sense a problem (i.e. fan failure of ACU-1 and ACU-2, failure of CWP-1 or CWP-2, Activation of both ACU-1 and ACU-2 activation of EF-1, etc.), a signal shall be sent to the SFMTA SCADA System.

The Network Management System (Appendix Twelve (12), Section Four (4) shall. at a minimum:

- Monitor activation of either HVAC system. including which system(s) is in operation
- Monitor problem/fault indicators
- Monitor room temperature and humidity.

5.9.6 Approved Contractors List

The building management of One Market Plaza maintains a list of approved contractors to perform work at the site. The following firms have been named:

Mechanical:

- Columbia
- AR & B
- Standard Sheetmetal

Design-Build Services for the Radio System Replacement**Section 5.0**

- S.F. Mechanical
- ACCO

Electrical:

- Paganini
- Decker
- Cupertino
- Lera
- Metropolitan
- ASF

The Contractor shall be required to subcontract with these firms or any others preapproved by the building management to perform work at One Market Plaza.

5.10 South Hill Communications Facility**5.10.1 General Notes**

The South Hill Communications Facility in Daly City houses existing City and County of San Francisco (CCSF) equipment. The SFMTA wishes to co-locate MTMS and PSVRN equipment at this site with the CCSF equipment. For the SFMTA, The South Hill Communications Facility shall house above ground radio communications facility for the MTMS and PSVRN systems.

If necessary, the Contractor shall verify whether the existing tower structure can accommodate the new MTMS and PSVRN antennas and feed lines.

5.10.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site.
- Install a new emergency power system including a new emergency generator. This power system shall support both the new SFMTA shelter and the existing City Radio Equipment shelter. A complete and detailed load study shall be completed. The drawings indicate the anticipated result of this task and are not prescriptive.
- Perform a detailed subsurface investigation of the site in preparation for designing the foundation for a new radio equipment shelter.
- Install a complete site ground system that integrates the new shelter and the existing shelter and tower grounding system.
- Provide and install a new radio equipment shelter within the South Hills compound. The new shelter shall incorporate all necessary and desirable infrastructure features needed to support the new radio equipment. These features shall include but not be limited to: access control, internal environmental regulation, lighting, cable management, seismic restraint, fire suppression, fire detection and alarm, and etc.

Design-Build Services for the Radio System Replacement

Section 5.0

- Provide a minimum of four (4) fire extinguishers, carbon dioxide, 20 pounds, rated 10-B:C, rechargeable
- The new security alarm system shall notify SFMTA Operations Control Center, City staff at CRS Twin Peaks, and the third party monitoring company listed as Central Station, Proprietary, or Remote Station by a nationally recognized listing agency
- The new fire alarm system shall notify SFMTA Operations Control Center, City staff at CRS Twin Peaks, and the third party monitoring company listed as Central Station, Proprietary, or Remote Station by a nationally recognized listing agency
- Start-Up all systems using vendor resourced as appropriate. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA.

During construction the following inspections will be performed by the SFMTA unless otherwise formally notified:

- Inspection of all foundations excavations prior to installation of rebar
- Inspection of all foundation construction prior to the pouring of concrete
- Observation of on-site Concrete Quality Tests
- Inspection of site ground system prior to backfilling.

The Contractor shall provide the following calculations, to be performed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. [CDRL 12-5-16 South Hill Site Calculations and Tests].

Soils:

- Ground Resistance Tests
- Sub-Soil Hazard inspection.
- Soil Stability Report
- Concrete Hardness.

Electrical Calculations:

- Detailed Electrical Load Study including the existing City Radio Shelter
- Generator loading study.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings [CDRL 12-5-17 South Hill Completed Construction Drawings]
- Completed Materials Specifications [CDRL 12-5-18 South Hill Completed Materials Specifications].

Design-Build Services for the Radio System Replacement

Section 5.0

5.10.3 Civil Architectural

The Contractor shall be required to construct a new communications shelter to accommodate the PSVRN and MTMS equipment at this site.

The Contractor shall perform any required Civil/Architectural work at this site required to accommodate the MTMS and PSVRN equipment.

Civil/Architectural drawings are contained in Appendix Nine (9).

5.10.4 Electrical and Grounding

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment. Contractor shall ensure that any modified electrical panels will meet NEC requirement and notify SFMTA if any code deficiencies are identified beyond the modified panel.

Electrical and Grounding drawings are contained in Appendix Nine (9). Network connectivity drawings are also contained in Appendix Nine (9).

Existing conditions are provided here for reference only and should be verified prior to any design or construction activity:

- PG&E meter #8078R3
- UPS is 850VA
- Department of Emergency Management's new load requirements, to be added as part of a CERS system upgrade are approximately 3.56KW
- The existing incoming service is in a 3" conduit originates down the hill, from the PG&E service pole to the existing prefab.
- The distance from PG&E transformer to panel is approximately 434 feet.
- Diesel Generator is 40kW/50kVA. 120/208V, 30, 4W.
- Existing loads as follows:

Fail Soft Mode	Phase A	Phase B	Phase C	Power	PF
	Peak Readings				
Both AC off	42 A	29 A	58 A	18 KW	.98
1 AC on (in rush)	66 A	67 A	72 A	22 KW	.99
	211 V	211 V	210V		

5.10.5 Mechanical

The Contractor shall perform any required mechanical work at this site required to accommodate the MTMS and PSVRN equipment.

Design-Build Services for the Radio System Replacement**Section 5.0**

Mechanical drawings are contained in Appendix Nine (9). The Contractor shall be responsible for performing any mechanical or HVAC upgrades required to accommodate the MTMS and PSVRN equipment to be installed.

HVAC control sequence of operation, including NMS requirements, are listed above in Section 5.8.4 for One Market Plaza.

5.11 Clay and Jones Communications Facility

The Clay and Jones Communications Facility houses existing City and County of San Francisco (CCSF) equipment. The SFMTA wishes to co-locate MTMS and PSVRN equipment at this site with the CCSF equipment.

5.12 Underground Communication Facilities

Functional requirements for the underground radio communications requirements are listed in Appendix Twelve (12) Section Two (2).

The Contractor shall be responsible for performing civil/architectural, mechanical, electrical, grounding, and any other work to implement the underground portions of the MTMS and PSVRN communications systems.

Underground communications drawings are contained in Appendix Nine (9).

The Contractor shall perform all underground work in accordance with the Special Provisions listed in Appendix Three (3), "Form of Agreement". This shall include all the SFMTA imposed restrictions on time allowed to work in the underground tunnels, advanced notice for work schedule, etc.

The following preliminary assessment is provided for work in underground tunnels, platforms, and passageways, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site.
- Prepare for the SFMTA review and approval, a plan for the implementation of the SFMTA required track safety training and track safety supervision.
- Prepare for the SFMTA review and approval, a plan including tunnel/track access and work that reflects the need to maintain revenues services and train schedules.
- Prepare a detailed plan for a tunnel survey to confirm information shown on the drawings.
- Perform the tunnel survey.
- Do the necessary RF engineering to demonstrate that the selected communications technology will provide the desired communications coverage and service reliability. See Appendix Twelve (12) Section Two (2) for coverage and performance requirements.
- Prepare a complete tunnel radio system design showing all equipment, cables, racks, etc for the SFMTA review and potential approval.
- Install all required cable mounting hardware and cables.
- Install all in-tunnel electronics and power distribution.
- Install all station located electronics and power supplies.

Design-Build Services for the Radio System Replacement**Section 5.0**

- Install all above ground antennas.
- Coordinate with the SFMTA to provide appropriate electrical power for the station mounted equipment.
- Start-Up all systems using vendor resources as appropriate. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA.

The Contractor shall perform the following calculations and develop reports, to be performed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. [CDRL 12-5-19 Underground Calculations and Reports].

Reports:

- Track and Safety Plan
- Tunnel Access Plan
- Comparison between radio communications technologies.

Calculations:

The following calculations shall be performed by qualified personnel. The results shall be presented in a report format to the SFMTA for review. The calculation reports shall be prepared and signed by a Registered Engineer licensed in California.

- Power loss and regulation of tunnel power distribution.
- RF power link budget in each tunnel section.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings [CDRL 12-5-20 Underground Completed Construction Drawings]
- Completed Materials Specifications [CDRL 12-5-21 Underground Completed Materials Specifications].

The underground designs shall be coordinated with SFMTA Fleet Engineering to confirm that the equipment locations do not interfere with the light rail vehicle clearance envelope.

5.13 Vehicle Operations and Maintenance Facilities

The SFMTA employs a number of vehicle operations maintenance facilities:

- Potrero Division
- Muni Metro East
- Presidio Division
- Green Division
- Woods Division (separate Operations and vehicle maintenance areas)

Design-Build Services for the Radio System Replacement**Section 5.0**

- Flynn Division
- Kirkland Division
- Cable Car Barn
- Scott Non-Revenue Division
- Islais Creek (planned future).

Each of these facilities will require the Contractor to perform necessary electrical, grounding, and mechanical work to install the following:

- Network equipment
- Dispatch work stations
- Wireless access points and antennas for high speed bulk data transfer
- Servers for MTMS store-and-forward operations
- Other equipment as required for MTMS and PSVRN operation including control stations, desktop voice consoles, etc.

Contractor shall ensure that any modified electrical panels will meet NEC requirement and notify SFMTA if any code deficiencies are identified beyond the modified panel.

Drawings showing equipment installation details for each of these sites are included in Appendix Nine (9). The equipment quantity and locations as shown in the "Maintenance Facilities- Network Schematics" drawings of Appendix Nine(9) are for reference only.

5.14 Vehicle Equipment Installations

The Contractor shall install all Contractor provided on-board equipment in the SFMTA's vehicles. The Contractor shall supply all wiring, cable harnesses, connectors, brackets, fuses, and all other hardware required to connect each device to other Contractor-provided equipment, existing vehicle equipment, and the vehicle power supplies. The types and quantities of vehicles requiring installation are listed in Appendix Twenty Eight (28), "Cost Proposal". A final vehicle count will be agreed upon at contract award. The SFMTA reserves the right to adjust vehicle quantities and types for equipment installation subsequent to Contractor NTP.

The Contractor shall work with the SFMTA staff to ensure that installation procedures and equipment locations are acceptable to the SFMTA. The Contractor shall submit, for review and approval, installation plans, installation test procedures, installation procedures, and drawings for each type of vehicle.

It is the Contractor's responsibility to determine and/or obtain all necessary vehicle information to ensure no vehicle equipment is damaged during the installation process. Any damage done by the Contractor during installation shall be repaired by the Contractor at the Contractor's own expense.

The Contractor shall provide documentation and/or evidence that all material and electronic waste removed from the SFMTA's vehicles has been legally and responsibly disposed of and/or recycled.

The Contractor and the SFMTA shall mutually agree on locations, times, and the SFMTA resources provided during installation at each site. In general, installations should be scheduled at times when

Design-Build Services for the Radio System Replacement**Section 5.0**

most vehicles are available and not needed for service. The Contractor shall coordinate installation of equipment on the SFMTA's revenue vehicles with Maintenance supervisors, Resident Engineer, or the other SFMTA staff at each Division.

The Contractor shall provide a Quality Control (QC) representative to randomly select and inspect a percentage of the vehicle installations. The QC representative shall report directly to the Contractor's management and have the authority to direct installers to immediately remedy any deficiencies and/or impose restrictions on installation activities until such deficiencies are corrected.

The Contractor shall remove all existing vehicle antennas, and cabling, replace with new, and test to confirm that the VSWR is less than 1.5:1.

The Contractor shall maintain and deliver installation checklists and equipment inventories for each individual vehicle having equipment installed [CDRL 12-5-22: Vehicle Installation Details]. These checklists and inventories shall be delivered for each vehicle after installation is approved.

5.14.1 General Installation Standards

Unless otherwise specified in Appendix Twelve (12), Section Two 2 "Radio Communications Components", system installation shall conform to the following general standards:

- Workmanship and appearance of work throughout shall be of the best commercial quality and adhere to the latest edition of all applicable standards and codes
- Work shall be performed only by qualified personnel, and shall be supervised by technically competent, trained, experienced supervisory personnel at all times
- All equipment and components shall be easily accessible for adjustment and service
- Cabling and equipment exposed to the weather shall be adequately protected from wind, rain, and dust. Seals, gaskets, packing, sheathing, finishes, mountings, and all other exposed items shall be designed for maintenance-free performance under long-term exposure to weather, including ultra-violet radiation.
- Equipment and cabling installed inside buses shall be adequately protected from water and dust, including that present during bus cleaning operations
- Equipment requiring adjustments shall be securely installed inside buses and vehicles using tamper-proof containers, fasteners, etc.
- Wiring and cabling shall be installed using the following standards:

Conductors shall be continuous between terminals, without splices

Conductor gauge, insulation, and shielding shall be adequate for the intended purpose

Cable and wire shall be run neatly, with adequate lacing or clamping

Consistent cable and wire color coding shall be used

All applications requiring physical movement and flexing shall use stranded conductors

Wire and cable shall be labeled every 6 inches.

Design-Build Services for the Radio System Replacement**Section 5.0**

- Ring-type, crimped lugs shall be used with stranded wires terminated on screw-type terminals. Connections shall be made only with crimping tools that meet the connector manufacturer's specifications.
- Shielded wiring, or other means of signal isolation, shall be used wherever necessary to avoid cross-talk, hum, pops, clicks, whine, and other forms of interference. The Contractor shall provide an interference-free system.
- Unless installed in conduit, wiring within consoles, beneath raised floors, and from outlet boxes to free-standing or desk-mounted equipment shall be neatly installed, bundled with appropriate tie-wrap devices, and tied to supports if practicable
- Dispatch center signal and control wiring, and connection of devices referenced in this Specification, shall be installed in conduits or concealed, and shall be included as part of the work to be performed by the Contractor. Wiring shall be accessible for maintenance. At remote sites and in equipment rooms, open cabling is permitted on cable racks provided they are neatly tied
- Interconnect cabling used within consoles, equipment cabinets, or in areas where the wiring will not be installed in metallic conduit, shall be insulated with heat-resistant material to minimize pyrolysis and fire hazard
- Cable and wiring penetrations through metal cabinets shall be insulated with dielectric grommets
- Cable and wiring installed in modular furniture shall be run in the trays or channels designed for that purpose
- Extra wiring necessary for equipment movement shall be neatly coiled, tied, and concealed
- Wiring in dropped ceiling areas shall not lie on top of light fixtures or ceiling tiles
- Cable penetrations through building outside walls shall be thoroughly packed and waterproofed
- Cables, wiring forms, and terminals shall be identified by permanent labels, tags, or other appropriate means. Marking shall clearly indicate the function or source. Cables shall be identified at both ends with indications of the source and destination of that cable run. The cable identification shall agree with the wiring and interconnect diagrams
- Installation at all sites shall be in complete compliance with all applicable local building, seismic, and fire codes.

5.14.2 Rubber-Tire Vehicle Installation Standards

The following requirements apply to all mobile radio and ITS equipment to be installed in the SFMTA's vehicles.

All the SFMTA vehicle installations shall be subject to inspection and approval before acceptance, by inspection personnel to be named by the SFMTA. Acceptance shall include but not be limited to:

- Appearance

Design-Build Services for the Radio System Replacement

Section 5.0

- Effective usefulness
- Full programming as set forth by agreement
- Full testing, including power out, deviation, receiver sensitivity, antenna VSWR, and all programmed features, to meet or exceed published specifications.

Prior to any Contractor testing, the coach electrical supply should be verified as suitable and adequate for proposed equipment requirements. Routing, connections and circuit protection for radio and any on board equipment connectivity shall be inspected and approved by the SFMTA, as part of the mini-fleet test, and carried forward to production installations.

The Contractor shall make every effort to protect all interconnecting cable runs, especially cables routed underneath the vehicle.

All cabling that is routed underneath the vehicle shall be secured in high impact plastic looms and secured to a stationary support device.

Ties to such supports shall be stainless steel straps that are designed for this purpose; nylon tie-wraps are not acceptable.

Care shall be taken to avoid the vehicle exhaust system or other areas that create excessive heat.

Where wiring passes through compartment walls, floors, or rooftops, the Contractor shall protect the wiring from sharp edges with rubber grommets and shall ensure waterproofing to interior compartments.

Installation in any vehicle shall not interfere with any functional device, nor shall it affect the safe operation of the vehicle. On vehicles equipped with driver and passenger side air bags, the Contractor equipment shall not interfere with deployment. If necessary, the Contractor shall propose and install a passenger side air bag disabling switch. Modification of any safety equipment or air bags on the SFMTA's vehicles shall be performed by a US-DOT certified technician and include support for SFMTA registration with the California Department of Motor Vehicles.

All vehicles that have tilt cabs shall be provided with new ground braids between the cab and the frame of the vehicle. This ground braid shall be installed on metal that is free from paint, grease, or dirt, and shall include a star lock washer to ensure a reliable and secure ground connection.

All main power leads shall be obtained from the same voltage source as that used by existing radio equipment.

The SFMTA prefers a design that will utilize a single Microphone or both radio communications and PA use.

In vehicles that employ intercom systems, the new equipment shall be connected to the intercom system upon cutover to the new radio system. New radios shall be checked for compatibility with the intercom system at the time of installation.

The new equipment shall not create or receive interference from other electronic equipment in the vehicle, assuming this other electronic equipment is operating within its operational and regulatory compliance. If any modification is required to the Contractor's equipment to correct such interference, such correction shall be performed on all vehicles to ensure uniformity of equipment at no additional cost to the SFMTA.

Design-Build Services for the Radio System Replacement**Section 5.0**

All fuses shall be installed in locations that are easily accessible. No fuses shall be installed in locations under the vehicle.

All wiring shall be installed in a manner that is secure and free from interference or damage by the occupants.

All antennas shall be mounted permanently to the roof of the vehicle.

No cable connectors fabricated in the field shall be crimp-type. All connectors shall be soldered using 60/40 solder within heat shrink that incorporates some form of sealant to ensure proper connection.

Reflected power or VSWR shall be measured after installation of each antenna and cable. Maximum reflected power shall not exceed 4% of the radio unit's output power.

No wiring shall be spliced within the loom covering that wire.

"LOK" or "I-Tap" style splice connectors shall not be permitted.

No wire shall change color between the source and the radio unit.

The Contractor shall be responsible for making corrections to any and all vehicles that experience dormant operation battery drain. where such drain can be attributed to new equipment installation. In such case, the Contractor shall be required to install equipment cut-off timers or other means to prevent dormant loads from draining the vehicle batteries.

The Contractor is encouraged to check vehicle batteries before radio installation to avoid problems. If a vehicle is found to have faulty batteries, the Contractor shall notify the SFMTA and note this on the installation documentation.

5.14.3 Rail Vehicle Installation Standards

Specific rail vehicle installation standards are contained in Appendix Twenty-Two (22). These standards, where applicable based on Contractor-provided equipment, shall apply to the SFMTA's fleet of Breda Light Rail Vehicles, cable cars, and the Historic Fleet.

The Contractor's equipment installation on the Historic Fleet shall be subject to additional review and approval by the Market Street Railway (the nonprofit preservation partner of the San Francisco Municipal railway), and other public stakeholder groups. The Contractor's installation on such vehicles should be designed to preserve the historic look and finish existing in each distinct vehicle and/or vehicle type.

The San Francisco cable car is considered a national icon. As such, the Contractor's equipment installation on the vehicles will be subject to additional review and approval by other stakeholder groups. The Contractor's installation on the cable cars should be designed to preserve the historic look and finish existing in each distinct vehicle.

5.15 System Cutover

The contractor shall develop a detailed System Cutover Plan per requirements in this section and other sections of these Specifications and submit the Plan for the SFMTA review and Approval [CDRL 12-5-23 System Cutover Plan]. The Plan shall include details for the entire Cutover process even if the specifics are not included herein. Proposers shall submit, as part of their proposals, a Sample System

Design-Build Services for the Radio System Replacement**Section 5.0**

Cutover Plan for a similar system be installed at an agency similar in size to the SFMTA [PRL 12-5-3 Sample System Cutover Plan].

The System Cutover Plan shall describe a smooth transition between the SFMTA's use of existing systems to use of the PSVRN and MTMS, with no effective loss of control over revenue vehicle operations. This plan shall allow for a period of parallel operations of the existing equipment and PSVRN and MTMS. The Contractor shall be responsible for implementing all software and hardware and providing all necessary equipment required to support system phase-over.

The System Cutover Plan shall describe in detail the design and procedures used to support the parallel operation, testing and verification of functionality of the new system, and the transition of operations to the new system. The field performance, "mini-fleet", and full fleet testing to be performed during the cutover phase shall be described in this plan.

The vehicle installation plans shall define how the vehicle installation work will be performed, the sequence in which vehicle installations will be performed (e.g., the order of the installations by Division, site, or vehicle type), the schedule for installing on-board vehicle equipment, and the support and facilities expected from the SFMTA.

The System Cutover Plan shall identify how the contractor shall plan, manage, install equipment, integrate, test, and commission all the equipment for PSVRN and MTMS at all fixed sites illustrated in the drawings contained in Appendix Nine (9), and all of the SFMTA fleet vehicles (rubber-tire fleet, historic fleet, cable cars, electric trolleys, light rail vehicles, and non-revenue service vehicles). Upon written request by the Contractor, the SFMTA shall make the available drawings and schematics for the vehicles available. Several vehicles such as historic fleet, do not have schematics. The SFMTA does not guarantee nor confirms the accuracy of these documents and the contractor shall thoroughly inspect the vehicles to verify the accuracy of the drawings at no additional cost to the SFMTA.

5.15.1 System Cutover Plan

The Contractor's System Cutover Plan shall include specific details for the SFMTA to comprehend the overall management and control process of the Cutover. As a minimum, the contractor shall include, as a minimum, the following details in the Plan:

- i. Overall organization including reporting structure and organization chart
- ii. General approach and methodology to manage the Cutover process
- iii. Pre-cutover activities and support needed from the SFMTA
- iv. Cutover activities and support needed from the SFMTA
- v. Post-cutover activities and support needed from the SFMTA
- vi. Detailed description of project schedule activities including methodology to control schedule
- vii. Work task breakdown, including activities performed by the prime and subcontractors, and system integration in flowchart format
- viii. Methodology and approach for QA/QC, configuration control, inspections, labeling, and testing
- ix. Safety requirements and precautions

Design-Build Services for the Radio System Replacement

Section 5.0

- x. Compliance with standards, regulations, and codes
- xi. Drawings, reports, and data
- xii. Cutover schedule.

This is a partial list of requirements and the contractor shall include additional items based on past experience. The SFMTA or its designee shall have the liberty to request the Contractor to include additional information as deemed necessary for the cutover process.

The System Cutover Plan shall be submitted to the SFMTA prior to beginning Factory Acceptance Testing.

5.15.2 System Cutover Schedule

The Contractor shall develop and Submit for Approval a detailed schedule and associated description of all activities for the cutover including the milestones [CDRL 12-5-24 System Cutover Schedule].

The schedule shall be in a time-scaled, bar-chart format indicating the detailed progress of the cutover from the beginning through end. The contractor shall update the schedule and submit it to the SFMTA each week based on the progress. As a minimum the schedule shall include the following details:

- i. Completed activities and progress during previous week in narrative format and highlighted on the schedule
- ii. Planned and actual progress for each maintenance facility
- iii. Key milestones including but not limited to payments, submittals, deliverables, approvals, and tests
- iv. Planned activities for the next month.

All milestones, start-dates, completion dates shall be consistent with the contract milestone dates.

When predicting future activities, the contractor shall identify the specific support needed by the SFMTA.

5.15.3 Meetings

The Contractor shall schedule dedicated meetings every two weeks and shall send invitations to the SFMTA. The objectives of meetings shall be to provide information, discuss issues, request information, or update the SFMTA of the cutover progress. The duration of meetings may vary based on the type of agenda, however, the contractor shall be responsible for documenting meeting minutes and submitting the minutes to the SFMTA for approval. The meetings shall include:

- The installation progress,
- Issues, concerns,
- Resolution related to the cutover process.

5.15.4 Systems Engineering and Integration During Cutover

As part of the System Cutover Plan, the contractor shall develop a comprehensive and detailed description of how systems engineering and integration will be achieved during the cutover process

Design-Build Services for the Radio System Replacement**Section 5.0**

[CDRL 12-5-25 System Engineering and Integration Description During Cutover]. The details shall include specifics including but not limited to:

- i. How cables shall be installed and routed
- ii. How and where the equipment shall be installed
- iii. How and where the power will be tapped from and power utilization
- iv. How the vehicle borne equipment will be integrated
- v. Hardware and software integration.

This is a minimal list and the contractor shall be responsible for including all pertinent information to the SFMTA. If deemed necessary, the SFMTA may request additional information. Throughout the document references shall be made as needed to each subsystem installation drawings, schematics, installation plans, and other documents as necessary. Generic statements repeating the RFP language shall not be accepted.

5.15.5 Compliance with Standards, Codes, and Regulations

The Contractor shall comply with all applicable standards, codes, regulations, laws and requirements whether specified in these documents or not. The contractor shall ensure that all such requirements are identified within the System Cutover Plan.

5.15.6 Drawings, Reports, and Data

The contractor shall include all necessary drawings, reports, and data as part of the System Cutover Plan. If any drawings, reports, and data are submitted as part of the design package then the System Cutover Plan may reference such drawing, report, or data. If the required documents are not submitted as part of the design then the Contractor shall include such information with the System Cutover Plan. The SFMTA reserves the right to request additional information.

The drawings, reports, and data submitted as part of the System Cutover Plan shall include sufficient details for the reviewer to make an assessment of the subsystem or assembly under consideration. The drawings shall include specifics in appropriate scale and shall include the plan views, side views, transverse sections, longitudinal sections, and clearances as applicable.

All drawings shall comply with the SFMTA's CADD Standard.

5.16 Transit Management Center - 1455 Market Street**5.16.1 General Notes**

SFMTA intends to lease space on the 7th floor of a commercial office building located at 1455 Market Street in San Francisco. This building is across the street from SFMTA Headquarters at One South Van Ness Avenue. The draft functional layout is shown in Appendix Forty Seven (47) Transit Management Center - 1455 Market Street.

5.16.2 Preliminary Scope of Work

The Contractor's scope at this facility shall be limited to installation of dispatch consoles, connecting radio system to existing NICE voice recorder to recode radio traffic and any other related equipment or systems within the existing infrastructure.

Design-Build Services for the Radio System Replacement

Section 5.0

5.16.3 Civil Architectural

The Contractor shall install the same number of dispatch consoles as specified in the Lenox Way drawings.

5.16.4 Electrical and Grounding

No electrical or grounding work will be required. SFMTA will provide power and data cabling to all dispatch consoles and equipment racks.

5.16.5 Mechanical

Existing equipment racks shall be used.

Contractor installation of the dispatch consoles shall comply with state and local seismic bracing requirements.”

5.17 Dispatch Console Furniture

The Contractor shall provide and install dispatch consoles of identical type in the Lenox Way and Transit Management Center at 1455 Market Street (depending on which options selection). The number and purpose for each console is specified in the Lenox Way drawings.

The console furniture will be provided by SFMTA for Transit Management Center at 1455 Market St.

The Contractor shall provide and install all interconnections and wiring between the consoles and power, communications, and LAN sources.

The console furniture shall meet the following requirements:

All console furniture shall be assembled at the console furniture supplier's facility. Consoles shall be inspected and approved by SFMTA prior to shipping.

The Contractor shall verify that all console equipment fits in its intended location, can be adjusted for use by the intended users, and can be powered via the installed power outlets.”

Wiring - All wiring connecting the console equipment shall be neatly bundled and concealed cable raceways wherever possible.

During the design phase the contractor will survey the TMC to determine whether or not the existing facility is adequate to support the console design.

5.18 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

PRL 12-5-1 Environment Requirements

PRL 12-5-2 Required Equipment Space

PRL 12-5-3 Sample System Cutover Plan.

5.19 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

Design-Build Services for the Radio System Replacement

Section 5.0

- CDRL 12-5-1 Lenox Way Site Calculations and Reports
- CDRL 12-5-2 Lenox Way Completed Construction Drawings
- CDRL 12-5-3 Lenox Way Completed Materials Specifications
- CDRL 12-5-4 Bernal Heights Site Calculations
- CDRL 12-5-5 Bernal Heights Completed Construction Drawings
- CDRL 12-5-6 Bernal Heights Completed Materials Specifications
- CDRL 12-5-7 CRS Twin Peaks Site Calculations
- CDRL 12-5-8 CRS Twin Peaks Completed Construction Drawings
- CDRL 12-5-9 CRS Twin Peaks Completed Materials Specifications
- CDRL 12-5-10 Forest Hill Calculations
- CDRL 12-5-11 Forest Hill Completed Construction Drawings
- CDRL 12-5-12 Forest Hill Completed Materials Specifications
- CDRL 12-5-13 One Market Plaza Site Calculations
- CDRL 12-5-14 One Market Plaza Completed Construction Drawings
- CDRL 12-5-15 One Market Plaza Completed Materials Specifications
- CDRL 12-5-16 South Hill Site Calculations and Tests
- CDRL 12-5-17 South Hill Completed Construction Drawings
- CDRL 12-5-18 South Hill Completed Materials Specifications
- CDRL 12-5-19 Underground Calculations and Reports
- CDRL 12-5-20 Underground Completed Construction Drawings
- CDRL 12-5-21 Underground Completed Materials Specifications
- CDRL 12-5-22: Vehicle Installation Details
- CDRL 12-5-23 System Cutover Plan
- CDRL 12-5-24 System Cutover Schedule
- CDRL 12-5-25 System Engineering and Integration Description During Cutover.
- CDRL 12-5-26 Transit Management Center (1455 Market Street) Completed Construction Drawings
- CDRL 12-5-27 Transit Management Center (1455 Market Street) Completed Materials Specifications

The Contractor is advised that the above list does not necessarily constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole, or by reference, as part of the complete package of deliverables and submittals. Any additional CDRLs required will be mutually agreed during the Design Phase.

6.0 QUALITY PROGRAM

(Moved to Supplementary Conditions Document 00824 Quality Program)

7.0 TESTING & SYSTEM ACCEPTANCE

This section shall apply to all equipment provided as part of the integrated Public Service Voice Radio Network (PSVRN) and Multimodal Transit Management System (MTMS).

All materials furnished and all work performed under Contract 1240 shall be tested as specified following.

In general, deliverables shall not be submitted until all required tests have been completed, all deficiencies have been corrected to the SFMTA's satisfaction, and the hardware and software has been approved for submission by the SFMTA.

Should any tests indicate that specific hardware, software, or documentation does not meet these Specification Requirements, the appropriate items shall be replaced, upgraded, or added by the Contractor, at the Contractor's expense, as necessary to correct the noted deficiencies. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The test program shall be considered successfully complete only when:

- All tests have been performed
- All variances have been resolved to the satisfaction of the SFMTA
- All test records and reports have been submitted to the SFMTA and have been approved
- SFMTA acknowledges, in writing, successful completion of all testing.

System Acceptance shall only occur after successful completion of the System Availability Test and other requirements and criteria as specified in this section.

7.1 Test Plans & Procedures

Test plans and test procedures for all tests shall be provided by the Contractor to ensure that each test is comprehensive and verifies all the features of the functions to be tested. During the development of test plans and test procedures for application software, firmware, and hardware, special emphasis shall be placed on comprehensively testing of each function and feature. The test procedures shall be modular to allow individual test segments to be repeated as needed.

For each factory and field test, test plans and test procedures shall provide a high level functional summary. Test procedures shall provide the step-by-step activities associated with each test.

All test plans and test procedures shall be submitted to the SFMTA for review and approval and shall also be subject to the approval process as defined in the Contractor's Quality Assurance Plan.

7.2 Integrated System Test Plan

The Integrated System Test Plan (ISTP) must be approved by the SFMTA prior to the start of any testing [CDRL 12-7-1 Integrated System Test Plan], There shall be one ISTP, made up of individual subsystem test plans as required. The following information shall be included in the ISTP:

- Test schedule
- Vehicle and facility access requirements, and resource constraints

Design-Build Services for the Radio System Replacement**Section 7.0**

- Record-keeping procedures and forms
- Procedures for monitoring, correcting, and retesting variances
- Procedures for controlling and documenting any and all changes made to any system or subsystem after the start of testing
- Block diagram and general descriptions of the hardware test configurations, including Contractor and the SFMTA supplied equipment, radio equipment, revenue and non-revenue vehicle equipment, external communications equipment, and any test or simulation hardware
- A list of all individual tests to be performed and the purpose of each test segment
- Provisions for testing of the SFMTA-defined operational scenarios
- Provisions for independent testing by the SFMTA to exercise the features of the installed system
- Identification of all special hardware, software, tools and test equipment to be used during testing
- Techniques and scenarios to be used to simulate ultimate system sizing, processor utilization, and performance, especially during the peak loading test
- Copies of any certified test data (e, g. environmental data) to be used in lieu of testing
- Example forms for test reports and test failure reports,

7.3 Test Procedures

All test procedures shall be submitted to the SFMTA for approval that are based upon, and consistent with, the approved ISTP [CDRL 12-7-2 Test Procedures). Test procedures shall be submitted to the SFMTA for approval only after the ISTP has been approved by the SFMTA. Fully approved test procedures are required prior to the commencement of the respective testing. Testing shall not commence without approved test procedures. The SFMTA will only approve test procedures if they are inclusive and thoroughly test each purchased system component. both independently and collectively. All test procedures shall include the following items:

- Function or feature to be tested
- Purpose of each test segment
- Set-up and conditions for testing
- List of procedures to be followed
- All input and test equipment settings
- Expected results for each test segment
- Pass/Fail acceptance criteria for each test segment
- Descriptions of all simulation tools and techniques used during the test.

Design-Build Services for the Radio System Replacement**Section 7.0****7.4 Test Records**

Complete records of all test results shall be maintained by the Contractor and made available for inspection by the SFMTA or its representative(s) at any time [CDRL 12-7-3 Test Records). In accordance with the Contractor's Quality Assurance Program, the following items shall be included in the test records:

- Reference to the appropriate test procedure
- Test results for each test segment. including a passed/failed indication and any modifications made to the procedures or test setup during the test
- Identification of the Contractor's test engineer and of the SFMTA's representative(s) witnessing the test
- Date and time of the test
- Provision for comments by the SFMTA's representative(s)
- Copies of any variance reports generated
- System documentation including logs. files. configuration description, measurement records. or printouts saved as part of the test.

7.5 Reporting of Test Variances

A Test Variance Report shall be prepared by the Contractor and witnessed/concurred by the SFMTA personnel each time a deviation from specified requirements, test procedures, or the Contractor's design is detected during any formal or informal, factory or field testing, between the start of factory testing and through to final acceptance of the complete system (combined PSVRN and MTMS) [CDRL 12-7-4 Test Variance Reports]. In accordance with the Contractor's Quality Assurance Program, the Test Variance Report shall include a complete description of the variance, including the following items:

- A sequential identifying number assigned to the variance
- The date and time the variance was first discovered
- Variance classification (Class 1, 2, or 3)
- Variance status (open. closed, etc.)
- Appropriate references to the test procedures, technical specifications, or design documentation
- A description of the test conditions at the time the variance was detected
- Identification of Contractor and the SFMTA witnesses
- A sign-off by both the Contractor and the SFMTA when the correction of the variance has been verified.

Each variance shall be assigned to one of the following three classes, depending on its severity and impact on the testing and the system. Variances will be classified by the Contractor with the SFMTA having approval rights:

Design-Build Services for the Radio System Replacement**Section 7.0**

Class 1 Severe variance that prevents, invalidates, or significantly impairs further testing. Testing will stop for immediate evaluation and correction by the Contractor.

Class 2 Significant variance. Testing will continue and the variance will be corrected by the end of the current session or day.

Class 3 Isolated variance that does not impact or invalidate other testing. Testing will continue and the variance will be corrected and tested at a mutually agreed upon time (e. g. at the end of the test, or later in the test period prior to shipment).

7.6 Disposition of Test Variances

The Contractor shall document all actions taken to correct variances. Sufficient information shall be provided in the variance documentation to enable an SFMTA representative to determine the need for retesting the function, for testing interaction with any previously tested function, and for updating appropriate documentation as a result of the corrective action. Variance corrections that would result in a change to an approved document or configuration changes must be approved by the SFMTA prior to implementation by the Contractor.

Variance reports shall be closed when authorized Contractor and the SFMTA representatives acknowledge, by signatures, correction of the variance. The Contractor shall propose a means to securely enable variance documentation, summaries, and reports to be accessible via the Internet by the SFMTA or its representatives.

The Contractor shall maintain a variance summary that lists the following for each variance:

- Variance number
- A brief description of the variance
- Date generated
- Test procedure reference
- Variance class
- Current status
- Date the variance was closed
- A brief description of the resolution of the variance.

The current variance summary shall be published by the Contractor at the completion of each phase of testing, just before a new phase of testing, and/or whenever requested by the SFMTA [CDRL 12-7-5 Test Variance Summary).

7.7 Factory Testing

The following types of tests, as discussed below, shall occur as part of factory testing at the Contractor's and subcontractors' facilities:

- Component/device/module testing
- Individual sub-system testing

Design-Build Services for the Radio System Replacement**Section 7.0**

- Sub-system integration testing.

The following conditions must be satisfied prior to the start of the factory tests:

- All applicable hardware and software engineering design changes shall be incorporated into the PSVRN and MTMS
- PSVRN and MTMS documentation, including drawings, list of deliverables, software functional documents, factory test plans and test procedures, and user manuals shall have been reviewed and approved by the SFMTA
- All action items related to approval documents, system performance, and test simulation techniques shall be resolved.

All testing hardware, software, and special test and calibration equipment required to demonstrate the acceptable operation of the PSVRN and MTMS, including radio communications with the on-board vehicle equipment, communications control features, and simulation of system loading shall be provided by the Contractor. Equipment shall not be substituted by the Contractor during factory tests without prior the SFMTA authorization.

Factory testing shall consist of a Contractor-performed dry run of the factory tests, formal factory testing, and unstructured and/or ad-hoc testing by the SFMTA, its representative(s), or the Contractor.

Written certification that the dry run testing has been successfully completed shall be provided to the SFMTA prior to the start of formal factory testing. All variances that would preclude testing all, or portions of, the formal factory testing shall be corrected by the Contractor prior to the start of formal testing. The SFMTA or its representative(s) shall have the right to review the variances with the Contractor and to determine which variances must be fixed prior to the start of the formal factory testing. The Contractor shall provide the SFMTA with copies of all variances found during the dry run testing.

All radio communications systems tests shall be performed using mobile antennas "over-the-air".

For radio communications systems factory testing at the LMR Contractor's facility, all equipment to be provided shall be included in the test configuration.

As part of MTMS testing, an abbreviated suite of equipment shall be provided but must still include, as a minimum, two trunked voice radio communications channels, one trunking control channel, and two (2) data channels. Testing shall include demonstration of trunked voice and data channel operations.

The factory testing shall include simulation of all AVL functions by equipping a Contractor-supplied test vehicle with a full set of the Contractor-provided revenue vehicle equipment. Both structured and unstructured testing shall be performed using the test vehicle.

The factory tests shall be considered successfully complete only when all tests have been performed, all variances have been resolved to the satisfaction of the SFMTA, all test records have been issued to the SFMTA, the SFMTA approval of all test reports, and the SFMTA acknowledges, in writing, successful completion of the factory testing and authorization to ship the PSVRN and MTMS to the SFMTA.

Design-Build Services for the Radio System Replacement**Section 7.0****7.8 Unstructured Testing**

Periods of unstructured testing shall be permitted during the course of the functional testing to allow the SFMTA representatives to verify the proper operation of the PSVRN and MTSM under conditions not specifically included in the approved test procedures. Unstructured testing of specific functions, features, or operations may be conducted during the course of the structured testing where the unstructured testing does not impact the structured testing. Unstructured testing also shall be allowed at the SFMTA's discretion, both at the end of a structured test segment and after the completion of the functional performance testing. At least one hour of each testing day and up to eight (8) hours at the end of each test segment (e.g. Radio Coverage Acceptance Test, Mini-Fleet Test, Field Performance Test, etc.) shall be designated for unstructured test time. During unstructured tests, the Contractor's test representatives shall be present and available for consultation with the SFMTA representatives. All simulation software and hardware, and other test facilities used during the structured portions of the testing shall be made available for the SFMTA's use during unstructured testing. Unstructured testing will not be conducted during the System Availability Test.

7.9 Integrated System Test Program

The Integrated System Test Program shall consist of the phases listed below, performed in the following order:

1. Component, Device, and Module Testing
2. Individual Subsystem Testing
3. Subsystem Integration Testing
4. Radio Coverage Acceptance Test
5. Field Performance Test
6. Mini-Fleet Test
7. System Availability Test.

7.9.1 Component, Device, and Module Testing

Component, device, and module testing shall include all individual hardware, software and firmware components. As a minimum, testing shall apply to the following equipment:

Fixed Equipment:

- Computer servers - both general and special purpose
- Computer storage equipment - Storage Area Networks (SAN), etc.
- Computer workstations
- Dispatch consoles and other furniture
- Radio Equipment - transmitters, receivers, site controllers
- GPS time base clock
- GPS receivers

Design-Build Services for the Radio System Replacement

Section 7.0

- GPS reference station
- Audio switching equipment
- Monitors, keyboards, printers and other computer peripherals
- Antenna and feed-line equipment - antennae, combiners, multi-couplers, isolators, surge protectors, bi-directional amplifiers, etc.
- Wire and cable
- Equipment racks and enclosures, ladder racks, etc.
- Headsets and footswitches
- Connectors, brackets, braces, other miscellaneous hardware
- Power supplies including uninterruptible power supplies
- Network equipment - switches, routers, wireless access points, media converters, etc.
- Passenger Information signs - Indoor or outdoor LED and LCD displays, sign controllers, etc.
- Computer Aided Dispatch (CAD)/Automatic Vehicle Location (AVL) System
- Digital trunked radio communications system
- Network management system
- Passenger Information System
- All software modules.

Mobile Equipment:

- Mobile Data Terminals (MDT)
- Laptop computers and mounting brackets
- Vehicle Logic Unit (VLU)
- Electronic display signs
- Wire and cable, terminal blocks, and interfaces
- Equipment racks and enclosures
- Brackets and braces
- Power supplies
- Antennas
- GPS receiver
- Radio - mobile transmitters, receivers
- Telephone handset

Design-Build Services for the Radio System Replacement**Section 7.0**

- Handheld and covert microphones
- PA amplifier and speakers
- Switches
- Wireless Local Area Network (WLAN) equipment, air-cards, etc.
- All software modules.

Portable Equipment

- Portable radios
- Batteries
- Accessories - microphones, holsters, antennas, etc.
- All software modules.

7.9.2 Individual Subsystem Testing

Individual subsystem testing shall include all contractor-defined groups of equipment classified as subsystems. The subsystems shall include but not be limited to the PSVRN, MTMS, including all base Intelligent Transportation System components, and any purchased optional equipment. Testing shall include hardware functional tests and tests to verify that all software functional requirements defined in Appendix Twelve (12) "Technical Specifications" and in Contractor (and Sub-Contractor) provided documentation have been met.

7.9.3 Subsystem Integration Testing

As a minimum, subsystem integration tests shall be performed between the following in a factory environment (i.e. not at the SFMTA):

- Individual components of the PSVRN
- Individual components of the MTMS c
- The PSVRN integrated with the MTMS (base and optional components).

Sub-system integration testing may be permitted or progress at the SFMTA sites and facilities upon approval, and/or in cases where SFMTA provided equipment is to be integrated with Contractor's equipment.

Sub-system integration testing shall verify that all features and functions of the integrated PSVRN and MTMS have been properly designed and implemented. The SFMTA staff or representatives shall witness and participate in sub-system integration testing of a fully integrated PSVRN and MTMS, conducted at the Contractor's facility prior to shipment. The following items, at a minimum, shall be tested:

- Operation of all features, modes, devices, hardware, software, firmware, and interfaces
- Testing of all voice and data channel features, network control, network management system, and fault/diagnostic monitoring

Design-Build Services for the Radio System Replacement**Section 7.0**

- Testing of all revenue and non-revenue vehicle functions using actual vehicle radios and equipment
- Testing of AVL functions using a mobile test vehicle and base map
- Verification of all data transfers to and from the MTMS
- Testing of all applications, user interfaces and dialog screens
- Testing of all on-board equipment interfaces, data transfers, and dialog screens
- Testing of all emergency alarm features including monitoring of covert audio
- Simulation of failures and abnormal operating conditions
- Simulation of hardware failures and failover for PSVRN and MTMS components that have backups, are clustered, are distributed, or are redundant
- Verification that spare memory capacity and processor loading requirements have been met
- Verification of device and system recovery from AC and DC power supply failures, over-voltage, and under-voltage
- Verification of accuracy of hardware and software documentation via random checks.

If the SFMTA representatives believe the quantity and/or severity of the PSVRN and/or MTMS variances warrant a restart of any test, the test shall be halted, remedial work shall be performed, and the complete test shall be rerun at a time agreed upon between the Contractor and the SFMTA.

Travel expenses for the SFMTA staff and its representatives shall be reimbursed due to test delays based on severe variances. This shall apply to delays extending beyond one night during a trip or if testing must be stopped and resumed at a later date. Travel expenses shall include hotel, meals, airfare, and ground transportation.

7.9.4 Radio Coverage Acceptance Tests

Radio Coverage Verification Tests

The coverage verification tests are to be performed under full foliage conditions, preferably in the Spring and Summer months.

The preliminary tile or grid maps and associated coverage acceptance field test plan shall be submitted by the Contractor within ninety (90) calendar days after the notice to proceed is supplied by the SFMTA. The SFMTA must be included in the process of selecting test tiles or grids prior to mutually agreeing to the tests.

The SFMTA will submit any deletions or additions that must be included in the Coverage Acceptance Test Plan within thirty (30) calendar days after receiving the preliminary coverage test plan. The final test plan, as well as all grid or tile maps, is considered part of the Final Design Review. This submittal shall incorporate all agreed-upon revisions, as well as those related to the changes made in the final network design. Completion of Final Design Review shall be contingent upon an approved Coverage Acceptance Test Plan [CDRL 12-7-6 Coverage Acceptance Test Plan).

Design-Build Services for the Radio System Replacement

Section 7.0

The Qualified Proposer shall submit a sample Coverage Acceptance Test Plan as part of their proposal [PRL 12-7-1 Sample Coverage Acceptance Test Plan]. A example plan is included in Appendix Seventeen (17). The Qualified Proposer's Sample Coverage Acceptance Test Plan shall be finalized to become the Draft Coverage Acceptance Test Plan, which will become part of the Contract 1240 documents.

The final Coverage Acceptance Test Plan is subject to approval of the SFMTA. Any testing conducted prior to final approval will not be considered valid.

The approach to selecting actual drive routes shall be described and shown on an appropriate map, suitable for use during the test. Test routes and the test evaluation shall emphasize roadways utilized by the SFMTA.

If the system is completed so that coverage testing would take place without full foliage conditions, the Contractor shall propose either to:

- Postpone full system acceptance until testing can be done under full foliage conditions; or
- Test without full foliage, but factoring in agreed-on attenuation factors as degradation of the test results to account for foliage.

If the latter is proposed, the Contractor shall describe in detail how his obligations to fulfill all specification requirements, including coverage reliability, will be met after testing has taken place.

Testing shall be done in both talk-in and talk-out directions. Coverage requirements require that each direction pass the criteria specified, for each device specified (mobile and portable).

The SFMTA staff shall be permitted to participate and/or witness all tests.

For Delivered Audio Quality (DAQ) tests, personnel from the SFMTA and the Contractor will be present to rate the quality of the transmission. The rating will be on a DAQ basis of 0 to 5 as defined in TSB-88, using the phonetically balanced Harvard Sentences.

There are three (3) categories of voice system tests to be performed:

1. Site-Specific Tests for the specific locations listed below:

- Maintenance Facilities
- Tunnels (above ground and below ground)
- SFMTA platforms and ticketing areas (underground and above-ground) n
- SFMTA underground subway service rooms n
- Subterranean areas (Cable Car Machinery).

2. Mobile coverage throughout the Service Area

3. Portable coverage throughout the Service Area

For site specific maintenance facilities, DAQ tests will be made at randomly selected outdoor locations with a portable radio operator walking. A minimum of 50 measurements will be taken per bus yard. The hand held radio will be positioned in a swivel hip-mounted holder. The radio will be tested with the use

Design-Build Services for the Radio System Replacement

Section 7.0

of a speaker/microphone as part of the test equipment configuration. Tests at each location shall meet or exceed coverage requirements specified herein for portable radios.

For site specific tunnels, DAQ tests will be made at randomly selected spots with a portable radio operator standing in a moving subway vehicle. The number of test measurements will be established later. The hand held radio will be positioned in a swivel hip-mounted holder. The radio will be tested with the use of a speaker/microphone as part of the test equipment configuration. Tests at each location shall meet or exceed coverage requirements specified herein for portable radios.

For site specific tunnels, signal strength and Bit Error Rate (BER) measurements shall be made along all underground track-ways at randomly selected track-way locations using the subway vehicle antenna. The number of test measurements will be established later. Tests in each tunnel shall meet or exceed the requirements specified herein for vehicular radios.

For site specific platforms and ticketing areas, DAQ tests will be made at randomly selected spots with a portable radio operator walking. A minimum of 25 measurements will be taken per station platform and per ticketing area (each). The hand held radio will be positioned in a swivel hip-mounted holder. The radio will be tested with the use of a speaker/microphone as part of the test equipment configuration.

Tests at each platform and at each ticketing area shall meet or exceed coverage requirements specified herein for portable radios.

For site specific underground subway service rooms and subterranean areas (Cable Car Machinery), DAQ tests will be made at randomly selected positions at each location with a portable radio operator standing. A minimum of three (3) measurements will be taken per location. The hand held radio will be positioned in a swivel hip-mounted holder. The radio will be tested with the use of a speaker/microphone as part of the test equipment configuration. All tests combined shall meet or exceed coverage requirements specified herein for Cable Car Machinery portable radios. In addition, two out of three measurements at each area shall meet or exceed applicable DAQ requirements.

Mobile Service Area measurements (signal strength, BER and Message Success Rate), and portable Service Area measurements (signal strength, BER) will be performed by traveling throughout the service area. The objective in selecting the routes will be to select test locations that are randomly and evenly located within the service area, and are representative of actual use conditions. This shall be achieved by dividing the service area into grids as described below. Sampling rates within each grid shall confirm to TSB-88 requirements. Resulting measured data shall be median values.

The minimum number of tiles or grids for the mobile and portable signal strength and BER Service Area measurements shall follow. Inaccessible tiles shall be excluded from measurements and calculations. Tile count is based on the following:

95% Required Service Area Reliability

99% Confidence Level

1% Sampling Error Allowance.

Mobile radio coverage tests shall prove to the satisfaction of the SFMTA representatives that the radio system provides reliable communications coverage and performance for two-way voice and data transmission for mobile radios at all outdoor locations throughout the required Service Area previously

Design-Build Services for the Radio System Replacement**Section 7.0**

defined. The mobile radio coverage tests to be performed by the Contractor shall consist of received RF signal level measurements throughout the required Service Area and DAQ.

The tests shall commence after the radio equipment is installed and tested at all of the SFMTA sites. The procedures to be followed during the Radio System Coverage Acceptance Tests shall be developed by the Contractor and submitted to the SFMTA for approval as part of the factory and field test plan and procedure documents.

Voice System Coverage Test Failure

A mobile or portable coverage test shall be considered to have failed if it fails to score as required (both in the site-specific and Service Area tests).

Following failure of a coverage test, the contractor shall take corrective action. This action shall be at no cost to the SFMTA, either for the corrections or for re-testing to verify adequacy of the corrections.

If system design configuration changes or modifications are made to correct inadequate performance, all associated tests that were conducted in areas affected by the change will be repeated.

For the purposes of this test, the Contractor shall have the responsibility to provide the test vehicles and drivers.

At the conclusion of this activity, the Contractor shall present to the SFMTA written certification that the tests performed were in accordance with the approved plan, and that the results in reference to corrective action, have resulted in the passing of the prior failed test locations.

7.9.5 Field Performance Test

The Field Performance Test shall include an integrated PSVRN and MTMS with all purchased options, as installed at the SFMTA.

The Field Performance Test shall be conducted after the integrated PSVRN and MTMS is installed at all of the SFMTA's sites AND successful completion of the Radio Coverage Acceptance Test. The purpose of this testing will be to ensure that the integrated PSVRN and MTMS, as installed in the field and on a single revenue vehicle, works properly as a fully integrated and installed system.

This testing shall encompass the full range of PSVRN and MTMS functionality including all Options purchased and areas of operation that were simulated or only partially tested in the factory and areas where variances were found during factory testing. The SFMTA shall provide on-site support during this test to assist in the testing and to help identify variances. All test variances must be corrected prior to the start of the Field Performance Test. At the successful completion of the Field Performance Test, the radio coverage acceptance tests, and the correction of any resulting variances, the integrated PSVRN and MTMS shall be ready to support the "Mini-Fleet" testing.

7.9.6 Mini Fleet Test

Following the completion of the Field Performance Test and Radio Coverage Acceptance Test, a comprehensive test of the integrated PSVRN and MTMS shall be conducted with a small subset of the SFMTA's fleet. The Mini-Fleet Test is intended to verify proper operation and integration of each of the SFMTA's non-revenue and revenue vehicles with the PSVRN and/or MTMS fixed-end equipment.

Design-Build Services for the Radio System Replacement**Section 7.0**

The mini-fleet will consist of each different bus type, rail vehicle type, cable car, and each different non-revenue vehicle type. These vehicles shall be equipped with all required on-board vehicle equipment including optional equipment purchased. These vehicles shall be operated in actual or simulated revenue or non-revenue service to fully test, at a minimum, the following under actual service conditions:

- Schedule and route adherence
- Automatic Vehicle Location
- Voice communications and data messaging
- Emergency alarm processing
- Real-time traveler information feed
- All other PSVRN and MTMS equipment, functions, and all other options purchased.

This test shall verify that all PSVRN and MTMS components have been supplied, installed, and perform all functions in accordance with their specified requirements. The Mini-Fleet Test vehicles may be operated on a selected subset of the SFMTA's routes, provided these selected routes encompass the entire service area and will allow testing of all the operational and functional conditions expected to be encountered during the service day and throughout the entire service area.

One bus shall be operated on each route to verify proper operation of the Automatic On-Board Traveler Information System.

One bus shall be operated on each route to verify proper operation and specified accuracy for existing traveler information system feed.

The test shall also verify mechanical, electrical, and electromagnetic compatibility with all other existing on-board equipment on all vehicles including farebox, CCTV, vehicle monitoring systems.

This testing will be repeated as necessary until the integrated PSVRN and MTMS is ready to support revenue service for the entire fleet. The SFMTA shall provide on-site support during this test to assist in the testing and to help identify variances.

7.9.7 System Availability Test

The System Availability Test is intended to document that the PSVRN and MTMS can meet its system availability requirements.

Following the Field Performance Test, Mini-Fleet Test, and the placing of the entire vehicle fleet into revenue service under the PSVRN and MTMS, a 720-hour System Availability Test shall be conducted to verify availability requirements. All variances must be corrected, all hardware and software documentation must be delivered, and training received and approved by the SFMTA prior to the start of the System Availability Test.

During the System Availability Test, the complete PSVRN and MTMS shall demonstrate availability as specified in Appendix Twelve (12) Section One (1) of this Specification owing for downtime and hold time as defined below:

Design-Build Services for the Radio System Replacement**Section 7.0**

- Down Time - Downtime occurs whenever the criteria for successful operation defined in Appendix 12 (Twelve) Section One (1) are not satisfied. Down time shall penalize availability and will be measured from the time of failure until full service is restored. In the event of multiple failures, the total elapsed time for repair of all problems shall be counted as downtime.
- Hold Time - Certain events may occur that are beyond the control of both the Contractor and the SFMTA. These events may prevent successful operation of the PSVRN and MTMS but, at the same time, are not valid for the purpose of measuring availability. Such periods of unsuccessful operation may be declared "hold time" by mutual agreement of the SFMTA and the Contractor. Hold time will be availability-neutral, counting neither toward nor against availability and will not be considered in availability statistics. Specific instances of hold time events include scheduled shutdown of equipment, power interruption, or environmental excursion. Periods during which an intermittent, recurring software or hardware failure is experienced will be considered hold time, provided that the Contractor is engaged in remedial action to correct the failure.

In addition the following items will be considered hold time and will not affect measured availability:

1. Preventive maintenance
2. Events in which the contractor responds within 'Service Level' limit as defined in the 0835 document
3. Force Majeure
4. Effects of SFMTA provided equipment failures.

The Contractor will be responsible for conducting the System Availability Test. The SFMTA will operate the PSVRN and MTMS according to procedures described in the approved Contractor documentation. The SFMTA staff shall record details for any system failures within a Contractor-provided form or template.

During the System Availability Test, the Contractor shall provide all maintenance according to the service levels specified in Document 00835 System Warranty and Maintenance of the Supplementary Conditions for the two-year warranty period.

The SFMTA shall reserve the right to require the Contractor to restart the System Availability Test based on test progress, equipment failures, system changes, etc.

After 720 hours of cumulative test time, test records shall be examined to determine if the availability criteria specified in Appendix Twelve (12) Section One (1) have been met. If test objectives have not been met, the test shall continue until the specified availability is achieved.

7.9.8 System Acceptance

Prior to System Acceptance, the Contractor shall demonstrate that the integrated PSVRN and MTMS fulfills all RFP requirements of Contract 1240. Final acceptance shall require, but not be limited to, the following:

- Completion of all facility work, system, component, hardware and software delivery, installation, testing, optimization, phased integration, documentation, and training.

Design-Build Services for the Radio System Replacement

Section 7.0

- Acceptance of facilities, individual systems, and equipment by the SFMTA. Correction of any operational, performance, or workmanship defects shall be at the sole expense of the Contractor.
- Written certification by the Contractor of compliance with the RFP requirements, including Radio Coverage and Acceptance Test results.
- Successful completion of the Coverage Acceptance Test
- Successful completion of the System Availability Test and all pre-requisite testing

Final acceptance of the integrated PSVRN and MTMS shall only occur after:

- Completion of all contractual requirements to the SFMTA's satisfaction
- Successful completion of all tests as determined by the SFMTA acceptance and approval of all test reports
- SFMTA acceptance of all delivered equipment as listed in the Contractor provided hardware inventory
- SFMTA approval of all drawings, manuals, and all other documentation
- SFMTA approval of all CDRL items
- Integration of all revenue vehicle equipment and functionality
- SFMTA approval of PSVRN and MTMS equipment installations at all locations
- SFMTA approval of PSVRN and MTMS equipment installations on all vehicles
- SFMTA approval of all Contractor-provided training
- Correction of all variances
- Final clean-up of all installation sites
- Provision of all source code as determined by escrow requirements specified in Appendix Twelve (12) Section Nine (9).

Upon Conditional Acceptance of the Mini Fleet Test, the SFMTA may derive beneficial use from any or all components of the PSVRN and MTMS. During and prior to final acceptance, the Contractor shall provide maintenance and service as specified in Appendix Twelve (12) Section Eight (8).

7.10 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

PRL 12-7-1 Sample Coverage Acceptance Test Plan.

7.11 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

CDRL 12-7-1 Integrated System Test Plan

CDRL 12-7-2 Test Procedures

Design-Build Services for the Radio System Replacement

Section 7.0

CDRL 12-7-3 Test Records

CDRL 12-7-4 Test Variance Reports

CDRL 12-7-5 Test Variance Summary

CDRL 12.7.6 Coverage Acceptance Test Plan.

The Contractor is advised that the above list does not necessarily constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole, or by reference, as part of the complete package of deliverables and submittals. Any additional CDRLs required will be mutually agreed during the Design Phase.

8.0 TRAINING AND SUPPORT

This section discusses the requirements for training, support, and system maintenance to be provided for the Public Service Voice Radio Network (PSVRN) and Multimodal Transit Management System (MTMS).

8.1 Training

The Contractor shall provide a comprehensive training program that prepares the SFMTA and City and County of San Francisco (CCSF) staff for operation, general support, preventive and corrective maintenance of all radio communication equipment, vehicle installed equipment, the base MTMS system, the base PSVRN system, and all optional components purchased. Training may be conducted by the Contractor, Contractor's Subcontractors, third-party suppliers, or original equipment manufacturers.

In response to the RFP, the Qualified Proposer shall fully describe the training program to include, as a minimum, classroom style instruction, operational style classes, a detailed training plan, session duration, description of available training material, and resumes of potential course instructors [PRL 12-8-1 "Training Program Description"]. As part of PRL-12-8-, Training Program Description, the Qualified Proposer shall indicate which courses will require Subcontractor instruction, and the names, contact information, and references of Subcontractors that the Proposer expects to execute this training.

The Contractor shall submit to the SFMTA a comprehensive training plan based on the requirements discussed in this section, [CDRL 12-8-1 Training Plan]. The Contractor shall periodically submit to SFMTA comprehensive training reports including staff enrolled, attending, and successfully completing all aspects of the Training. [CDRL 12 8-4 Training Reports]."

8.1.1 Dispatcher Training

The Contractor shall provide Dispatcher training in the use of the PSVRN dispatch console and MTMS workstations. This course shall provide a thorough understanding of the user interface, startup, and operation, general design, systems concepts and features, and error messages. Training shall be provided for the base system and all options purchased.

8.1.2 Vehicle Operator Instructor Training

The Contractor shall provide training for the SFMTA vehicle operator instructors for each type of vehicle. Training shall include a thorough understanding of operation and user interface of all vehicle installed equipment, including general system design concepts and features. Training shall include hands-on training using the actual hardware and software being delivered to the SFMTA.

Training shall be organized by vehicle type, including distinct training for rubber-tire vehicles, light rail vehicles, historic vehicles, cable cars, and non-revenue vehicles.

The Contractor shall provide each user laminated "quick-start" guides (preferably pocket-sized) instructing the user on the proper use of the equipment in operational circumstances.

8.1.3 Vehicle Operator Training Hardware

To assist in efficiently and effectively training SFMTA's diverse group of vehicle operators, the Contractor shall provide equipment in desktop enclosures for classroom use.

Design-Build Services for the Radio System Replacement**Section 8.0**

The Contractor shall provide the following on-board vehicle equipment for training vehicle Operators and other staff on the proper use and operation at SFMTA's training facilities:

Ten (10) sets of training equipment for training bus Operators

Two (2) sets of training equipment for training Light Rail Vehicle Operators

Two (2) sets of training equipment for training non-revenue vehicle operators.

Each set of the training equipment shall be mounted within a rigid frame, equipment box, or enclosure suitable for placement on a desktop and for use by the personnel being trained. The training equipment shall be fully operational and shall be identical to the equipment being provided and installed by the Contractor in SFMTA's vehicles. The equipment shall interconnect to the MTMS and PSVRN central systems using an over-the-air connection to the trunked radio and data systems. The equipment shall provide both voice and data messaging functionality, identical in operation to that provided on the revenue and non-revenue vehicles. The equipment shall include the necessary power conversion equipment to operate from a standard 120VAC outlet.

One (1) set of bus and one (1) set of light rail vehicle training equipment shall be tested as part of the factory acceptance testing. All equipment shall be delivered to the SFMTA four (4) weeks prior to performing the vehicle operator training.

8.1.4 Radio Communications Subscriber Unit Training

The Contractor shall provide instructor training on radio system subscriber unit operation, using both the MTMS and PSVRN functionality, including an overview of the system. The Contractor's training on radio operations shall include training in orientation, management, and operation of all subscriber equipment provided including:

- Mobile radios
- Portable radios
- Desktop consoles
- Control stations
- All accessories
- Alternative support systems, diagnostic systems, specialized equipment for system monitoring, etc. as displayed at the dispatch console.

The training shall be designed so that upon completion, the student shall be qualified to train system end users on the operation of the equipment.

The Contractor shall provide each user laminated "quick-start" guides (preferably pocket-sized) instructing the user on the proper use of the equipment in operational circumstances.

8.1.5 LMR Network Management System Training

Separate training shall be provided for the radio communications system (LMR) Network Management System. Training shall include system orientation and familiarization, including discussion and equipment demonstration. The Contractor shall conduct comprehensive classroom console operator

Design-Build Services for the Radio System Replacement**Section 8.0**

training for the communications personnel operating the new LMR Network Management System (NMS) in two separate sessions:

- Session 1 shall be conducted in a classroom environment, using training aids, and a model of the SFMTA's LMR NMS environment, including all components for both the MTMS and PSVRN
- Session 2 shall also be conducted using operational NMS console equipment on the live system.

Training shall be conducted on-site during system optimization. The training schedules shall be arranged and conducted with each student attending Sessions 1 and 2 (once as a minimum).

8.1.6 General Network Management System Training

The Contractor shall provide training for all network management components provided, in addition to that provided for the LMR equipment (Section 8.1.5). The course content shall include the following, as a minimum:

- Documentation structure, numbering system, and configuration control system
- Block diagram and system description
- Installation documentation
- Use of software applications
- Trouble diagnosis to module level
- Troubleshooting techniques
- Adding future components to be monitored
- Operation and administration of network security and configuration management utilities
- Database management.

8.1.7 System Administration Training

This course shall provide training on all of the procedures necessary to configure, operate, and maintain the PSVRN, MTMS, and all other purchased options (with the exception of the radio communications system discussed below) in an efficient, controlled, and well-documented manner. These courses shall include, as a minimum, training in:

- System database structure, content, organization, and maintenance
- Computer server system administration for all installed applications
- System backup procedures
- System restoration and disaster recovery procedures
- Installing software updates provided by the Contractor or third-party software suppliers
- Periodically updating the schedule and other data that is imported into and/or exported from the system

Design-Build Services for the Radio System Replacement**Section 8.0**

- Managing all other system interfaces including those to Trapeze, 511.org, farebox,
- Interpreting and responding to messages generated by all error-monitoring software
- System administration for all options purchased
- Report generation and development
- Incident form development
- System user security access including management of user roles and responsibilities.

8.1.8 Radio System Maintenance Training

The Contractor shall provide separate maintenance level factory certified training for the SFMTA and CCSF technical staff for all PSVRN and MTMS radio communications components and equipment.

Training shall include system orientation, management, operation, and maintenance of all system infrastructures and associated system equipment provided.

The training shall include education On the theory of operation, preventive maintenance, and corrective maintenance procedures for the entire system infrastructure and all systems contained therein.

The training shall be designed so that upon completion, a technician will be qualified to perform all levels of installation and setup, optimization, phasing, troubleshooting, and maintenance of the system to the removable component level.

The Contractor shall permit the SFMTA and CCSF staff to videotape maintenance and alignment procedures performed on equipment.

The course content shall include the following, as a minimum:

- Use of diagnostic software and tools
- Use of alarm monitoring equipment
- Documentation structure, numbering system, and configuration control system
- Block diagram and circuit description-all units
- Installation and turn-on procedure
- Alignment, phasing, and testing procedure
- Trouble diagnosis to unit and board level
- Unit replacement procedure
- Operating and safety
- Traffic continuity procedures.

8.1.9 Vehicle Equipment Maintenance Training

The Contractor shall train selected the SFMTA staff to be qualified instructors in the maintenance of vehicle equipment. Training shall include, for revenue and non-revenue vehicle types, as a minimum:

- System overview

Design-Build Services for the Radio System Replacement**Section 8.0**

- Vehicle review (installed operational vehicle)
- Maintenance manual layout and installation drawings
- Vehicle equipment descriptions including all individual components
- Descriptions of vehicle interfaces
- ITS equipment overview
- Radio, VLU, and MDT programming
- Radio and ITS options maintenance
- Diagnostics, troubleshooting, and adjustments
- Simulated troubleshooting
- Vehicle on board equipment interface maintenance
- Return material authorization procedures.

8.1.10 Training of Other System Users

The Contractor shall review the SFMTA's and CCSF's organization and include plans for all other SFMTA and CCSF system user including, as a minimum, staff from:

- Administration
- Customer Service (SFMTA and CCSF 311 staff)
- Safety and Security
- Planning.

8.1.11 Training Schedule

The Contractor shall schedule and provide the training courses as appropriate for the overall project schedule and shall coordinate with the SFMTA to schedule training [CDRL 12-8-2 "Training schedule"]. Training shall be "just in time" so that there is not an extended gap between training execution and system implementation.

The Contractor shall develop a training schedule in consultation with the SFMTA after Contract Award. The training schedule shall include all the SFMTA shifts (e.g. day, swing, and grave) and coincide with the actual SFMTA hours for these shifts. For each course, the following requirements shall apply:

- The Contractor shall provide a list of course objectives and core competency skills for each training session at least 90 days in advance of the first scheduled session
- Whenever possible, the training should be conducted with substantial hands-on involvement using the SFMTA's systems and equipment
- The Contractor shall train the SFMTA employees, Contractors, or the other SFMTA and CCSF designees on the premises or other such locations approved by the SFMTA, unless otherwise specified.

Design-Build Services for the Radio System Replacement

Section 8.0

As part of their work scope, the Contractor shall include 20% of training hours held in reserve to address problem areas experienced during operation and maintenance, or as a result of system changes based on updates, or warranty actions.

8.1.12 Training Location

With the exception of radio system maintenance training, all training shall be conducted at the SFMTA facilities. If the Contractor determines that a particular training course must be conducted elsewhere, the Contractor must demonstrate need and receive SFMTA approval.

The SFMTA will attempt to provide classroom facilities for all training conducted at a SFMTA facility. If such facilities are not available, the SFMTA shall request that the Contractor arrange other suitable facilities within the City of San Francisco, at the SFMTA's expense, subject to prior written review and approval.

8.1.13 Class Size

The Contractor shall provide training for the following SFMTA personnel:

Course	Maximum Participants
Dispatcher Training	40
Vehicle Operator Instructor Training	12
Radio Communications Systems Operational Training	30
LMR Network Management	12
System Administration Training	24
Radio System Maintenance Training	15
Vehicle Equipment Maintenance Training	20
Other System Users	30

For radio system maintenance training, the Contractor shall provide:

- Round trip transportation from San Francisco to the LMR system provider's training location, including all transfers

Design-Build Services for the Radio System Replacement**Section 8.0**

- Hotel accommodations
- Federal per diem allowance for meals and incidental expenses in the host city.

The SFMTA and CCSF staff shall be able to attend this training separately in order to minimize disruption of service and operations.

8.1.14 Training Manuals and Equipment

The Contractor shall prepare training manuals and agendas for each training course [CDRL 12-8-3 "Training Manuals and Agendas"]. These manuals and agendas shall be submitted to the SFMTA for review sixty (60) days prior to the start of classroom instruction. Principal collateral used for training shall be tailored to reflect all of the SFMTA's specific hardware, software, terminology, and user requirements. Reference manuals, maintenance manuals, and user's manuals may be used as supplementary training material but not as the primary training manual.

Upon completion of each course, instructor's manuals, training manuals, and training aids shall become the property of the SFMTA. As part of the delivered system documentation and the final documentation, the Contractor shall supply the SFMTA with all changes and revisions to the training manuals and other training documentation, through completion of the warranty period. The SFMTA reserves the right to copy and distribute all training manuals and aids for use in the SFMTA and CCSF conducted training courses.

The Contractor shall furnish for use during training courses all special software, equipment, training aids, and any other materials required to train course participants. The number of training manuals, special tools and other training equipment shall be adequate for the number of participants attending each course. Training documentation shall be submitted in accordance to the documentation requirements in Appendix Twelve (12) Section Nine (9). For each course, the following training materials shall be used:

- Training aids (e.g., videos, system diagrams, training manuals, mockups) showing functionality
- The Contractor shall provide one set of manuals per student plus an additional six sets of manuals
- All manuals shall be provided as an editable Microsoft Word document accompanied by a searchable Adobe Acrobat PDF document
- Six CD ROM copies of training documentation shall be supplied.

There shall be no restrictions or licensing requirements for the SFMTA's or CCSF's use of vendor provided reference or training information when used for the SFMTA or CCSF training purposes.

In addition to specific coverage requirements stated within each course, training shall include system orientation and familiarization, including discussion and equipment demonstration.

8.1.15 Shadowing

SFMTA staff shall be permitted to accompany (shadow) the Contractor while performing maintenance activities. The Contractor shall give timely notification when and where maintenance activities occur so

Design-Build Services for the Radio System Replacement**Section 8.0**

CCSF and SFMTA staff can be assigned. Shadowing shall be conducted at the CCSF and STMA's discretion, and may not be proposed as substitute in place of training classes as required.

8.2 System Support Services

Throughout the design, implementation, testing, and field installation phases of the project, the Contractor shall supply all engineering data and services, as required by the SFMTA. The Contractor shall provide support regarding the necessary site preparations, communication facilities, field installation of equipment, system cutover, and solutions to technical problems. These support services shall apply to all components provided for the PSVRN, MTMS, all optional equipment purchased, all interfaces, all software, and operational requirements.

8.2.1 System Setup

With the SFMTA's support and input, the Contractor shall be responsible for initially setting up the system and for entering or loading all the required data into the devices and systems, including but not limited to the following:

- Defining and setting up the hardware and software configurations
- Defining and configuring the user accounts, roles, and security permissions
- Defining and configuring all data required for system databases
- Defining and configuring the routing of CAD event queue entries
- Defining and configuring the canned mobile data terminal messages
- Successfully importing all schedules and route definitions from the SFMTA's Trapeze scheduling system
- Setting the initial values for all user-adjustable parameters
- Entering all radio communications parameters
- Configuring all network devices for security and accessibility
- Configuring all interface parameters
- Importing all Radio Dispatcher reference information and procedure files
- Setting the initial schedule and route deviation reporting thresholds
- Installing the latest update of the GIS database
- Verification of the SFMTA bus stop geo-coding data.
- Defining and configuring all other data necessary for a functional MTMS and PSVRN.

8.2.2 System Packaging and Shipment

The Contractor shall pack, crate, or otherwise suitably protect all equipment to withstand shipment to the appropriate the SFMTA and CCSF locations. Packing methods shall meet or exceed manufacturer's recommendations. Equipment shall be shipped assembled and completely wired wherever possible.

Design-Build Services for the Radio System Replacement**Section 8.0**

The size and nature of available doors, stairways, elevators, and other passageways with access to the SFMTA and CCSF sites where equipment is to be installed shall be verified by the Contractor. Shipping instructions and plans shall be developed according to these inspections. The equipment shall be shipped and moved into place without requiring modification or alteration to any building.

All equipment shall be shipped F.O.B. to the specified the SFMTA or CCSF location. The Contractor shall provide a contact list to the shipper or coordinate with the SFMTA Project Manager. Contractor shall bear all risk of loss or damage for all equipment at all times during shipment and installation.

Each package, crate, or part shall be clearly marked with the name of the recipient, shipping destination, the SFMTA contract number, and other such markings as appropriate. Complete packing lists shall be supplied showing the contents and identity of each package. One copy of the list shall be securely attached to the outside of each shipping unit. The Contractor shall send another copy of the list to the SFMTA's Project Manager prior to delivery.

The equipment shall be shipped to addressees designated by the SFMTA. The SFMTA shall be notified by the Contractor two (2) weeks prior to any shipment and again forty-eight (48) hours prior to arrival of equipment. Equipment shall be delivered during times mutually agreed upon by the SFMTA and the Contractor unless prior approval has been granted by the SFMTA.

Upon delivery of equipment at a specified the SFMTA location, the SFMTA will undertake a visual inspection of delivered equipment. The SFMTA will issue a notice of receipt for all delivered equipment. This notice shall not constitute acceptance of any equipment but shall only indicate that delivery has been accomplished.

Insurance covering full replacement value on all deliverables shall be obtained and maintained by the Contractor during shipment, unloading, unpacking, and setup at the SFMTA and CCSF premises.

8.2.3 Spare Parts

The Contractor shall provide the following spare parts as listed in the "Cost Proposal Form" (Appendix Twenty-Eight (28)):

- Spare on-board Automatic Vehicle Location (radio, VLU, MDT, etc.) equipment for revenue vehicles
- Spare on-board digital voice announcement equipment for revenue vehicles
- Other required on-board vehicle equipment
- Other spare parts as specified.
- Spare parts shall include the same level of warranty and support specified in Document 00835 Warranty and Maintenance of the Supplementary Conditions.

8.2.4 Spare Parts End-of-Life

If at any time, the Contractor, or supplier to the Contractor, plans to discontinue manufacturing any of the on-board devices provided to the SFMTA, the Contractor shall notify the SFMTA accordingly. The SFMTA shall have the opportunity to purchase any of the spare parts that are being discontinued that the SFMTA requires for the PSVRN and/or MTMS.

Design-Build Services for the Radio System Replacement

Section 8.0

8.2.5 Long Term Material Support

The Contractor shall warrant support in the form of replacement parts for the Contractor's mobile and portable equipment for a minimum of ten (10) years from the last date of manufacture of the product, and for a minimum of ten(10) years from the last date of manufacture on all other Contractor provided equipment. If the identical replacement part is no longer available, the Contractor's support shall include providing of replacement parts that are form/fit/function compatible with the existing system configuration.

Technology refresh of computer server network equipment that will have less than the required ten (10) year life from end of manufacture shall be identified along with a replacement schedule.

8.2.6 Test Equipment and Software

The Contractor shall provide all special test equipment, instrumentation, cable harnesses, break-out boxes, software, etc. The Contractor shall also provide two (2) radio communications service monitors of the SFMTA's choosing capable of supporting the new radio system technologies being utilized.

8.2.7 System Parts List

The Contractor shall provide a list of all system parts and components in machine readable form (MS-Excel, CSV, etc.). The list shall include, as a minimum, part description, type, manufacturer, version, and unique Contractor's part number. [CDRL 12- 8-5 System Parts List]

As part of the allowance items specified in Appendix 28 Cost Proposal Form, the Contractor shall provide as-needed support to SFMTA staff populating the Spear maintenance management system with the parts list."

8.3 System Maintenance

At all times prior to System Acceptance, the Contractor shall be fully and solely responsible to ensure that the PSVRN and MTMS meets all requirements of these specifications, and for all system maintenance as defined below to meet the system availability requirements specified in Appendix Twelve (12) Section One (1).

All non-conforming or defective equipment shall be immediately repaired or replaced to the SFMTA's satisfaction, according to the Contractor's QA Program Plan.

8.3.1 Two Year Warranty

The Contractor shall be responsible for maintenance of the PSVRN and MTMS during the two (2) year warranty period. The two (2) year warranty period shall begin upon System Acceptance of the entire system by the SFMTA and extend for two (2) years following System Acceptance.

The following level of service shall be provided during the two (2) year warranty period:

System Element	Service Level
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System Element	Service Level
<p>All Contractor-provided mobile and portable hardware and software</p>	<p>Daily on-site support during SFMTA's normal business hours.</p> <p>Remote technical phone support shall also be available Monday through Friday during SFMTA's normal business hours.</p>
<p>All Contractor-provided fixed equipment and hardware including but not limited to base stations, site controllers, NMS, antenna systems, power supplies, computer servers, and network equipment.</p>	<p>Four (4) hour on-site response, twenty-four (24) hours per day, seven (7) days per week, 365 days per year.</p> <p>Remote technical phone support shall also be available Monday through Friday during SFMTA's normal business hours.</p>
<p>Fixed equipment software including but not limited to application software, database management systems, security software, and NMS.</p>	<p>Four (4) hour on-site response, twenty-four (24) hours per day, seven (7) days per week, 365 days per year.</p> <p>Remote technical phone support shall also be available Monday through Friday during SFMTA's normal business hours.</p>

Qualified Proposers are required to quote warranty support to the levels described above. Qualified Proposers may recommend, as part of their submittal, additional alternative maintenance approaches

Design-Build Services for the Radio System Replacement**Section 8.0**

based on their experience deploying systems similar in size and technology to that required by the SFMTA.

8.3.2 Extended Support Program

As an Optional Service, Qualified Proposers shall offer pricing for three subsequent years for an Extended Support Program taking affect after the end of the two (2) year warranty period. Prior to the end of the two (2) year warranty period, the SFMTA may, at its discretion, enter into discussions with the Contractor to provide coverage on a portion or all of the equipment provided under the Extended Support Program. Unless otherwise specified, Qualified Proposers shall assume that each year of the Extended Support Program will provide the same level of service as the Two Year Warranty specified above.

8.4 SFMTA Provided Project Space

The SFMTA will likely be able to provide space within the Muni Metro East facility to enable the Contractor to place up to four (4) 40-foot steel storage ("Conex" style) containers and a construction trailer to store equipment and tools. In such case, it will still be the Contractor's responsibility for provisioning and paying for power and telecommunications connectivity to their trailer and containers. If required, the SFMTA will work with the Contractor to facilitate connection of power and telecommunications service.

8.4 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

PRL 12- 8-1 Training Program Description

8.5 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

CDRL 12-8-1 Training Plan

CDRL 12-8-2 Training Schedule

CDRL 12-8-3 Training Manuals and Agendas

CDRL 12-8-4 Training Reports

CDRL 12-8-5 System Parts List

The Contractor is advised that the above list does not necessarily constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole, or by reference, as part of the complete package of deliverables and submittals. Any additional CDRLs required will be mutually agreed during the Design Phase.

9.0 TECHNICAL DOCUMENTATION

The Contractor shall provide complete documentation for the MTMS and PSVRN. Each document shall be identified by a Contractor document number and the SFMTA Contract No. 1240. Where a document is revised for any reason, each such revision shall be indicated in accordance with the Contractor's Quality Assurance procedure for design and change control.

Documents shall be submitted in accordance with the Contractor's Quality Assurance procedure for document control. Preliminary and draft electronic copies of all documents shall be submitted to the SFMTA in "MS-Office" format for commenting, proposed changes, corrections, etc. Final copies of all documents shall be provided to the SFMTA in MS-Office and Adobe Portable Document Format (PDF). Copies of documents or drawings scanned to/saved as PDF format only will not be acceptable (documents must be editable and searchable).

As a minimum, the following documentation shall be provided.

9.1 System Functional Description Document

A System Functional Description Document (SFDD) shall be provided that contains a high-level definition of the specific hardware, software, firmware, interfaces, and the functions performed by each [CDRL 12-9-3 System Functional Description Document]. The SFDD shall serve as a complete introduction to the MTMS and PSVRN and to the more specific hardware and software documents below. The following information, as a minimum, shall be included in the SFDD:

- An overview of the hardware configuration showing all major hardware subsystems. The overview shall include block diagrams in sufficient detail to show the interrelationships of major hardware subsystems and the elements that comprise them.
- A description of the major hardware subsystems, the elements that comprise them, their interrelationships, and the functions they perform. Major requirements imposed on the configuration such as system availability, processor performance, spare mass storage, and device redundancy shall be described.
- An overview of the major software subsystems describing the software, the interrelationship of software within a subsystem, and the relationship between subsystems. High-level software subsystem block/flow diagrams shall be included to enhance the reader's understanding of the overall capabilities of the MTMS and PSVRN. The subsystems to be described shall include, as a minimum, the Computer Aided Dispatch, Automatic Vehicle Location, radio communications system, operating system, network backhaul, network software, system interfaces, system security, historical storage, support utilities, database, map, interfaces, and report generation. Descriptions for all purchased options shall also be included in this document.

A complete description of the software and the individual functions performed by the software shall be provided. Significant features, concepts, and algorithms pertaining to each function shall be described with special emphasis on equipment, software, and features unique to the MTMS and PSVRN.

9.2 Hardware Documentation

Documentation for all supplied hardware shall be provided. In addition to the documentation specifically identified below, the Contractor shall provide the SFMTA with all documentation originally supplied with standard OEM hardware devices purchased from others.

Hardware Inventory, Floor Plans, and Wiring Diagrams

The following items shall be provided by the Contractor:

- Inventory of all hardware to be supplied, including the manufacturer's name, model number, serial number, name plate data, overall dimensions, and quantities [CDRL 12-9-4 Hardware Inventory]
- An inventory of all hardware documentation. The Contractor shall maintain the inventory list through final acceptance of the system [CDRL 12-9-5 Hardware Documentation Inventory]
- Detailed installation wiring and cabling diagrams. Any special precautions associated with cabling shall be clearly identified. All cable and wiring terminations shall be shown on drawings, and all terminal markings, cable connector markings, and cable lengths shall be clearly indicated [CDRL 12-9-7 Installation Wiring and Cable Diagrams].

Site Preparation Manuals

To supplement the detailed site drawings, physical planning and site preparation manuals shall be provided for all hardware [CDRL 12-9-8 Site Preparation Manuals]. The manuals shall contain, but not be limited to:

- Site floor plans indicating rack, cabinet, console, and peripheral device locations and sizes for each fixed radio site, bus yard, and the Lenox Way Operations Control Center [CDRL 12-9-9 Site Floor Plans]. The locations and sizes of all equipment to be mounted in each rack, cabinet, and console shall be identified.
- Drawings of all racks, cabinets, enclosures, consoles, computer, and communications equipment
- Mounting details, clearance requirements, and environmental restrictions
- Antenna alignment details
- Electrical power supply requirements
- Heat dissipation specifications
- Device installation requirements.

Radio System Technical Data

The Contractor shall provide the Radio System technical data as specified in Appendix Twelve (12) Section Two (2).

Reference and Instruction Manuals

Reference and instruction manuals shall be provided for all hardware [CDRL 12-9-10 Hardware Reference and Instruction Manuals]. Hardware user manuals shall be provided where applicable. These manuals shall include documentation relating to hardware, including descriptions, specifications, theory of operation, installation information, and drawings. The Contractor shall include an attachment to each document outlining those portions of the document, if any, that do not apply to the SFMTA's hardware.

Maintenance Manuals

Manuals and other descriptive material shall be provided for all Contractor-provided equipment, regardless of whether the equipment is manufactured by the Contractor or another supplier [CDRL 12-9-11 Maintenance Manuals]. This documentation shall include descriptions, specifications, theory of operation, printed circuit module schematics, layout drawings (showing component types and positions), motherboard schematics (showing inter-module connections), back-panel and assembly wiring diagrams, pin lists, and other electrical, electronic, and mechanical hardware data.

Instructions shall be provided for preventive and corrective maintenance procedures that include examinations, tests, adjustments, and periodic cleaning. The manuals shall provide guidelines for isolating the causes of hardware malfunctions and for localizing faults.

Complete parts lists and breakdowns with sufficient descriptions to identify each field-replaceable component shall be provided.

9.3 Diagnostic Program Manuals

Diagnostic program users manuals shall be provided with complete instructions on the loading and operation of all hardware and software diagnostic programs required for the equipment to be maintained by the SFMTA and City and County of San Francisco (CCSF) staff [CDRL 12-9-12 Diagnostic Program Manuals]. The text shall include guides for locating faults, symptoms, possible causes of trouble, and suggested remedial action. Sample printouts shall be included from the diagnostic programs, along with their explanations.

9.4 General Software Documentation

Documentation for all supplied software shall be provided to the SFMTA [CDRL 12-9-13 Software Documentation]. Software documentation shall include an inventory of all software documents, to be maintained by the Contractor through final acceptance of the complete MTMS and PSVRN systems.

Existing documentation and user manuals for third-party standard software shall be provided. Standard software is defined as field-proven software purchased from third-parties or software developed internally as a base for all projects, that fully satisfies the requirements of this Specification without modification for the SFMTA. Typical examples include operating systems, compilers, software development utilities, software diagnostic programs, network managers, interface specifications, web services, XML schema and definitions, and window managers.

9.5 Software Functional Requirements Document

A Software Functional Requirements Document shall be provided covering each MTMS and PSVRN function [CDRL 12-9-14 Software Functional Requirement Document]. It shall contain the following information for each software function:

- An introduction describing the purpose of the function with references to other documents to aid the reader's understanding of the functions performed
- A complete description of the function
- A complete description of the algorithms, operation, and the data and logic interfaces with other functions.

9.6 Program Source Code

The Contractor shall provide a machine-readable copy of all source code, installers, and executable files developed for the SFMTA [CDRL 12-9-15 Program Source Code]. Source code and executables shall also be provided for interfacing the MTMS and PSVRN to other SFMTA and CCSF systems and for all displays and reports developed specifically for the SFMTA. The machine-readable files provided shall contain all the data required to enable the SFMTA to restore, reinstall, add, modify, or delete the SFMTA specific applications, displays, reports, and interfaces to other systems.

For the remainder of the software and firmware, the Contractor shall provide an escrow agreement that guarantees the SFMTA access to the source code and other files of the software and firmware should the Contractor be unwilling or unable to perform future system software/firmware maintenance or modifications required by SFMTA [CDRL 12-9-16 Software Escrow Agreement].

9.7 Database Documentation

Database documentation shall be provided that describes the structure of the MTMS and, if applicable PSVRN relational database server databases [CDRL 12- 9-17 Database Documentation]. The documentation shall define the individual elements (files, records, fields, and tables) that comprise the interrelationship of elements in different sub-databases. Portions of the database developed specifically for the PSVRN and MTMS shall be identified. The Contractor shall provide user documentation for the database management system or database access routine utilized by the Contractor. A database dictionary shall also be provided [CDRL 12-9-18 Database Dictionary].

9.8 PSVRN and MTMS User Manuals

Separate PSVRN and MTMS User Manuals shall be provided that contains detailed operating instructions and procedures to be used by all the SFMTA and CCSF users [CDRL 12-9-19 PSVRN User Manual] [CDRL 12- 9-20 MTMS User Manual]. The PSVRN and MTMS User Manuals shall include a description of the operation of the PSVRN and MTMS (hardware, software and radio equipment) as it relates to the user's tasks.

The PSVRN and MTMS User Manuals shall be customized for the SFMTA and shall be based on the delivered system configuration. It is not acceptable to describe the Contractor's standard system and then identify differences between the standard and delivered systems. The PSVRN and MTMS User Manuals shall not include standard or optional descriptions that do not apply to the delivered PSVRN, MTMS and/or their options.

The PSVRN and MTMS User Manuals shall describe each function and how it is to be used. Procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be adjusted, and the effects obtained by varying each parameter. All user guidance and error messages shall be described, along with the steps necessary to recover from errors.

The PSVRN and MTMS User Manuals shall include a copy of each type of display and report used along with a description of each data field. User instructions for each display shall be provided.

The PSVRN and MTMS User Manuals shall describe procedures to be followed as a result of computer system restarts, failures, and failovers, and failures of elements of the radio system. The PSVRN and MTMS User Manuals shall have sufficient information to guide users on how to restart and reconfigure each system and subsystem.

9.9 Revenue Service Operator Manuals

The Contractor shall provide revenue service Operator Manuals for each type of vehicle (rubber-tire, light rail vehicle, historic vehicle, etc.) that contains detailed operating instructions and procedures on all of the Contractor-provided equipment to be installed on-board the SFMTA's revenue vehicles [CDRL 12-9-21 Revenue Service Operator Manuals]. Information in the manual shall be presented in terms that are meaningful to the Operators. The operation of the equipment shall be explained as it relates to each of the Operators' tasks.

All of the features and functions of the equipment installed in the vehicle, including options, shall be explained in the manual. The Operator Manuals shall be customized for the SFMTA and shall be based on the delivered equipment. It is not acceptable to describe the Contractor's standard equipment and then identify differences between the standard and delivered equipment. Procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be entered, and the effects obtained by varying each parameter. All user guidance and error messages shall be described, along with the steps necessary to recover from errors.

The final Revenue Service Operator Manuals shall be delivered to the SFMTA at least three weeks prior to the start of Operator training courses.

The Contractor shall also provide quick-guides for each type of revenue service vehicle, laminated, in half-sheet format.

9.10 Field Supervisor Manual

The Contractor shall provide a Field Supervisor Manual that contains detailed operating instructions and procedures on all of the Contractor-provided equipment to be installed in Field Supervisor vehicles [CDRL 12-9-23 Field Supervisor Manual]. Information in the manual shall be presented in terms that are meaningful to the Field Supervisor personnel. The operation of the equipment shall be explained as it relates to the Field Supervisor tasks.

All of the features and functions of the equipment installed in the Field Supervisor vehicles shall be explained in the manual. The Field Supervisor Manual shall be customized for the SFMTA and shall be based on the delivered equipment. It is not acceptable to describe the Contractor's standard equipment and then identify differences between the standard and delivered equipment. Procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be

entered, and the effects obtained by varying each parameter. All user guidance and error messages shall be described, along with the steps necessary to recover from errors.

The final Field Supervisor Manuals shall be delivered to the SFMTA at least three weeks prior to the start of the Field Supervisor training course.

9.11 Non-Revenue Vehicle Manual

The Contractor shall provide a Non-Revenue Vehicle Manual that contains detailed operating instructions and procedures on all of the Contractor-provided equipment to be installed in Non-Revenue vehicles [(CDRL 12-9-23 Non-Revenue Vehicle Manual)]. Information in the manual shall be presented in terms that are meaningful to the Non-Revenue vehicle operators. The operation of the equipment shall be explained as it relates to the Non-Revenue vehicle tasks.

All of the features and functions of the equipment installed in the Non-Revenue vehicles shall be explained in the manual. The Non-Revenue Vehicle Manual shall be customized for the SFMTA and shall be based on the delivered equipment. It is not acceptable to describe the Contractor's standard equipment and then identify differences between the standard and delivered equipment. Procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be entered, and the effects obtained by varying each parameter. All user guidance and error messages shall be described, along with the steps necessary to recover from errors.

The final Non-Revenue Vehicle Manuals shall be delivered to the SFMTA at least three (3) weeks prior to the start of the Non-Revenue Vehicle operator training course.

9.12 System Administrator Documentation

User-oriented system documentation shall be provided to guide the SFMTA and CCSF personnel [in the operation and procedures required to maintain and update the MTMS and PSVRN, including system software and firmware, database, application software, and other system elements [CDRL 12-9-24 PSVRN System Administration Documentation] [CDRL 12-9-25 MTMS System Administrator Documentation]]. System Administrator documents shall be provided for the following items, as a minimum:

- Software code management
- Programming language compilers and assemblers
- Network communications management
- System performance monitoring and tuning
- System restart failover management and diagnostic procedures
- System management Database management
- Report generation and management
- GIS management
- Diagnostic programs
- Software utilities

System restoration, rebuilding, and disaster recovery

System backups

All third-party and OEM software and utilities

Other Contractor-supplied system software not included above.

The MTMS and PSVRN System Administration Manuals shall contain separate appendices for each option purchased.

9.13 Test Documentation

Documentation for all factory, field, and availability tests shall be provided in accordance with the requirements defined in Appendix Twelve (12) Section Seven (7).

9.14 Training Documentation

Training documentation shall be provided in accordance with the requirements defined in Appendix Twelve (12) Section Eight (8).

9.15 Radio Dispatcher User's Manual

A MTMS and PSVRN Radio Dispatcher's Manual shall be provided that contains detailed operating instructions and procedures to be used by the dispatcher personnel [CDRL 12-9-26 PSVRN Radio Dispatcher Manual] [CDRL 12-9-27 MTMS Radio Dispatcher Manual]. This Dispatcher Manuals shall include a description of the operation of the PSVRN and MTMS (hardware, software and radio equipment) as it relates specifically to the Dispatcher's tasks.

The Dispatcher Manuals shall describe each function and how it is to be used. Procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be adjusted, and the effects obtained by varying each parameter. All user guidance and error messages shall be described, along with the steps necessary to recover from errors.

The manuals shall include a copy of each type of display and report available specifically to Dispatchers using the PSVRN and MTMS along with a description of each data field. User instructions for each display shall be provided.

9.16 Utilization of a Requirements Traceability Matrix

Within forty-five (45) days of Notice to Proceed (NTP), the Contractor shall submit a Requirements Traceability Matrix (RTM) to the SFMTA that captures the contractual, regulatory and statutory requirements of the project [CDRL 12-9-28 Requirements Traceability Matrix]. The RTM shall be maintained by the Contractor Project Manager, and reference design, evaluation, testing, and quality control elements satisfying each requirement. Each requirement shall be uniquely numbered and fit in a hierarchical breakdown of requirements. The RTM shall be maintained and used to guide project execution, such as management of corrective action requests, test plans and test cases, throughout the duration of the project.

9.17 Options Documentation

The Contractor shall provide specific documentation for all options purchased [CDRL 12-9-29 Options Documentation]. Documentation requirements for options shall be the same as for the base equipment.

9.18 Document Quantities

In addition to electronic “soft” copy, the Contractor shall provide the following quantities of bound paper “hard” copies for each submittal:

Document (Section #)	Review Copies	Final Copies
System Functional Description Document	20	20
Hardware Documentation	20	20
Inventory, Floor Plans, Wiring, Block Diagrams	20	20
Site Preparation Manuals	20	20
Radio System Technical Data	20	20
Reference Manuals and Instruction Books	20	20
Maintenance Manuals	20	20
Diagnostic Program Manuals	20	20
Software Documentation	20	20
Program Source Code	20	20
Database Documentation	20	20
PSVRN and MTMS User Manual	20	20
Bus Operator Manual	20	20
Ferry Operator Manual	20	20
Field Supervisor Manual	20	20
Non-Revenue Vehicle Manual	20	20
System Administrator Documentation	20	20
Test Documentation	20	20
Training Documentation	20	20
Radio Dispatch User’s Manual	20	20
Options Documentation (each option)	20	20

9.19 Document Review and Approval

Document review and approval shall be done in accordance with the Contractor’s Quality Assurance procedure for Design Review.

To help the SFMTA manage the review and turnaround of documents during any given period, the Contractor shall stagger the release of documents over the time allocated in the project schedule for document review. The number and size of documents shall be factored into the documentation release schedule.

The SFMTA shall have the right to require the Contractor to make any necessary documentation changes at no additional cost to the SFMTA to achieve conformance with the Contract.

Any purchasing, manufacturing, or programming implementation initiated prior to written the SFMTA approval of the relevant documents or drawings shall be performed at the Contractor's risk.

Review and approval of any document by the SFMTA shall not relieve the Contractor of its overall responsibilities to satisfy system functions and features in accordance with this Contract.

9.20 Drawing Standards

All design drawings submitted shall comply with the SFMTA CADD drawing standard. The most recent copy of the SFMTA CADD drawing standard shall be provided, upon request, to qualified Proposers.

9.21 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Proposers need only specify, in table form, where in their proposals this information is contained):

PRL 12-9-1 Project Schedule.

9.22 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

CDRL 12-9-1 CPM Project Schedule (requirement see Document 00833)

CDRL 12-9-2 Project Management Plan (requirement see Document 00833, section 1.2)

CDRL 12-9-3 System Functional Description Document

CDRL 12-9-4 Hardware Inventory

CDRL 12-9-5 Hardware Documentation Inventory

CDRL 12-9-6 Vehicle Installation Drawings

CDRL 12-9-7 Installation Wiring and Cable Diagrams

CDRL 12-9-8 Site Preparation Manuals

CDRL 12-9-9 Site Floor Plans

CDRL 12-9-10 Hardware Reference and Instruction Manuals

CDRL 12-9-11 Maintenance Manuals

CDRL 12-9-12 Diagnostic Program Manuals

CDRL 12-9-13 Software Documentation

CDRL 12-9-14 Software Functional Requirement Document

- CDRL 12-9-15 Program Source Code
- CDRL 12-9-16 Software Escrow Agreement
- CDRL 12-9-17 Database Documentation
- CDRL 12-9-18 Database Dictionary
- CDRL 12-9-19 PSVRN User Manual
- CDRL 12-9-20 MTMS User Manual
- CDRL 12-9-21 Bus Operator Manual
- CDRL 12-9-22 Field Supervisor Manual
- CDRL 12-9-23 Non-Revenue Vehicle Manual
- CDRL 12-9-24 PSVRN System Administration Documentation
- CDRL 12-9-25 MTMS System Administrator Documentation
- CDRL 12-9-26 PSVRN Radio Dispatcher Manual
- CDRL 12-9-27 MTMS Radio Dispatcher Manual
- CDRL 12-9-28 Requirements Traceability Matrix
- CDRL 12-9-29 Options Documentation
- CDRL 12-9-30 Software Training Session

The Contractor is advised that the above list does not necessarily constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole, or by reference, as part of the complete package of deliverables and submittals. Any additional CDRLs required will be mutually agreed during the Design Phase.

appendix fourteen

Required SFMTA User Work Stations & Licenses

Dispatch Workstations and Consoles by Organizational Breakdown		9-Feb-10
Unit	Variant	Operational Qty
Central Control (Lenox)		
Rubber Tire Dispatch and Train Control	1	11
Theater Supervisor / Spare	1	1
Rubber Tire Dispatch and Train Control	3	5
Senior Operations Manager (SOM)	2	1
Superintendent	1	1
Backup/Interim Control Center Readiness (1 SVN)	1	8
Other Emergency Responders		
Outside Agency	4	1
SFMTA Management and other indirect users	4	10
Customer Service (311)	4	10
Security/PoP Dispatch	1	2
DPT Dispatch	4	2
Cable Car		
Machinery	1	1
Operations	1	1
Stations and Wayside Booths		
Station Agents	4	15
Station Operations and wayside booths	4	5
Divisions		

Dispatch Workstations and Consoles by Organizational Breakdown		9-Feb-10
Unit	Variant	Operational Qty
Woods Integrated Radio Consoles	1	2
Woods Dispatch Workstation	2	2
Woods Networked Clock	5	1
Woods Control Station	3	1
Presidio Integrated Radio Consoles	1	2
Presidio Dispatch Workstation	2	2
Presidio Networked Clock	5	1
Presidio Control Station	3	1
MME Integrated Radio Consoles	1	2
MME Dispatch Workstation	2	2
MME Networked Clock	5	1
MME Control Station	3	1
Green and Carhouse Integrated Radio Consoles	1	3
Green and Carhouse Dispatch Workstation	2	3
Green and Carhouse Networked Clock	5	1
Green Control Station	3	1
Potrero Integrated Radio Consoles	1	2
Potrero Dispatch Workstation	2	2
Potrero Networked Clock	5	1
Potrero Control Station	3	1

Dispatch Workstations and Consoles by Organizational Breakdown		9-Feb-10
Unit	Variant	Operational Qty
Kirkland Integrated Radio Consoles	1	1
Kirkland Dispatch Workstation	2	1
Kirkland Networked Clock	5	1
Kirkland Control Station	3	1
Flynn Integrated Radio Consoles	1	1
Flynn Dispatch Workstation	2	1
Flynn Networked Clock	5	1
Flynn	3	1
Cable Car Barn Integrated Radio Consoles	1	1
Cable Car Barn Dispatch Workstation	2	1
Cable Car Barn	3	1
Cable Car Barn Networked Clock	5	1
Motive Power	3, 4	1
Command Coach 9030	1	1
SFMTA Radio Shop	1,3	1
Supervisor notebook	4	20
Training	1, 2, 3, 4	1
Development Environment	1, 4	1

Variant 1: Dispatch Workstation w/ Integrated Radio Console

Variant 2: Dispatch Workstation (no voice communications)

Variant 3: Fixed installed control station

Variant 4: Web App (no voice communications, reduced functions)

Variant 5: Networked Clock

appendix **twenty-two**

Rail Vehicle Material and Workmanship

SECTION 22
MATERIALS AND WORKMANSHIP

Section	Page
22.1 GENERAL	1
22.1.1 Quality	1
22.1.2 Standards	1
22.2 JOINING AND FASTENING	1
22.2.1 Joining	1
22.2.1.1 General	1
22.2.1.2 Joint Fitting	2
22.2.1.3 Metal-to-Metal Connections	2
22.2.1.4 Wood-to-Metal Connections	2
22.2.1.5 Wood-to-Wood Connections	3
22.2.2 Fasteners	3
22.2.2.1 General	3
22.2.2.2 Threaded Fastener Standards	4
22.2.2.2.1 Inch-Standard Fasteners	4
22.2.2.2.2 Metric Fasteners	4
22.2.2.3 General Requirements	4
22.2.2.3.1 Fastener Materials and Coatings	4
22.2.2.3.2 Alternate Coatings	5
22.2.2.3.3 Requirements for Nuts	6
22.2.2.3.4 Washers and Retention Devices	6
22.2.2.3.5 Joint Design	7

22.2.2.3.6	Fastener Tightening and Torque	7
22.2.2.3.7	Critical Fasteners	8
22.2.2.3.8	General Purpose Fasteners	9
22.2.2.3.9	Decorative and Appearance Fasteners	9
22.2.2.4	Rivets and Lock Pins	10
22.2.2.5	Rivet and Bolt Holes	10
22.3	STAINLESS STEEL	10
22.3.1	General	11
22.3.2	Austenitic Stainless Steel	11
22.3.3	Ferritic Stainless Steels	11
22.3.4	Testing	12
22.4	LOW-ALLOY, HIGH-TENSILE STEEL	12
22.4.1	General	12
22.4.2	Testing	12
22.5	STEEL CASTINGS	13
22.5.1	General	13
22.5.2	Design Qualification of Structural Castings	13
22.5.3	Quality of Structural Castings	14
22.5.3.1	Magnetic Particle Inspection	14
22.5.3.2	Radiographic Inspection	14
22.5.4	Repair Welding and Cast-Weld Design	14
22.5.5	Disposal of Non-Conforming Castings	15
22.5.6	Steel and Aluminum Forgings	15
22.5.6.1	General	15
22.5.6.2	Design Qualification of Structural Forgings	16
22.5.6.3	Quality of Structural Forgings	16
22.6	ALUMINUM	16
22.6.1	General	16

22.6.2	Design Stresses	17
22.6.3	Fabrication and Fastening	17
22.6.4	Protection of Contact Surface	17
22.6.5	Interior Trim	18

22.7 ELASTOMERS 18

22.7.1	General	18
22.7.2	Tests	19
22.7.3	Life Expectancy	19
22.7.4	Metal Parts	20
22.7.5	Bonding	20
22.7.6	Truck Parts	20
22.7.7	Seals	20

22.8 GLAZING MATERIALS 20

22.8.1	Safety Glass	20
22.8.1.1	Type	21
22.8.1.2	Flatness	21
22.8.1.3	Dimension Tolerance	21
22.8.1.4	Overlap Tolerance	21
22.8.1.5	Color	21
22.8.1.6	Haze	22
22.8.1.7	Specks and Scratches	22
22.8.1.8	Bond Separation	22
22.8.1.9	Marking	22
22.8.2	Plastic Glazing	22

22.9 FLOOR COVERING 22

22.10 WOOD AND PANELS 23

22.10.1	Lumber	23
22.10.2	Plymetal	23
22.10.3	Plywood	23

22.10.4	Honeycomb Panels	24
22.10.5	Panel Contour Tolerance	24
22.10.6	Melamine-Faced Aluminum	24
22.10.7	Phenolic Cored Panels for Flooring	25

22.11 SECTION DELETED 26

22.12 FIBERGLASS-REINFORCED PLASTIC 26

22.12.1	General	26
22.12.2	Construction	27
22.12.2.1	Resin	27
22.12.2.2	Reinforcement	27
22.12.2.3	Gel Coat	27
22.12.2.4	Additives	28
22.12.3	Strength Requirements	28

22.13 THERMOPLASTIC SHEET 29

22.13.1	General	29
22.13.2	Quality	29
22.13.3	Strength Requirements	29

22.14 PIPING AND TUBING 30

22.14.1	General	30
22.14.2	Air Piping, Tubing and Fittings	31
22.14.3	Section Deleted	32
22.14.4	Brazing and Soldering of Piping, Tubing and Fittings	32
22.14.5	Hydraulic Piping, Tubing and Fittings	33

22.15 SECTION DELETED 33

22.16 WIRE AND CABLE 34

22.16.1	General	34
22.16.2	Conductors	34
22.16.3	Insulation	35

22.16.3.1	General Wiring Insulation	36	
22.16.3.2	Wire Insulation for High Temperature Applications		42
22.16.3.3	Wire Insulation Within Equipment	43	
22.16.3.4	Wire Insulation at Crowded Locations	43	
22.16.4	Multi-Conductor Cables	44	
22.16.4.1	General	44	
22.16.4.2	Fillers	44	
22.16.4.3	Tape	44	
22.16.4.4	Shield	44	
22.16.4.5	Jackets	45	
22.16.5	Wire Wrap	45	
22.17	WIRING	46	
22.17.1	General	46	
22.17.2	Wire Handling	46	
22.17.3	Wiring Layout and Installation	47	
22.17.3.1	Wire Harness	47	
22.17.3.2	Circuit Separation	48	
22.17.3.3	Wire and Cable Runs	49	
22.17.3.3.1	Cable Cleating and Support	50	
22.17.3.3.2	Wire Securement and Termination	51	
22.17.3.4	Circuit Shielding	53	
22.17.4	Insulation Resistance	54	
22.17.5	Marking	54	
22.17.6	Pulling Compound	55	
22.17.7	Solder	56	
22.17.8	Tape	56	
22.18	WIRE AND CABLE CONNECTIONS	56	
22.18.1	General	56	
22.18.2	Terminal Boards and Terminal Points	56	

22.18.3	Wire Terminations	57
22.18.4	Power Cable Terminations	58
22.18.5	Motor Lead Terminals	58
22.18.6	Cable Connectors	58
22.18.7	Quick-Disconnect Terminals	59
22.18.8	Grounding Return Connections	60
22.18.8.1	Grounding	60
22.18.8.2	Bonding	60
22.18.9	Wire Splicing	60

22.19 CONDUIT 61

22.19.1	Types	61
22.19.2	Size and Fill	62
22.19.3	Installation	62

22.20 CONDUIT FITTINGS AND JUNCTION BOXES 62

22.20.1	General	62
22.20.2	Boxes	63
22.20.3	Conduit Interface	63
22.20.4	Covers	63

22.21 WIREWAYS 63

22.22 WELDING, BRAZING, AND SOLDERING 64

22.22.1	General	64
22.22.2	Structural	64
22.22.3	Welder Qualification	65
22.22.4	Inspection	65
22.22.5	Post-Weld Cleaning Requirements	66
22.22.6	Contractor Documentation	66
22.22.7	Special Welding	67
22.22.8	Resistance Welding	67
22.22.9	Resistance, Spot Weld and Intermittent Weld Spacing	67

22.22.10	Toughness of Welded Assemblies	68
22.22.11	Brazing	68
22.22.12	Torch Soldering	68
22.22.13	Welding Terms, Symbols and Definitions	68

22.23 PAINTS AND COATINGS 69

22.23.1	General	69
22.23.2	Materials and Preparation	69
22.23.3	Exterior Painting	70
22.23.4	Apparatus and Underfloor Equipment	71
22.23.5	Painting Restrictions	71
22.23.6	Interior Painting	72
22.23.7	Corrosion Protection	73
22.23.8	Acoustical Insulation	73
22.23.9	Trucks	73
22.23.10	Paint Process Documentation	73

22.24 FLAMMABILITY AND SMOKE EMISSION REQUIREMENTS 74

22.24.1	General	74
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22.25 SECTION DELETED 74

22.26 ELECTRICAL AND ELECTRONIC DESIGNS 74

22.26.1	Section Deleted	74
22.26.2	Section Deleted	74
22.26.3	Hardware	74
22.26.4	Wiring	74
22.26.5	Optical Fibers	74

22.27 SEMICONDUCTOR STANDARDS 75

22.27.1	General	75
22.27.2	Ratings	75
22.27.3	Availability and JEDEC Registration	76

22.27.4 Other Prohibitions 77

22.28 PRINTED CIRCUIT BOARD STANDARDS 77

22.28.1 General 77
22.28.2 Marking 78
22.28.3 Component Mounting 78
22.28.4 IC and Device Sockets 79
22.28.5 Conformal Coating 79
22.28.6 Keying 79
22.28.7 Circuit Board Connectors 80
22.28.8 Testing 80
22.28.9 Plated-Through Holes 80
22.28.10 Multilayer Boards 81
22.28.11 Enclosures 81
22.28.12 Extenders 82

22.29 MICROPROCESSOR-BASED SYSTEM HARDWARE 82

22.29.1 Hardware Platform 82
22.29.2 Electrical Isolation and Pre-Processing 82
22.29.3 Section Deleted 83
22.29.4 Section Deleted 83
22.29.5 Section Deleted 83
22.29.6 Section Deleted 83
22.29.7 Section Deleted 83

22.30 ELECTRICAL DEVICES AND HARDWARE 83

22.30.1 General 83
22.30.2 Contactors and Relays 83
 22.30.2.1 General 84
 22.30.2.2 Section Deleted 86
22.30.3 Switches 86
22.30.4 Circuit Breakers 87

22.30.4.1	General	87	
22.30.4.2	High-Voltage Circuit Breakers	88	
22.30.4.3	Low-Voltage Circuit Breakers	89	
22.30.5	Fuses	89	
22.30.6	Bus Bars	90	
22.30.7	Capacitors and Resistors	91	
22.30.8	Transformers and Inductors	91	
22.30.9	Switch, Circuit Breaker and Fuse Panels	92	
22.30.10	Battery Backup Circuits	92	
22.30.11	Section Deleted	93	

22.31 SECTION DELETED 93

APPENDIX TBD

MATERIALS AND WORKMANSHIP FOR RAIL VEHICLES

22.1 GENERAL

22.1.1 Quality

Material and workmanship shall be in accordance with the stated Specification or description, unless written approval for substitution is obtained.

Inclusion of a material or method in this section does not indicate approval for application or use in a specific situation. When a material or method is specified in this section, this section shall be applicable; however, specific requirements detailed in appropriate Technical Specifications sections take precedence over this section.

22.1.2 Standards

The following domestic standards and specifications define materials for this contract: Federal or Military Specifications or Standards, the Specifications of the Aluminum Association of America, AAR, ANSI, ASME, ASTM, FRA, IEEE, and additional requirements, as specified herein. Where other or foreign standards are proposed by the Contractor, the Contractor shall submit documentation for SFMTA review and approval demonstrating that the proposed standards are the equivalent of the foregoing standards and specifications. Proposed substitute specifications shall be submitted in both English and the language of the country of origin.

22.2 JOINING AND FASTENING

22.2.1 Joining

22.2.1.1 *General*

Certain combinations of materials require particular care in joining to avoid the possibility of corrosion. Isolating and moisture-proofing materials, appropriate to the materials being joined, shall be used at all times where these combinations exist.

22.2.1.2 *Joint Fitting*

Joints shall be properly fitted, whether exposed or concealed. When not otherwise specified in drawings or specifications, gaps between joints shall be held to a dimension not greater than 10% of the thinner material being joined, or 0.002-inch (0.05-mm), whichever is greater. Gaps shall be uniform in width. The edges of panels shall have a smooth, finished appearance.

Where excessive gaps (greater than those permitted by approved drawings or standards) are found to exist at the faying surfaces of structural bolted or riveted connections, metal shims of the same material as that of the deficient part may be used, but only with the written permission of SFMTA. Shims, if used, shall be permanently fastened to one of the base parts being joined. The use of epoxy or other plastic filler at such locations is expressly prohibited.

22.2.1.3 *Metal-to-Metal Connections*

Where metals contact each other, the contact surfaces shall be free of dirt, grease, rust, and scale. Unless specified otherwise, the contact surfaces shall be coated with a metal based primer that conforms to Society for Protective Coatings Specification SSPC-Paint 25. Metal primer may be omitted for like-stainless steel to like-stainless steel joints.

Dissimilar metal protection shall be applied where necessary to prevent metal corrosion. Where dissimilar metals are joined using mechanical fasteners, the joint shall be protected against electrolytic corrosion. Joining of dissimilar metals is subject to specific SFMTA approval.

For proper treatment of a connection involving aluminum, refer to Section 22.6.4.

22.2.1.4 *Wood-to-Metal Connections*

Where wood and ferrous metal surfaces are placed together, the wood shall be coated with aluminum paint conforming to Federal Specification TT-P-38, and the metal shall be coated with a primer that conforms to Society for Protective Coatings Specification SSPC-Paint 25.

Unless otherwise approved, all bolts or rods passing through wood shall be coated with aluminum paint conforming to Federal Specification TT-P-38.

22.2.1.5 *Wood-to-Wood Connections*

Where wood and wood are placed together, both abutting surfaces shall be coated with aluminum paint conforming to Federal Specification TT-P-38.

22.2.2 **Fasteners**

22.2.2.1 *General*

The Contractor and suppliers are responsible for selecting fastener types, sizes, styles, lengths, materials, grades, and finishes that will meet the requirements of this Specification. The Contractor shall minimize the number of different sizes and styles of fasteners used.

Fasteners used throughout the car shall be inch standard fasteners, except that ISO Metric fasteners may be used in conformance with Section 22.2.2.2. Cadmium plated fasteners shall not be used.

All fasteners used on this vehicle can be classified under one of four categories: critical; general purpose; decorative; or electrical and electronic. The criteria for classification are expressed below. All fasteners must meet the general requirements for design and material in addition to any requirements contained in the section specific to the particular category. All fasteners, in any category, which attach to car structure, shall be in accordance with Section 10.3.

Critical fasteners include, but are not limited to, all fasteners applied to carbody structure, trucks, bolsters, truck-mounted brake equipment, couplers, and power collection devices. Additionally, any fastener is considered critical if failures cannot be tolerated, that is, if even a single fastener fails there is a possibility of brake failure, derailment, or accident. In the event of a dispute, SFMTA shall be the final arbitrator on which fasteners are classified as critical.

Fasteners used to attach interior lining or trim and exposed to passenger view are specified under Decorative and Appearance Fasteners.

Fasteners used to secure wire terminations to an electrical or electronic device are considered electrical and electronic, and are specified in appropriate Materials and Workmanship subsections for electrical devices and wiring.

Fasteners not falling into one of the other three categories are classified as general purpose.

Detailed requirements pertaining to critical, general purpose and decorative fasteners are listed below.

22.2.2.2 *Threaded Fastener Standards*

22.2.2.2.1 **Inch-Standard Fasteners**

All inch-standard threaded fasteners shall conform to ANSI B1.1 Standard, Unified Inch Screw Threads, (UN and UNR Thread Form) or Industrial Fasteners Institute Fastener Standards.

22.2.2.2.2 **Metric Fasteners**

Upon approval, specific Line Replacement Units (LRUs) that are provided to the Contractor by a supplier or subsupplier may be supplied with metric fasteners to ANSI B1.13M (ISO-metric) Standards. In these cases, all internal fasteners and threaded components of the approved unit shall have ISO-metric threads. Internal to components there shall be no mixing of metric and inch threaded fasteners. External mounting fasteners and threaded connecting components shall have ISO-inch threads to ANSI B1.1 Standards. Each unit, component, or group containing ISO-metric threads shall be indelibly identified, in an approved manner and in a conspicuous approved location, to signify that the unit contains metric threaded fasteners. All repair and maintenance manuals shall be conspicuously marked on each page where metric threaded fasteners were used within the unit. Replacement, repair, or maintenance parts supplied under this Specification shall contain all necessary replacement fasteners of the correct size and grade.

Metric fasteners shall be marked as required in "Metric Fastener Standards," Industrial Fasteners Institute, latest edition.

22.2.2.3 *General Requirements*

22.2.2.3.1 **Fastener Materials and Coatings**

When making connections to heat producing apparatus, thermal expansion of the components shall be taken into consideration for selection of fastener materials. If the joined components are high expansion alloys such as copper or austenitic stainless steel, austenitic stainless steel fasteners shall be used. If the joined components are low expansion materials such as carbon

steel or Ferritic stainless steel, zinc plated carbon steel fasteners of minimum Grade 5 shall be used.

All carbon, alloy, and martensitic stainless steel fasteners shall be plated with zinc, unless specifically waived by SFMTA. Cadmium plated fasteners are not permitted. Grade 8 or metric grade 10.9, or stronger, fasteners shall not be plated if the OEM finish is other than plating. The zinc plating thickness shall conform to ASTM B633 SC2, SC3, SC4 or ASTM B695, Class 8. The zinc plating shall meet the salt spray requirements of ASTM B695, Class 8, Type I.

22.2.2.3.2 Alternate Coatings

Alternate fastener coatings are permissible if qualified by testing per ASTM B117 with no red rust after 72 hours of exposure. The Contractor shall submit qualification results for each process used at each subcontractor applying the proposed coating.

In order to use an alternate coating, the Contractor shall submit:

- A. The coating manufacturer's product data including required thickness
- B. ASTM B117 test results from an accredited third party laboratory
- C. Documentation of torque/tension characteristics
- D. A statement from the coating manufacturer regarding the propensity for the coating process to cause hydrogen embrittlement of the fastener during coating.

Regardless of the coating's propensity for hydrogen embrittlement, each lot of high strength fasteners (Grade 5 or Metric Grade 8.8 or higher) shall be tested for hydrogen embrittlement in accordance with Section 22.2.2.3.7. Each lot of lower strength fasteners shall be tested for hydrogen embrittlement if the coating has the possibility of causing hydrogen embrittlement.

If the proposed coating results in a change in the K-value for the plated fastener, as defined by Industrial Fasteners Institute Standard IFI-543, outside the range of 0.13-0.15, the vendor shall use the alternate coating on all fasteners within the particular LRU. The LRU shall contain an indelible label identifying the coating type used within the LRU and the required torque values for each size fastener used therein. Fasteners internal to a subcomponent within an LRU may

use the standard coating system if they are not subject to removal during Owner's maintenance activities.

22.2.2.3.3 Requirements for Nuts

All nuts shall be of a grade, class, and material (including plating) compatible with the mating fastener. Inch standard nuts shall conform to ANSI/ASME B18.2.2 for diameters of 1/4-inch and larger, and ANSI/ASME B18.6.3 for diameters less than 1/4-inch. Metric nuts shall conform to ANSI B18.2.4.1M or ANSI B18.2.4.2M.

Unless otherwise required by a specific application, all nuts shall be regular height, nylon insert, self-locking stop nuts (ESNA or approved equal), conforming to Military Standard MS-21044 and Military Specification MIL-N-25027. Where nylon-insert self-locking stop nuts cannot be used, self-locking bolts and screws conforming to MIL-DTL-18240 Type L may be used. Nylon insert lock nuts, bolts, or screws shall not be used near heat sources that shall exceed the manufacturer's recommended operating temperature or 200°F, whichever is lower.

All metal prevailing-torque type locknuts shall only be used where there is insufficient clearance to install ESNA type locknuts, or where the locknut is exposed to temperatures above 200°F (93°C).

All carbon, alloy, and martensitic stainless steel nuts shall be plated with zinc, unless specifically waived by the Engineer. Grade B or metric grade 10.9, or stronger, nuts shall not be plated if the OEM finish is other than plating. The zinc plating shall conform to ASTM B633, SC2 Type I, SC3 Type I, or SC4 Type I, or ASTM B695, Class 8, Type I.

Alternate coatings may be applied to nuts per the requirements of Section 22.2.2.3.2.

22.2.2.3.4 Washers and Retention Devices

Washers, of a grade and strength compatible with the fastener, shall be used under the heads of all hex bolts, unless otherwise approved, and under all nuts. Washers shall conform to ANSI B18.22.1 or ANSI B18.22M, latest revision, as is appropriate for the application. Where high strength fasteners are applied, washers shall be hardened and comply with IFI Fastener Standards.

Lock washers shall not be used for fatigue applications where the fastener must be torqued and marked. The use of lock washers is discouraged throughout the vehicle and all systems. Other types of washers, including Belleville washers, may be used for special applications with SFMTA's approval. Lock washers, when applied, shall conform to IFI Fastener Standards.

22.2.2.3.5 Joint Design

All screws or bolts used to secure access panels to the interior, undercar, or roof equipment shall be made captive to the panel in which they are used. All fasteners used to secure access covers, doors, or panels to equipment boxes or interior panels shall be made captive to the panel in which they are used. Where access for service is expected more often than every 5 years, access panels shall be equipped with quarter-turn fasteners. Quarter-turn fasteners shall have a minimum shank diameter of 0.25-inch (6 mm), be of adequate strength, and as manufactured by Southco, or approved equal.

Unless otherwise approved by SFMTA, threaded fasteners shall not be threaded directly into non-metallic materials. Metal thread inserts shall be used when a threaded fastener is secured to a non-metallic material.

When bolts are used to secure apparatus where the bolt head is not accessible, a reusable mechanical locking device shall be used to prevent the bolt head from turning when the nut is being turned.

At least 1-1/2 screw threads shall be visible beyond all nuts. When used without elastic stop nuts, bolts shall not project more than 1-1/2 threads plus 1/4-inch (6 mm) for bolts 1/4-inch (6 mm) diameter or less and shall not project more than 8 threads for larger diameter bolts, unless otherwise approved. With elastic stop nuts, bolt threads shall not project more than 1/4-inch (6 mm), regardless of bolt size.

Undercar equipment shall not be supported by bolts in tension.

22.2.2.3.6 Fastener Tightening and Torque

All critical fasteners and general purpose fasteners used to secure equipment to the carbody, including truck and brake equipment bolts and all fasteners exposed to fatigue loads, shall be torqued to a minimum preload equal to 75 percent of their proof load and "torqued striped" after

torquing by paint or other approved means. All other fasteners shall be torqued to a value appropriate to the application, so that they do not loosen in service.

Fastener installation torque for standard oiled or waxed bolts with standard or heavy hex nuts may be calculated from Industrial Fasteners Institute, Fastener Standards, equations using values for "K" of 0.18 for unplated and 0.15 for plated threads. Fastener torque for bolts with alternate coatings shall be calculated using K values provided per Section 22.2.2.3.2. Locknuts shall be torqued in accordance with their manufacturer's recommendations or the Contractor may conduct tests to determine installation torque. For those nuts or bolts requiring "torque striping," SFMTA may require bolt torque-tension tests to verify that installed preload is equivalent to 75 percent of proof loads.

When necessary, alternate methods of determining fastener preload may be proposed for SFMTA's consideration.

22.2.2.3.7 Critical Fasteners

All critical fasteners shall have documentation identifying manufacturer and purchase specifications available for examination by SFMTA at the Contractor's QA department. This documentation shall include the fastener material or grade, and finish including plating material and specifications, when applicable. Whether the buyer is a subcontractor, supplier, or the Contractor, the Contractor shall obtain and hold this documentation for a period of not less than termination of the last car's warranty period.

All critical fasteners shall either: (1) be manufactured, tested, and distributed in accordance with ASME FAP-1-1990, Quality Assurance Program for Fastener Manufacturers and Distributors, including the requirements of ASME accreditation; or (2) have a representative sample of each production lot of fasteners tested for conformance to purchase specifications by an independent laboratory accredited by the American Association of Laboratory Accreditation (AALA), or approved equal.

A production lot is defined as one size of fastener, from one manufacturer, produced during one continuous production run. Fasteners not meeting this definition of production lot shall be treated as separate lots. Testing shall be performed using sample quantities as proposed by the Contractor and approved by SFMTA. Tests conducted shall confirm that fastener material meets specified chemistry and strength requirements. The Contractor shall obtain certified test results from the testing laboratory and hold the documents for a period of not less than the termination of the warranty period of the last car.

All critical fasteners that are plated or chemically cleaned shall have certifications showing freedom from hydrogen embrittlement. If non-standard, structural, or safety related fasteners are plated by other than the OEM; a representative sample of these fasteners shall be tested for hydrogen embrittlement by the Contractor or a supplier following ASTM F519 procedures. An ASTM F606 wedge test sample may be used in place of the F519 standard samples. Test loads shall be a minimum of 80 percent of yield strength or proof load and held for a minimum of 168 hours. Any failures shall reject the entire lot.

22.2.2.3.8 General Purpose Fasteners

Mounting and attachment bolts shall be sized to the design strengths for Grade 2 bolts and Class A nuts, however in no case shall the fastener diameter be less than 3/8-inch (10 mm), regardless of the design load. Grade 5 bolts and Class A nuts shall be used for installation of all equipment and/or structures. Pem-nuts, or similar friction-fit style fasteners, shall not be used anywhere on the railcar. Riv-nuts, or similar cinch-tight style of fasteners may be used only with specific permission from SFMTA.

Fasteners used within equipment shall meet all requirements of Section 22.2.2 (other than the requirements specifically listed for critical fasteners or decorative fasteners), and shall be sized as appropriate for the application.

All general purpose fasteners shall have documentation that identifies the manufacturer, base material, plating or finish if applied, and the fastener type. The Contractor or supplier shall maintain this documentation on file for SFMTA to review for a period of not less than the expiration of the warranty on the last car delivered.

22.2.2.3.9 Decorative and Appearance Fasteners

All interior fasteners exposed to passengers shall be either bright or finished to match the surfaces being joined, and installed such that the fastener head is flush with the mating surface. Bright finished fasteners used for stanchions shall be austenitic grade stainless steel. Bright finished interior fasteners may be either austenitic or plated martensitic stainless steel. Self-tapping screws are only permitted where they shall not be removed for normal maintenance more frequently than once in five years and shall be plated martensitic stainless steel.

All exterior fasteners visible to passengers shall be austenitic stainless steel for steel, LAHT steel, and stainless steel car bodies. Exterior aluminum shall be joined by austenitic stainless steel or aluminum alloy fasteners, as appropriate to the design and appearance requirements. Fasteners used on the side sill to attach equipment brackets are considered either critical or general-purpose fasteners, as appropriate for the application.

Fasteners on access panels, plates, covers, or other components accessible by passengers shall be of a single style tamperproof type approved by SFMTA.

All decorative and appearance fasteners shall have documentation that identifies the manufacturer, base material, plating or finish if applied, and the fastener type. The Contractor or supplier shall maintain this documentation on file for SFMTA to review for a period of not less than the expiration of the warranty on the last car delivered.

22.2.2.4 *Rivets and Lock Pins*

Rivets and lock pins exposed to passengers shall be austenitic stainless steel or aluminum, as appropriate to the materials being joined. Structural steel rivets shall conform to ASTM-A-502 or ANSI B 18.1.2 standards. Rivets may be hand driven when hot and shall completely fill the rivet holes. Rivets driven cold shall be mechanically driven. Exposed heads shall be concentric with the shank and free from rings, fins, pits, and burrs.

Swage-locking (Huckbolt-type) fasteners shall conform to Military Specification MIL-P-23469. All rough surfaces of the collar end of these fasteners shall be machined or ground smooth where accessible to passengers, crew, or maintenance personnel performing routine maintenance functions. SFMTA shall be the final arbiter in determining whether an application is hazardous to maintenance personnel.

22.2.2.5 *Rivet and Bolt Holes*

Rivet and bolt holes shall be accurately located and aligned, and, when necessary during assembly, holes shall be reamed round to specified size in position. Bolt hole clearances shall not exceed the IFI's requirements. All removed and replaced rivets shall have the holes reamed to the size required such that the next larger rivet may be driven securely.

22.3 STAINLESS STEEL

22.3.1 General

Permitted uses of structural stainless steels are specified throughout this Specification. Ferritic stainless steels shall be painted where exposed to passengers or the weather. Austenitic stainless steels may be unpainted. Unpainted stainless steels exposed to passengers shall be a single grade of austenitic stainless steel in which both the color and surface finish of abutting pieces shall match, except where the design specifically calls for contrasting appearance.

22.3.2 Austenitic Stainless Steel

Structural austenitic stainless steel components assembled by fusion or resistance welding shall be of AISI-type 201L or 301L and shall conform to the requirements of ASTM-A-666 except that the carbon content shall not exceed 0.03% and type 301L shall not exceed 0.25% nitrogen. Other stainless steels conforming to ASTM A 666 are acceptable for non-welded applications.

Stainless steel used in structural applications covered by this Specification shall also conform to APTA Standard SS-C&S-004-98, "Standard for Austenitic Stainless Steel for Railroad Passenger Equipment."

General requirements for delivery of stainless steel shall be as required by the Certification Provisions of ASTM-A666, and stainless steel to be used in structural applications shall be tested for susceptibility to intergranular corrosion in accordance with ASTM A 262, latest revision. Practice A of ASTM-A-262 can be used to accept material only; Practice E is required for final determination of acceptance or rejection of material that is not acceptable by Practice A.

22.3.3 Ferritic Stainless Steels

When specified, Ferritic stainless steel conforming to ASTM-A-176 may be used for carbody structural sheeting up to 4 mm thickness. Ferritic stainless steel sheet shall have a ductile-to-brittle transition temperature (DBTT) or nil-ductility temperature (NDT) below 0°C. Weld heat-affected-zones shall also have a DBTT or NDT below 0°C. Ferritic stainless steel sheet shall have a balanced composition (low carbon and/or suitable titanium content) that will, for all conditions of fabrication and assembly into the carbody, inhibit formation of martensite and limit chromium depletion in weld-heat-affected zones so that material shall meet ASTM-A-736 requirements for resistance to intergranular corrosion.

General requirements for delivery of stainless steel shall be as required by ASTM-A-480.

Where Ferritic stainless steels are welded to other structural steels, the less-noble steel shall be painted with weld through primer.

22.3.4 Testing

The Contractor shall prepare (or have prepared), submit, and receive approval of a test and inspection plan for acceptance of all stainless steel to be used in welded applications prior to purchasing any such material. The tests and inspections shall verify that the stainless steel conforms to specified requirements. For austenitic stainless steels, the test and inspection plan shall include frequency of submittal of certifications in accordance with Certification Provision of ASTM A 666 and frequency of submittal of checks for susceptibility to intergranular corrosion in accordance with ASTM A 262. For Ferritic stainless steels, the test and inspection plan shall include frequency of submittal of checks for susceptibility to intergranular corrosion in accordance with ASTM A 763.

22.4 LOW-ALLOY, HIGH-TENSILE STEEL

22.4.1 General

Low-alloy high-tensile (LAHT) steel structural shapes, plates, and bars shall, as a minimum, conform to the requirements of ASTM A588, where available. Plate steel may alternatively conform to ASTM A710, Grade A, Class 1 or Grade C, Class 1. Where not available in A588, hot rolled or formed structural shapes conforming to ASTM A36 may be used for limited applications including equipment supports and jack pads. General requirements for delivery of LAHT shapes, plates, and bars shall be as required by ASTM A6. Welded LAHT steel shall develop 15 ft-lbs Charpy V Notch impact strength in the Coarse Grain Heat Affected Zone (CGHAZ), 1 mm from fusion area at -20°F (-29°C).

Cold and hot rolled LAHT sheet and strip shall, as a minimum, conform to the requirements of ASTM-A606, Type 4. General requirements for delivery of these products shall be as required by ASTM-A568.

Other low-alloy, high-tensile steels which meet or exceed the above minimum requirements may be used, provided their detailed specifications are submitted and approved as equivalent, or better material, for the proposed applications. All LAHT steels shall be applied according to their specification properties.

Requests by the Contractor for alternate materials will be considered. The Contractor shall provide detailed and specific information on the proposed alternate material, using a U.S.-recognized trade name or UNS number. Chemistry and properties shall be provided in English and SI Units.

22.4.2 Testing

The Contractor shall prepare (or have prepared), submit, and receive approval of a test and inspection plan for acceptance of all structural steels in accordance with the requirements of this section before purchasing any such material. The test and inspection plan shall include provisions for submission of reports and certification to SFMTA for each shipment in accordance with the applicable requirements of Purchase Specification and specified CGHAZ impact tests.

22.5 STEEL CASTINGS

22.5.1 General

The Contractor is responsible for selecting casting grade, composition, strength, and finishing. However, steel castings used in the truck structure, bolster, and center bearing arrangement shall meet AAR Specification M-201 latest revision, Grade "B" plus 2% nickel, minimum. These castings shall be heat treated to develop a minimum tensile strength of 75,000 psi, a minimum yield strength of 48,000 psi, elongation of not less than 25% in 2 inches, and reduction of area of not less than 50%. Also, steel castings used for coupler, drawbars and anchors shall meet AAR Specification M-201, latest revision, Grade "C" quenched and tempered. Cast steel to ASTM A27, grade 65-35, may be used for truck structure, bolster and center bearing arrangements as an alternative to the AAR M-201 material specified above.

Where cast steel of superior properties is required for a specific application, the Contractor may propose such castings for SFMTA's review and approval.

22.5.2 Design Qualification of Structural Castings

One casting, selected by SFMTA from the first lot of production castings, shall be subjected to a qualification test of the casting design by the Contractor. Qualification tests shall include radiographic examination for material soundness using reference radiographs to ASTM-E446 and any mechanical testing, including static and fatigue load testing of truck frames and bolsters.

Acceptance levels for the design qualification radiographic examinations shall be selected by the Contractor as appropriate for the service intended, subject to the approval by SFMTA before any castings are produced. Radiographs shall meet the requirements of ANSI/ASTM-E94 and the quality level in the area of inspection shall be at least 2% (2-2T).

A qualification test report shall be prepared and submitted to SFMTA for approval. The production of any castings before receipt of SFMTA's approval of this report shall be at the Contractor's risk. All radiographs

that resulted from the qualification test shall be made available to SFMTA for review. In case the casting selected for qualification fails to qualify, a plan of action including details of how failed material will be handled shall be included in the qualification test report. Once a design is qualified and accepted by SFMTA no changes shall be made in the casting pattern, technique, heat treatment, or material composition without re-qualification in accordance with the requirements of this section.

22.5.3 Quality of Structural Castings

All structural castings supplied shall be equal to or better than the design qualification castings in all respects. The casting supplier or Contractor shall test, inspect, and accept castings in accordance with the process described in AAR Specification M-201. In addition, the inspections below shall be performed and a written report of the results of the tests and inspections shall be furnished for each lot of castings produced.

22.5.3.1 *Magnetic Particle Inspection*

Magnetic particle inspections of all surfaces of each casting shall be conducted according to ASTM E709, by personnel certified to MIL-STD-410. With respect to structural castings that include coupler, bolster, articulation (where applicable), and truck castings, the maximum permissible magnetic particle indication length shall be 1/4-inch in the direction transverse to the usual direction of loading, and 3/4-inch in the direction parallel to the usual direction of loading.

22.5.3.2 *Radiographic Inspection*

Radiographic inspection shall be conducted according to the requirements of ASTM E94 using reference radiographs to ASTM E 446. A sampling frequency shall be proposed by the Contractor and submitted for SFMTA approval.

Structural castings shall not exceed Severity Level 3 of ASTM E446 in all critical areas of such castings and shall not exceed Level 5 in all other areas of the castings. During demonstration that the stated severity level requirements of ASTM E446 have been met, successively-produced castings shall be reinspected by radiography in the defective areas shown in the prior radiographic inspection. After such severity levels have been proved, the sampling frequency for structural castings shall be 1 casting out of each 10 produced. If no castings are rejected by radiographic inspection, this frequency may be extended to 1 casting in 25.

22.5.4 Repair Welding and Cast-Weld Design

Repair welding of castings is permitted, provided the casting supplier performs all repair welds according to the structural welding requirements of Section 22.22. Castings requiring repair or modification by welding after completion of heat treatment may be stress relieved locally by using electrically controlled heating to not greater than 1,150°F, followed by slow cooling. Manual torch stress relief shall not be permitted.

For cast-weld designs, the entire length of all assembly welds on any welded assembly of several separate castings selected for design qualification shall be radio graphically inspected to ANSI/ASTM E94 using reference radiographs from the International Institute of Welding's, "Collection of Reference Radiographs of Welds," quality level Green. Portions of assembly welds stressed in tension by service loads shall meet quality level Blue.

22.5.5 Disposal of Non-Conforming Castings

If castings are found to be non-conforming to requirements determined by the design qualification castings, the material shall be repaired, retested, and reinspected or destroyed at the Contractor's expense.

22.5.6 Steel and Aluminum Forgings

22.5.6.1 General

The Contractor is responsible for selecting forging material grade, composition, strength and finishing that will meet the intended application. Forgings that are to be welded to structure shall meet the toughness (Charpy V-notch impact) resistance specified for welded structure at the lowest operating temperature. Forgings not welded shall have adequate toughness for their intended application.

- A. Steel forgings used for axles shall conform to ASTM A 729 or AAR M-101.
- B. Steel forgings used for wheels shall conform to ASTM A 504, AAR M-107/208 or APTA SS-M-012-99 (revised) with residual element limits as specified in AAR M-107/208.
- C. Steel forgings used for the truck structure, bolster, center-bearing arrangement or carbody structure shall be weldable and shall meet specified impact properties for welded steel structure at the lowest operating temperature.

- D. Steel forgings shall comply with requirements of ASTM A 668/A 668M standard for forgings, or as proposed by the Contractor and approved by SFMTA.
- E. Aluminum alloy forgings shall comply with requirements of ASTM B 247/B 247M standard, or as proposed by the Contractor and approved by SFMTA.
- F. Aluminum alloy extrusions shall comply with requirements of ASTM B 221/B 221M standard, or as proposed by the Contractor and approved by SFMTA.

22.5.6.2 *Design Qualification of Structural Forgings*

One forging, selected by SFMTA from the first lot of production forgings, shall be subjected to a qualification test of the forging design by the Contractor. Qualification tests shall include section and etching for verification of flow pattern, magnetic particle examination for surface imperfections, and radiographic examination for internal soundness. Mechanical testing shall include static and fatigue load testing, as appropriate for the intended usage. Acceptance levels for the design qualification radiographic examinations shall be selected by the Contractor as appropriate for the service intended, subject to the approval before additional forgings are produced. Radiographs shall meet the requirements of ANSI/ASTM-E-94 and the quality level in the area of inspection shall be at least 2% (2-2T).

A qualification test report shall be prepared and submitted for approval. The production of any forgings before receipt of SFMTA's approval of this report shall be at the Contractor's risk. All radiographs that resulted from the qualification test shall be made available to SFMTA for review. In case the forging selected for qualification fails to qualify, a plan of action including details of how failed material will be handled shall be included in the qualification test report. Once a design is qualified and accepted by SFMTA no changes shall be made in the forging dies, technique, heat treatment, or material composition without re-qualification in accordance with the requirements of this section.

22.5.6.3 *Quality of Structural Forgings*

All forgings supplied shall be equal to or better than the design qualification forgings in all respects. The forging supplier or Contractor shall test, inspect, and accept forgings in accordance with a written process that has been reviewed and approved by SFMTA. A written report of the results of the tests and inspections shall be furnished for each lot of forgings produced.

22.6 ALUMINUM

22.6.1 General

Aluminum alloy mill products shall be identified by Unified Numbering System designations and shall conform to The Aluminum Association specifications contained in the Association's publication "Aluminum Standards and Data." Aluminum alloy castings used for door thresholds shall conform to ASTM B-26, ASTM B-85, or ASTM B-108 for, respectively, sand, die, or permanent mold castings. Aluminum alloy forgings shall conform to ASTM B-247. Copies of all test reports for sheet, extrusion, and forgings used in the car structure shall be submitted to SFMTA.

22.6.2 Design Stresses

All aluminum structural members shall be designed so that calculated stresses under the specified AW3 passenger load do not exceed the allowable stresses listed in the latest revision of the Aluminum Association of America's, "Specification for Aluminum Structures" for bridge and similar type structures and "Engineering Data for Aluminum Structures." Proper allowance shall be made for the effects of fatigue, for column and plate stability effects, and for strength reduction at welded regions. Permissible fatigue stresses under the specified AW3 passenger load shall be established, with approval based on available relevant research data or on prototype testing under the variable load patterns expected to occur in service.

22.6.3 Fabrication and Fastening

The forming of aluminum parts; joining of parts by bolting, riveting, and welding; and the protection of contact surfaces shall, as a minimum, conform to the requirements of the Aluminum Company of America's Technical Report No. 524, "Specification Covering Use of Aluminum in Passenger Carrying Railway Vehicles," except as otherwise specified herein.

Fabrication techniques shall be such that the strength and corrosion resistance of the aluminum shall not be impaired or the surface finish permanently marred or discolored during construction.

22.6.4 Protection of Contact Surface

The specific measures to be taken by the Contractor to prevent the risk of direct metal-to-metal contact and resultant possible electrolytic corrosion shall be approved and shall depend upon the determination of the most suitable method which can be adapted to the design involved. The following instructions shall be the minimum protection:

- A. Aluminum alloy surfaces shall not be secured to or make direct metal-to-metal contact with the surfaces of copper, copper bearing aluminum alloy, brass, bronze, silver, nickel, nickel alloys, nickel plated parts, lead, tin, or wood.
- B. The contact surfaces of aluminum alloy with aluminum alloy shall be painted with a two-part epoxy primer that is chromate-free.
- C. The surfaces of aluminum alloy parts secured to steel parts shall be protected with a one-part polysulphide sealant, a corrosion-inhibiting paste or compound that is chromate-free, mica insulation joint material or an approved equivalent material that completely covers the faying surfaces. The insulating material shall be non-hygroscopic and, if fibrous, shall be impregnated with bitumen or an approved, non-corrosive, water and moisture-repellant substance. After driving, fasteners shall be primed and painted with red oxide or aluminum paint.
- D. Stainless steel and carbon steel fasteners plated with zinc shall be coated with a corrosion-inhibiting paste or compound that is chromate-free before installation. Where possible, only the head and the shank of the bolt shall be in contact with the aluminum part when secured in place. Suitable bushings may be used in place of the paste or compound.

22.6.5 Interior Trim

Where unpainted aluminum is exposed to contact by passengers, it shall have a clear (natural) anodic finish. The finish process shall be the Aluminum Company of America's "Alumilite 204" with a minimum coating thickness of 0.0004 inches and a minimum coating weight of 21 milligrams per square inch, or approved equal process.

22.7 ELASTOMERS

22.7.1 General

All elastomeric parts shall be of neoprene, or approved equal, unless otherwise specified. The elastomer shall be compounded and cured to perform satisfactorily in the temperature range specified in Section 1. The elastomers shall have high resistance to ultraviolet radiation, weather, all SFMTA car washing fluids, and the longest possible life consistent with the other characteristics specified. All elastomeric parts shall be resistant to ozone, oxidation, heat, oil, grease, and acid.

The following elastomeric parts shall be of neoprene unless otherwise specified or approved:

- A. Glazing Rubber

- B. Door Seals
- C. Door Nosing
- D. Isolation Tapes/Pads
- E. Other parts exposed to the outdoor ambient environment, except where otherwise specified.

All resilient mounts and elastomeric truck components shall be of natural rubber. Synthetic rubber compounds may be substituted for natural rubber only when approved for a specific application.

22.7.2 Tests

All tests shall be conducted according to the latest revisions of the specified ASTM test procedures, unless otherwise specified. All resilient, natural rubber mounts and elastomeric truck suspension components shall be tested in accordance with the procedures outlined for elastomers in Section 22.24; the results of the testing shall be submitted. The performance of only these elastomers will not be bound by the performance requirements for elastomers outlined in Section 22.24.

The test specimens shall be cut out from the extruded material, and at least one tensile strength and elongation test and one accelerated aging test shall be made on the material used for each order. If the compound or cure, or both, are changed during the production of material for one order, at least one test of each type shall be made for each different batch.

When testing the 6-inch by 1/2-inch ASTM "dumb bell" type test specimen (or smaller size if the size of the part necessitates) by the methods specified in ASTM D-3182, D-3183, D-3190, and D-412, the tensile strength shall not be less than 1,500 psi and elongation shall be a minimum 300%. The tensile strength of the elastomer shall not be reduced more than 25% when subjected to accelerated aging by the methods specified in ASTM-D-573, for a period of 96 hours in an air oven at 70°C (158°F). The tear resistance shall be 200 minimum when tested according to ASTM-D-624. When tested according to ASTM-D-471 the ASTM #3 oil swell volume change shall not exceed 80%.

The ozone resistance of the elastomer shall be tested in accordance with ASTM D-1149 using an ozone concentration of 1 ppm, an exposure time of 100 hours at 100°F, and a specimen elongation of 20%. The elastomer shall not exhibit any cracks during the test period.

22.7.3 Life Expectancy

For all parts made by vulcanizing an elastomer to metal, any premature failure (less than 5 years) between metal and the elastomer or in the elastomer, occurring when the parts are used in normal

service and according to the provisions of this Specification, shall be considered as having been caused by defect of materials or workmanship.

22.7.4 Metal Parts

Metal parts to which elastomeric material is vulcanized shall be made of SAE 1020 or SAE 1045 hot-rolled steel except for brass or brass alloys internal air brake components.

22.7.5 Bonding

The joining of elastomeric pieces shall be done by the hot vulcanization process. Bonding of elastomers shall not be allowed unless the Contractor submits the application, bonding procedure and bonding agent technical data for approval prior to the purchase of any materials.

22.7.6 Truck Parts

Truck bumpers, snubbers, and the exterior surfaces of air springs shall be made of natural rubber or approved equal. They shall be compounded to be resistant to abrasion, oil, grease, and acid.

22.7.7 Seals

Glazing strips shall be of neoprene conforming to ASTM C-542, or approved equal material.

All door mating edges, door and window seals, and glazing strips shall be of neoprene material. The durometer hardness measured with a Shore Type "A" durometer at a temperature between 70°F and 90°F shall be 70, ± 5.

22.8 GLAZING MATERIALS

22.8.1 Safety Glass

Safety glass shall meet the requirements under Item 1, Table 1 of the latest revision of ANSI Z26.1, "American National Standard for Safety Glazing Materials for Glazing Motor Vehicles and Motor Vehicle Equipment Operating on Land Highways - Safety Code."

Laminated safety glass used in the F-end of the car, including that in the end door, shall be certified as having been tested and having met the FRA 49CFR223 Type I requirements. Side window and non F-end glazing shall meet FRA 49CFR223 Type II requirements.

To prevent particles of glass from striking the Operator, the window in front of the Operator shall incorporate a spall shield as its interior surface.

22.8.1.1 *Type*

All safety glass shall be of the laminated sheet type and shall consist of a minimum of two sheets of glass bonded with an approved interlayer of plasticized polyvinyl butyral resin in the form of a membrane approximately 0.045-inch thick, and resistant to degradation from ultraviolet or visible light and heat.

22.8.1.2 *Flatness*

When an individual piece of glass is laid on a truly flat surface, such as a surface plate, the glass shall not indicate a bow of more than 0.030-inch per linear foot.

22.8.1.3 *Dimension Tolerance*

The overall dimensions of individual pieces as supplied shall be held within 0.060-inch of the dimensions ordered.

22.8.1.4 *Overlap Tolerance*

The overlap of one laminate of the piece with respect to the other, at an edge, shall not exceed 1/32-inch. Corners and burrs shall be ground smooth and all edges shall be treated in accordance with ANSI Z26.1, Section 6.

22.8.1.5 *Color*

The color of the glass shall be as required by Section 10. When new, there shall be no more than $\pm 4\%$ variation in the color of individual pieces of laminated sheet glass when examined over a white background.

22.8.1.6 Haze

All the laminates of the safety glass shall be so nearly free from haze that the glass shall have approximately the same clarity as a piece of the same nominal thickness of plate glass when viewed against a north light.

22.8.1.7 Specks and Scratches

Occasional specks of foreign material and scratches are permissible, provided such specks do not exceed 0.020-inch in greatest dimension, a maximum of 0.75" in length, and scratches do not exceed a total sum of 3 inches in length and neither are within the central three-quarters area of the light.

22.8.1.8 Bond Separation

The bond between two sheets of glass and the membrane shall be of such quality that when the glass is broken by twisting or by direct impact, there will be no separation between the glass sheets. Lights that contain unbonded areas ("let-go's") shall not be used.

22.8.1.9 Marking

All safety glass shall be marked with proper identification in accordance with ANSI Z26.1, Section 7, and appropriate FRA-Type designation. The window light shall be installed so that the identification marking can be read from the inside lower right hand corner.

22.8.2 Plastic Glazing

Plastic glazing shall not be used.

22.9 FLOOR COVERING

Floor coverings shall meet all applicable industry standards (APTA, ADA, ASTM, FRA, etc.) as well as all safety requirements as described in Section 4 of this Specification.

22.10 WOOD AND PANELS

22.10.1 Lumber

Lumber shall be thoroughly air seasoned or kiln dried before using and shall be dressed on all surfaces to full dimensions. Lumber shall be straight-grained, free from dry rot, knots, checks, and other defects that may impair its strength and durability or mar its appearance.

22.10.2 Plymetal

The term "plymetal" as used in this Specification means metal-faced plywood. All plymetal panels shall be tested in accordance with ASTM C 273 and the following requirements. Codes and standards other than those referenced in this specification may be submitted to SFMTA for approval. The submittal shall include technical justification demonstrating that the proposed substitution meets or exceeds the Codes and standards referenced in this specification.

Mechanical Properties	Minimum Metal to Wood Average Shear Value or 80% Wood Failure
Dry shear	250 lbf/in ²
Boil shear; 3-hour boil; tested wet at room temperature	150 lbf/in ²
Soak shear; 48-hour soak wet at room temperature	150 lbf/in ²
Creep or cold flow; under static load for 48 hours; at room temperature	250 lbf/in ²

The metal face of the plymetal panel that is faced with melamine shall be constructed in accordance with Section 22.10.6 prior to the melamine-faced metal panel being laminated to the plywood core.

22.10.3 Plywood

All plywood shall be manufactured to conform with the requirements of Grade - Structural I of the National Bureau of Standards Voluntary Product Standard (American Plywood Association) PS 1-95, or approved equal and then stored under cover. Each plywood panel shall be formed from one piece. Scarf or finger jointed panels are not allowed. All plywood shall be sealed with two coats of an epoxy paint, or approved

equal on all edges and cutouts as soon as possible after fabrication. All exposed edges of the panels, joints between panels, fastener heads, and openings of panels used in areas accessible to moisture shall be waterproofed and sealed with an approved coating prior to installation in the car.

22.10.4 Honeycomb Panels

The term "honeycomb panels" as used in this Specification refers to an assembly of honeycomb material bonded to melamine-faced metal panels or to metal panels. Honeycomb material shall be commercial-grade 3003 aluminum honeycomb meeting the requirements of MIL-C-7438G. Bonding shall be sufficient to develop the full strength of the honeycomb material.

22.10.5 Panel Contour Tolerance

Surfaces exposed to passengers shall not deviate from the specified contour by more than 3/32-inch in any 36-inch distance. The slope of any such deviation shall not exceed 3/32-inch in 12 inches.

22.10.6 Melamine-Faced Aluminum

Melamine-faced aluminum panels shall be constructed by laminating melamine to aluminum sheets. The melamine-impregnated papers shall be directly molded to the aluminum sheets at temperatures of no less than 270°F and pressure no less than 1,000 psi. The surface characteristics, after manufacture, shall be no less than that required of type GP (General Purpose) in the NEMA Standards Publication No. LD-3, latest revision. The melamine and the required binder sheets shall be 0.013 inches, \pm 0.005-inch thick. The aluminum sheets shall not be less than 0.025-inch in thickness when used as a facing on plywood. The aluminum sheets shall not be less than 0.081-inch in thickness when not laminated to a substrate such as plywood. Aluminum sheets shall be properly cleaned by etching, sanding, or other approved process to ensure full, permanent, adhesion.

The use of contact adhesives to bond the melamine sheets to the aluminum backing is not acceptable.

The bond between the melamine and aluminum sheets shall, as a minimum, meet the following requirements:

- A. Internal bond (ASTM-D-952): 2,600 lbf/in²
- B. Flexural strength - (S) (ASTM-D-790)

1. With grain: 26,500 lbf/in²
2. Crossgrain: 25,300 lbf/in²

C. Modulus of elasticity - (E) (ASTM-D-790)

1. With grain: 2.8×10^6 lbf/in²
2. Crossgrain: 3.1×10^6 lbf/in²

D. Tensile strength (ASTM-D-638)

1. With grain: 22,300 lbf/in²
2. Crossgrain: 20,300 lbf/in²

22.10.7 Phenolic Cored Panels for Flooring

Phenolic cored panels shall mean panels constructed of top and bottom fiberglass-reinforced phenolic resin matrix skins encapsulating a phenolic reinforced, syntactic foam coring. The panel skins shall be comprised, at a minimum, of 24 oz/square yard bi-axial and 9 oz/square yard mat laminated on each side of reinforced, syntactic foam coring. The corresponding minimum skin thicknesses shall be 0.050 inches thick.

The thickness of the phenolic resin matrix skins shall be increased, if necessary, to meet the following strength requirements. With the vehicle floor loaded to simulate a uniformly-distributed AW3 passenger load plus interior equipment, such as seats, interior liners, and equipment boxes, the following conditions shall be met:

- A. The floor panels shall not deflect more than 1/250 of the shortest span between supports, up to a maximum of 1/16 of an inch. The floor shall not take a permanent set when the load is removed. An analysis shall be submitted demonstrating compliance to deflection requirements.
- B. The floor panels shall sustain no permanent deformation under normal use (passenger portion of AW3 distributed uniformly along the vehicle during the design life of the car, and shall be designed to withstand the specified loading without exceeding 50 percent of the yield stress of the flooring material.
- C. The maximum stress in the floor beams shall be less than 50 percent of the critical buckling stress or 50 percent of the yield strength of the material, whichever is less.

The panel structure shall contain a dense fiberglass reinforced phenolic resin close-out core to provide support for all edges, cut outs and holes. Fastener holes shall be pre-drilled and countersunk to accommodate the approved fasteners.

The panel shall be manufactured using the matched die molding process with the application of heat and pressure. Production techniques shall ensure that the glass fiber reinforcement is uniformly distributed throughout the final product in such a manner as to avoid resin-rich or resin-starved sections.

A stress analysis shall be performed to confirm that the construction of the manufactured panel is adequate for its intended purpose and meets the specified strength requirements.

The panel shall meet the following requirements:

<u>Mechanical Properties</u>	<u>ASTM Test</u>	<u>Requirement</u>
Flatwise Tension	C-297	Strength greater than 1,300 psi
Flatwise Compression	C-365	Strength greater than 1,210 psi
Flatwise Shear	C-273	Strength greater than 310 psi
Flexural Properties	C-393	For a span of 15 inches, failure load greater than 155 lb/in

22.11 SECTION DELETED

22.12 FIBERGLASS-REINFORCED PLASTIC

22.12.1 General

Fiberglass-reinforced plastic (FRP) shall be a glass-fiber-reinforced, laminated material, composed of a gel coated surface, fiberglass reinforcement, and an approved resin. FRP shall withstand, without any physical deformation or structural damage, the environmental conditions in Section 1, be resistant to acids, alkalies, and cleaning solutions recommended by the Contractor.

FRP shall be manufactured by either open molding, hand layup, or the matched die molding process. Production techniques shall ensure that the glass fiber reinforcement is distributed throughout the final product in such a manner as to avoid resin-rich or resin-starved sections.

FRP parts shall have a greater thickness at attachment points and edges. Exposed sharp edges will not be allowed on any parts. A stress analysis shall be performed to confirm that the construction method chosen is adequate for its intended purpose and meets the specified strength requirements.

22.12.2 Construction

22.12.2.1 Resin

The resin shall be of good commercial grade, thermosetting, material selected to meet the physical properties of this Specification and molding process requirements.

22.12.2.2 Reinforcement

The fiberglass reinforcement shall be mat, fabric, woven roving, continuous roving, chopped spun roving, or swirl mat as required to meet the physical properties of this Specification and the molding process requirements. The glass content shall be confirmed through testing to ASTM-D-2584.

22.12.2.3 Gel Coat

The gel coat shall be resistant to scuffing, fire, weather, and cleaning agents. The gel coat shall have a minimum thickness of 0.016 inches and a maximum thickness of 0.032 inches. If the surface of the FRP panel is to be painted, a primer gel coat shall be used and the part shall be painted in accordance with Section 22.23. If the FRP panel does not receive paint, then the gel coat shall be pigmented to match the color selected by SFMTA. Three sets of samples shall be submitted to SFMTA.

Finished gel coated surfaces shall have a minimum gloss value of 85 when measured with a 60° glossometer and shall exhibit no print through of the reinforcements or have any appreciable orange peel.

22.12.2.4 Additives

Additives, fillers, monomers, catalysts, activators, pigments, fire retardants, and smoke inhibitors shall be added to the resin mixes to obtain finished products with the required physical characteristics of this Specification.

Mineral filler shall not exceed 28% of finished weight for any preformed matched die molding process.

22.12.3 Strength Requirements

Independent laboratory tests shall be performed on test coupons that are trimmed from production parts. Independent laboratory test reports shall be provided confirming that the reinforced plastic material complies with the requirements of the following standards. Test specimens shall be conditioned in accordance with ASTM D 618.

Minimum Requirements – Interior Components

<u>Mechanical Properties</u>	<u>ASTM Test</u>	<u>Open or Match Die Moldings</u>
Tensile Strength	D-638	10,000 lbf/in ²
Compressive Strength	D-695	18,000 lbf/in ²
Flexural Strength	D-790	15,000 lbf/in ²
Impact Strength	D-256	6 ft.-lbs per inch of notch
Hardness	–	45 Barcol

Minimum Requirements – Exterior Components

<u>Mechanical Properties</u>	<u>ASTM Test</u>	<u>Open or Match Die Molding</u>
Tensile Strength	D-638	18,000 lbf/in ²

<u>Mechanical Properties</u>	<u>ASTM Test</u>	<u>Open or Match Die Molding</u>
Compressive Strength	D-695	24,000 lbf/in ²
Flexural Strength	D-790	30,000 lbf/in ²
Impact Strength	D-256	8 ft.-lbs per inch of notch
Hardness	–	45 Barcol

22.13 THERMOPLASTIC SHEET

22.13.1 General

Thermoplastic sheet used in the construction of this vehicle shall withstand, without any physical deformation or structural damage, the environmental conditions described in Section 1 and shall be resistant to SFMTA cleaning solutions. Thermoplastic sheet shall be used as extruded or vacuum-formed.

Thermoplastic sheet shall be homogeneous and extruded from virgin stock which does not include any regrind of vacuum formed parts. The exposed surface of this material shall conform to the color, texture, and gloss specified in 22.8. Only UV stabilized pigments shall be used to create the specified color of the thermoplastic sheet. The color and surface finish of parts manufactured from this material shall be approved prior to the production run of any parts. Three sets of samples shall be submitted to SFMTA.

22.13.2 Quality

The finished parts shall be free of waves and quilting on both sides. Degraded polymer in the sheet shall not be allowed, and if present, shall be cause for rejection of the piece. Voids, lumps, and contamination shall also be cause for rejection of parts if the defects are larger than 0.010-inch, and the population of these defects is greater than one defect in four square feet.

22.13.3 Strength Requirements

Independent laboratory test certificates shall be provided stating that the thermoplastic sheet complies with the requirements of the following standards. Extruded sheet in the surface finish specified shall be used for testing.

<u>Mechanical Properties</u>	<u>ASTM Method</u>	<u>Value</u>
Specific Gravity	D-792	1.20 to 1.45
Tensile Strength	D-638	5,500 lbf/in ² minimum
Flexural Strength	D-790	8,000 lbf/in ² minimum
Flexural Modulus	D-790	3.3 x 10 ⁵ lbf/in ²
Hardness Rockwell "R" Scale	D-785	90 to 110
Heat Shrinkage; 15 minutes at 350°F	–	10% maximum
Heat Deflection (annealed) at 264 lbf/in ²	D-648	165°F minimum
Impact Strength, Fabricated Parts; Gardener Dart Drop 1/2-inch diameter ball at 73°F	D5420: 1996 and D5628	160 in-lb. Minimum

22.14 PIPING AND TUBING

22.14.1 General

All piping, valves, fittings, installation methods, and testing shall be in accordance with the Code for Pressure Piping, ANSI B31.1. All joints shall be easily accessible. All cut-out cocks or other manually operated valves shall be locking type with provisions for safety wire.

Following installation, all piping systems shall be cleaned to remove dirt, metal chips, oily contamination, and moisture. After cleaning, all piping systems shall be pressure tested in accordance with the latest edition of the Code for Pressure Piping, ANSI B31.1. All leaks shall be repaired and the system recleaned and retested until leak-free.

Pipes must be supported throughout their length and at all connections to prevent vibration or noise and to limit stresses in the pipe to less than 50% of the pipe's fatigue endurance limit. Pipes and their connections shall not interfere with the removal of other components. Pipe routing and support shall be planned and accomplished in an efficient, organized manner to keep the total length and number of fittings and bends to an absolute minimum. All changes in direction shall be accomplished by bending the pipe to a radius of not less than specified by AAR Specification No. 2518, Standard S-400, and not with fittings. Support and clearances provided between adjacent pipes and between pipes and surrounding structure, equipment or other appurtenances shall be sufficient to prevent chafing or contact due to any

combination of car loading and deflection, car dynamics, and thermally induced movement. The minimum clearance shall be 1/4-inch.

At all locations where pipe or tubing passes through holes in the floor, bulkheads, structure, or any fixed member, it shall be rigidly clamped to protect against possible damage or noise due to bearing, abrasion, or car dynamics-induced rattling. Clamps shall not be welded, brazed or otherwise permanently fastened to any pipe or tubing. Pipe and tubing interfaces with clamps shall be insulated with an elastomeric or woven non-asbestos mineral fabric tape material to protect and sound-insulate the pipe or tubing.

Wherever carbody piping interfaces with vibration-isolated rotating equipment such as the air compressor and air conditioning compressor-condenser unit, approved flexible vibration eliminators shall be used. The pipe connection at either end of the flexible elements shall be rigidly clamped no farther than 2 inches from the flexible elements. All pipe clamps shall be inherently rigid and shall be firmly attached to car structure. Cantilevered clamps or clamp supports that are weaker than service-proven designs will not be accepted. All clamps shall be of a suitable material for the application.

22.14.2 Air Piping, Tubing and Fittings

All pneumatic piping shall conform to ASTM A269, 304L seamless annealed stainless steel tubing, 18 gage minimum wall for 1/2-inch tubing, 16 gage minimum for 3/4-inch tubing, 14 gage for 7/8-inch tubing. All air pipes shall be sized in accordance with the function intended. The diameter of the main reservoir pipe and brake pipes shall meet the brake supplier's requirements; however, in no case shall these pipes be less than 7/8-inch O.D.

All air piping must comply in all respects with the air brake supplier's design and installation requirements. Prior to manufacture of production cars, the Contractor shall provide SFMTA with a report containing written approval from the air brake supplier of the Contractor's air brake piping fabrication, installation, and design concept. The following information shall be contained in the report:

- A. All critical line sizes and materials including the main reservoir pipe, the emergency brake pipe, and the brake cylinder piping.
- B. The installation details of the above critical lines including routing, total length and volume, elevation and slopes, and major joint and direction change locations. A list of all proposed bend radii shall also be provided.
- C. Pipe processing details including welding, brazing, cleaning, and fabrication methods, as required by Section 22.22.

- D. Locations of all major air brake control, relay, and emergency venting devices, and the proposed location and volume of all reservoirs.

- E. An air consumption analysis justifying the proposed air storage system design.

All air piping shall be installed in a manner to provide drainage away from devices, or branch pipes leading to devices, when the function of those devices could be impaired by the accumulation of water or ice. Low spots (traps) are strictly prohibited on the trucks. Truck piping shall not be run on the bottom of truck side frames, transom or bolster. All connections and joints where disassembly for service may be required shall utilize hydraulic piping-style, bevel seal fittings with threaded retaining nuts. The use of threaded fittings, where the threaded connection is used to retain piping pressure integrity, is expressly prohibited.

All pneumatic piping shall be retained by clamping devices with rubber inserts. All clamps shall have a minimum of two fasteners. Single fastener clamps, e.g. P-clamps, are expressly prohibited.

All hose and hose fittings utilized within the air system shall be in compliance with AAR M-601, AAR M-618, AAR M-620 and AAR M-927. All hose fittings shall be of the reusable type as manufactured by Stratoflex, or approved equal.

All cut-out cocks shall be of the vented type, except where function prohibits. All cut-out cock handles and their arrangements shall be as described in the Friction Brake section of this Specification.

22.14.3 Section Deleted

22.14.4 Brazing and Soldering of Piping, Tubing and Fittings

All brazing and soldering shall comply with the applicable parts of Section 22.22, and the following requirements. Unless specifically approved, all refrigerant piping and air system copper tubing shall be joined using silver solder conforming to Federal Specification QQ-B-654, Class 1 or 3. Refrigeration piping and tubing shall be internally swept with a continuous flow of a non-oxidizing gas such as dry nitrogen during brazing. Condensate drain tubing shall be joined using 95-5 solder or Silver Solder as above. Solder joints shall be wiped and have flux cleaned from tubing and fittings after soldering. After fabrication, the refrigeration and air systems shall each be cleared of all dirt and foreign matter, flushed with a degreasing agent and dried, all according to a written procedure prepared for each by the Contractor and approved by SFMTA.

22.14.5 Hydraulic Piping, Tubing and Fittings

All hydraulic pipes, tubing, and fittings shall be sized for the function intended without experiencing a pressure drop of more than 15% from control to function. All exposed tubing, piping, or fittings shall be stainless steel to MIL-T-6845 or MIL-T-8504 specifications. Tubing, piping, or fittings protected from under car exposure may be either stainless steel or carbon steel to SAE J524, SAE J535, or SAE J356 standards. Wall thickness shall be Schedule 80 for truck-mounted piping and sufficient to maintain a safety factor of 6 at the maximum system pressure. Wall thickness in other locations shall be sufficient to maintain a safety factor of 6 at the maximum system pressure.

All joints for tubing or piping shall utilize fittings of the same material as the tubing or piping. Joints shall be welded, brazed, flared to 37-degrees in accordance with SAE J533b, or made with compression fittings, Swage-Lock, or equal. Connections to manifold ports, valve bodies, and other hydraulic system components shall use straight thread fittings with separate O-ring seals. Quick connect couplings shall be of the double shutoff type with valves built into both mating parts of the coupling.

All hose utilized within the hydraulic system shall conform to SAE J517 standard and hose fittings shall conform to SAE J516 standard. All hose shall be rated to withstand four times the maximum operating pressure without bursting. Hose application limits shall conform to SAE J1273, SAE J343, and SAE J1405 standards. Hose shall not be used in locations where the temperature may exceed 200°F. Hose shall be supplied clean and with both ends capped.

There shall be no inaccessible joints. Tubing shall be bent utilizing a bending tool designed specifically for bending of the tubing to be used. All tubing and piping shall be deburred after cutting. Bent tubing shall have a uniform bend free of kinks. All tubing, fittings, and subassemblies shall be cleaned and capped on all openings after fabrication. Caps shall remain in place until immediately prior to incorporation into the final assembly.

Truck piping shall not be run on the bottom of truck sides, frames, transom, or bolster.

All cut-out cocks shall be designed to automatically depressurize the portion of the system which is being isolated by the cut-out cock.

22.15 SECTION DELETED

22.16 WIRE AND CABLE

22.16.1 General

A minimum number of wire types and sizes shall be used in the vehicle.

Selection of wire sizes and insulations shall be based on the current carrying capacity, voltage drop, mechanical strength, temperature, and flexibility requirements in accordance with applicable AAR, ICEA, ASTM, NEC, and MIL Specifications. However, in no case shall the properties of the wire and cable be less than those properties delineated in this Specification. Extra-fine wire stranding shall be utilized on applications subject to repetitive motion.

All applications of shielded cable shall be approved.

The Contractor and each supplier of equipment shall, through the Contractor, submit samples (at least 12 inches long), specifications, and qualification test documentation of each size and type of wire and cable specified, for approval, before utilizing said wire and cable.

Three copies of notarized, certified test reports shall be furnished by the Contractor.

Only wire or cable shall be used for carrying electrical current. Exceptions are third rail shoes and other devices specifically designed to be electrical conductors. Where this Specification uses wire insulation trade names, the use of an approved equal is acceptable.

Cable and wire shall be installed such that clearance is provided between any part of the carbody or support brackets. At no time shall the clearance between the cable or wire and carbody or brackets or wire trays be less than 1/4-inch.

Cables shall not be closer than 2 inches to any wheel or other moving surface.

22.16.2 Conductors

Conductors shall be soft, annealed tinned copper, in accordance with ASTM B 33 unless otherwise noted. Minimum stranding shall conform to AAR Standard RP-585 (S501), RP-589 (S502) or ASTM B 172 Class K or ICEA S-66-524, Table L-7, Class K for AWG No. 10 or larger, as appropriate for the application.

Stranding and conductor construction for wire sizes AWG No. 12 to AWG No. 16 shall be in accordance with ASTM B 174 Class K or ICEA S-66-524, Table L-8, Class M, as appropriate for the application.

Stranding and conductor construction for wire sizes AWG No. 18 and smaller shall be in accordance with ASTM B 174 Class L or ICEA S-19-81, Table L-8, Class M, or shall be 19 strand construction as appropriate for the wire size.

The use of solid wire is not permitted except for approved wire wrap applications.

Wiring shall be sized for the intended load, voltage drop, installation method, and applicable codes. Maximum wire ampacities shall conform to the National Electric Code (NFPA 70) Table 310-16, 110°C column for wires in raceways or conduit, and Table 310-17, 110°C column for wires in free air. When the free air rating is used, the Contractor shall furnish data to show that the cables will not exceed their rated temperature at the rated current. Where more than three conductors are routed in a raceway or conduit, the ampacities shall be derated as detailed by Note 8 to Tables 310-16 through 310-19. Wire ampacities shall be derated to meet the temperature requirements of all devices to which the wire connects. When short time ratings, short time overload temperatures, and thermal time constants are used to determine cable size, the parameters used will be submitted for approval.

In no case shall wire smaller than the following sizes be used:

- A. Wire that is pulled through conduits or wireways - No. 16 AWG.
- B. Wire on electronic units, cards, and card racks - No. 28 AWG.
- C. Wire within control compartments - No. 18 AWG.
- D. Multi-conductor cables where current is not a factor in wire size selection, such as LED indicator lights or status displays - No. 18 AWG.
- E. All other wire, including that which is laid in, rather than pulled through, wireways - No. 16 AWG.
- F. Multi-conductor cables within control compartments – AWG No. 20.

Trainline wiring, and all associated connections, shall be sized for operation of consists with the maximum number of cars as allowed by Section 1. The maximum voltage drop permitted between the battery or LVPS and any load in the vehicle shall not be greater than 2 V. Voltage drop measurements shall include both the supply and return leads as well as intervening circuit breakers and switches.

22.16.3 Insulation

22.16.3.1 *General Wiring Insulation*

The insulation shall be rated at 2,000 VDC in the case of wires carrying a nominal voltage greater than 100 VAC or VDC, and rated at 600 VDC in the case of wires carrying a nominal voltage equal to 100 V or less, AC or DC.

For all general carbody wiring, the insulation shall be a flame retardant, flexible, cross-linked polyolefin material having a continuous temperature rating of 110°C. Cables for data transmission, where cable current is not a factor for the selection of the cable cross section, may be rated for a lower temperature as proposed by the Contractor and approved by SFMTA. For wire sizes No.6 AWG and larger, the insulation material shall be formulated for extra flexibility. The use of thin-wall irradiated cross-linked polyolefin insulated wire will be considered on a case by case basis provided it can meet the requirements delineated below.

The irradiated cross-linked polyolefin wire insulation shall be constructed and tested in accordance with the requirements of AAR RP-585 and the following additional special requirements:

- A. The smoke, flammability, and toxicity requirements follow:
 - 1. Flammability test shall be performed in accordance with AAR RP-585 except that the duration of burning of the specimen after the fifth and last application of the flame shall not exceed 3 seconds.
 - 2. Smoke Density (Test Method, ASTM E 662: When tested in a National Bureau of Standards Smoke Chamber in accordance with the procedure specified in Section 8.5.3.1, the Specific Optical Density (Ds) at 4 minutes shall not exceed:
 - a. On a flaming test: 200
 - b. On a non-flaming test: 75
 - 3. Toxicity: See 5.2 for requirements.

- B. The insulation shall be in accordance with the requirements of AAR Standard S-501 and the additional special industry requirements in the following list:
 - 1. Insulation Resistance (Test Method ASTM Standard D 470): The minimum value shall be 1000 megohms for 1000 feet, using a 1000Vdc megohmmeter..

2. Heat Distortion – (Test Method per ICEA S-95-658) (150°C ±2°C, maximum percent of unaged value):
 - a. No. 4/0 AWG and smaller: 20%
 - b. Larger than No. 4/0: 10%

3. Moisture Absorption – Gravimetric Method (ASTM Standard D 470); (70°C, ±2°C, for 168 hours):
 - a. Maximum absorption in milligrams per square inch: 8

4. Moisture Absorption - Electrical Method (ICEA S-66-524): Increase in Capacitance, Maximum Percent:
 - a. 1 - 14 Days: 3.0%
 - b. 7 - 14 Days: 1.5%
 - c. Stability Factor after 14 Days: 1.0%
 - d. Alternate to Stability Factor Stability Factor Difference,
1 -14 Days Maximum: 0.5%
 - e. Specific Inductive Capacity
(1 Day Maximum): 6.0%

5. Ozone (Test Method per ICEA S-10-81 paragraph 6.8): After 24 hours exposure to an ozone concentration of 0.03% by volume at 90°C, ±2°C, there shall be no insulation cracks.

6. Tension Set (Test Method per ICEA S-19-81 paragraph 6.4.15.4 or ICEA S-66-524 paragraph 6.4.11.4); (Except that the specimen shall be stretched until the 2 inch gauge marks are 4 inches apart.): Maximum: 30%

7. Corrosion (Test Method ASTM Standard D 2671-Copper Mirror): The test specimen shall be approximately 0.4 gram of the insulation, cut into small pieces. After a test period of 2 hours at $175^{\circ} \pm 2^{\circ}\text{C}$, the removal of more than 5% of the copper film constitutes a failure. Duplicate test (two separate mirrors) shall be run. Specimen must pass both tests.

8. Abrasion Resistance (Test Method AAR RP 585): Abrasion resistance test shall be performed in accordance with Section 5.9.6 except that the finished cable shall show a resistance of no less than 5000 strokes.

9. Insulated cable, 1 AWG or larger shall be tested to the IEEE standard 383 (70,000 BTU/HR flame. Propagation maximum shall be 36 inches (914 mm) above flame source and there shall be no propagation after 15 minutes of the 20 minute test.

10. Notch Propagation: Notch samples around the whole wire and cable circumference to the depth shown in table below. Place notch so that it touches and is parallel with the axis of the mandrel. Wrap the notched cable around the mandrel for 3 complete turns on each side of the notch. Place the wrapped samples (on mandrel) in the environmental temperature chamber and soak for 4 hours at $-13^{\circ}\text{F} \pm 9^{\circ}\text{F}$ ($-25^{\circ}\text{C} \pm 5^{\circ}\text{C}$). After each temperature soak, the sample shall be returned to room temperature and then subjected to the voltage Test No. 3.1 on Table 3.1 of ICEA Specification S-66-524, Column A. (NEMA WC70).

<u>Size of Conductor</u>	<u>Diameter of Mandrel</u>	<u>Depth of Notch (Mils)</u>
18 through No. 10	3 x cable diameter	10/15
8 through 1		15/18
1/0 through 4/0		22
250 and larger		35

Exposure of the conductor or failure to pass the voltage tests of any of the three specimens will constitute a failure.

11. Single Conductor Thermal Overload Test: A continuous current of 115 amperes shall be applied to an 18 foot (5.5 m) length of AWG No. 10 test wire in 77°F (25°C) still air. A 3000 volt dc potential shall be maintained between the test wire and an AWG No. 18 bare copper wire wrapped snugly around the outer insulation surface of the test wire. Failure shall be defined to occur when a short circuit is established between the bare copper wire and the test wire. Minimum time to failure shall be three (3) minutes.
 12. Bundle Overload: A bundle overload using a seven-wire bundle shall be performed in accordance with AAR Standard RP-585 (S501), paragraph 5.9.1, and test results recorded.
 13. Temperature Cycling Tests: This test shall be done on an 8 ft. (2.4 m) length sample of AWG No. 10 wire with 2 kV insulation.
 - a. Thermocouples shall be attached to the outer jacket surface, and on the conductor, under a small incision in the insulation about 12 inches (305 mm) from one end of the sample. Both ends of the sample shall be securely clamped using hose clamps.
 - b. Prior to temperature cycling, the sample shall be conditioned for 2 hours at a temperature of 302°F (150°C).
 - c. The sample shall then be temperature cycled between ambients of 257°F (125°C) and -22°F (-30°C) by transferring the sample between an air-circulating oven, set at 257°F (125°C) and an air-circulating cold box set at -22°F (-30°C). The time during which the sample stays in each chamber shall be sufficient to allow both thermocouples on the sample to read the same temperature as the environment.
 - d. One cycle shall be defined as an approved dwell time at both 257°F (125°C) and -22°F (-30°C). The sample shall be subjected to a total of 250 cycles, with a visual observation at the end of each cycle for cracks and for other damage. After 250 cycles, the sample shall be immersed in water for 6 hours with both ends out, and then subjected to a dielectric test of 5 kVAC for 5 minutes and also examined by microscope to verify that no cracks exist.
- C. Flame-retardant, flexible, irradiated cross-linked polyolefin insulation rated at 257°F (125°C) may be used, provided it meets all the above standards, modified to reflect the temperature rating related characteristics. The revised values, and the use of such wire, must be approved. Cross-linked polyolefin insulation is not permitted for use on wires connected to heater elements or any other high-temperature device.

- D. All insulation other than irradiated cross-linked polyolefin shall meet the following test requirements based on MIL-W-22759 and using the following parameters:
1. Dielectric: Test per MIL-W-22759/10B (for 1,000 V wire with tests at 9.5 KV impulse) or MIL-W-22759/6B (for 600 V wires with tests at 8 KV impulse).
 2. Insulation Resistance: Test per ASTM D 470. Minimum accepted value shall be 1,000 megohms per 1,000 feet (304.8 m), using a 1,000 VDC megohmmeter.
 3. Spark Test. One hundred percent of all single conductor cables and all single conductor cables being used in a multi-conductor cable shall be inspected by Impulse Dielectric Test or by chain electrode Spark Test. Spark Test Apparatus and Procedure shall be in accordance with MIL-W-22759. Spark Test voltages shall be equivalent to impulse test voltages by corresponding RMS value at 3 kilohertz.

Impulse Test Voltage KV Peak	3 KHz Test Voltage KV RMS
8	5.7
9.5	6.7
10	7.1

4. Air Aging: Test per ASTM D 638. Age sample for seven days at 302°F (150°C) in an air oven. Minimum tensile strength and elongation shall not be less than 85 percent of the unaged values. Also test per IEEE Standard 383-1974 and ASTM D 573 for extended life.
5. Cold Bend: Test per NEMA WC3, except test temperature shall be -58°F (-50°C).
6. Weight Loss: Weight loss of the insulation material shall not exceed one percent when subjected to an oven temperature of 266°F (130°C) for 500 hours.

7. Chemical Resistance: An appropriate length of sample shall be measured for insulation diameter and total weight to record initial values. The wire shall be immersed to within 3 inches (76.2 mm) of each end in the test fluid for 24 hours at 149°F (65°C). During the immersion stage, the minimum bend radius of the wire shall be 10 times the diameter of the wire being tested. Upon removal from the test fluid, the specimen shall be cooled to room temperature for one hour and the diameter gauged and reweighed for comparison with the original values. The maximum diameter and weight increase shall not exceed 30 percent. Typical fluids for this test include:
 - a. Humble No. 1014 Railroad Diesel Lubricating Oil and lubricants (100 percent solution)
 - b. Humble Diesel 260 or Railroad T fuel oil (100 percent solution)
 - c. Mineral oil (100 percent solution)
 - d. Hydrochloric acid, nitric acid, sodium hydroxide, sulfuric acid (0.1 percent solution)
 - e. Potassium hydroxide (0.1 percent solution)
 - f. Petroleum distillates and other graffiti removers and cleaning compounds used at SFMTA
 - g. Kerosene solvents (100 percent solution)
 - h. Trisodium phosphate solution (50 percent solution)
 - i. Skydrol 500 B hydraulic fluid (100 percent solution)
 - j. Water.
8. Temperature Cycling Testing: The test shall be done on an 8 foot (2439 mm) length sample of AWG No. 12.
 - a. Thermocouples shall be attached to the outer jacket surface, and on the conductor under a small incision in the insulation about 12 inches (305 mm) from one end of the sample. Both ends of the sample shall be securely clamped using hose clamps.

- b. The sample shall be conditioned for 2 hours at a temperature of 302°F (150°C). The sample shall then be temperature cycled between ambients of 257°F (125°C) and -22°F (-30°C) by transferring the sample between an air-circulating oven, set at 257°F (125°C) and an air-circulating cold box set at -22°F (-30°C). The time during which the sample stays in each chamber shall be sufficient to allow both thermocouples on the sample to read the same temperature as the environment.
 - c. One cycle shall be defined as an approved dwell time at both 257°F (125°C) and -22°F (-30°C). The sample shall be subjected to a total of 250 cycles, with visual observation at the end of each cycle for cracks and for other damage. After 250 cycles, the sample shall be immersed in water for 6 hours with both ends out, and then subjected to a dielectric test of 5 kVAC for 5 minutes and also examined by microscope to verify that no cracks exist.
9. Single Conductor Thermal Overload Test: A continuous current of 115 amperes shall be applied to an 18 inch (45 mm) length of AWG No. 12 test wire in 77°F (25°C) still air. A 1,000-volt dc potential shall be maintained between the test wire and an AWG No. 18 bare copper wire wrapped snugly around the outer insulating surface of the test wire. Failure shall be defined to occur when a short circuit is established between the copper wire and the test wire. Minimum time to failure shall be three minutes.
10. Seven-Wire Bundle Thermal Overload Test: A seven-wire cable bundle shall be formed by twisting six insulated AWG No. 12 conductors around a center insulated AWG No. 12 conductor.

A 120 ampere current shall be passed through the center conductor for seven minutes. After a test period the cable bundle shall be examined for visible damage to the outer six conductors. Failure shall be defined to occur if any of the outer conductors split, rupture or melt and adhere to the center conductor insulation.
11. Qualification and Production Tests: The tests required for this Specification concerning Qualification and Production shall be in accordance with tests required in MIL-W-22759 for all lots produced, as called for in this Specification.

All test reports covering Production and Qualification tests shall be furnished with requested samples prior to any shipment of materials.

22.16.3.2 Wire Insulation for High Temperature Applications

High temperature insulation shall be used where connected to heat-generating apparatus, where the ambient temperature can exceed 257°F (125°C), or where Teflon is specified as a requirement. The insulation shall be rated at 1,000 volts DC in the case of wires carrying a nominal voltage greater than 100 volts AC or DC, and rated at 600 volts DC in the case of wires carrying a nominal voltage equal to or less than 100 volts AC or DC. The insulation shall have a continuous temperature rating of 302°F (150°C) or above and be in accordance with the following requirements:

- A. For wire sizes No. 16 AWG and larger: abrasion-resistant Teflon Polytetra-fluoroethylene (PTFE) meeting MIL-W-22759/6B or 10B as appropriate for voltage used, or silicone rubber meeting AAR S-503.
- B. For wire sizes No. 18 AWG and smaller: abrasion-resistant PTFE Teflon meeting MIL-W-22759/6B or 10B as appropriate. When used for interconnecting pieces of apparatus, this type wire shall be in bundles with a protective covering of high temperature, low smoke generating insulation.

The Contractor may propose other insulated wire specifications for approval in a specific high temperature application, specifying the design ambient temperature, routing, RMS ampere value, worst-case ampere value, worst-case temperature rise, stranding, and insulation material specification.

No high temperature insulated wire shall be used in conduit or raceways without specific approval. The Contractor shall submit all applications of high temperature wire insulation for approval.

22.16.3.3 Wire Insulation Within Equipment

Insulation on wiring within replaceable modular units, electronic apparatus such as cards and card racks, and other equipment, as approved, shall be Tefzel Ethylenetetrafluoroethylene (ETFE) per ASTM D 3159 and insulation construction per Military Specification MIL-W-22759/16 (AS), irradiated cross-linked polyolefin per Section 22.16.3.1 above, or Teflon Polytetrafluoroethylene (PTFE) type EE per Military Specification MIL-W-16878/5.

22.16.3.4 Wire Insulation at Crowded Locations

Wire for connections to the control console, or in any other locations where there are equally crowded concentrations of low voltage control wiring, shall be insulated with Tefzel (ETFE) per ASTM D 3159 and insulation construction per Military Specification MIL-W-22759/16 (AS) except the wall thickness shall be 0.025 inches. When used for this application, these type wires shall be bundled with a protective covering of cross-linked modified polyolefin or similar approved high temperature rated, low smoke generating insulation.

22.16.4 Multi-Conductor Cables

22.16.4.1 General

Multi-conductor cables, where approved, shall be constructed using wiring as described in Section 22.16.2 and 22.16.3 and/or NEMA WC27500. Where a conflict exists, the most restrictive condition will apply. Multi-conductor cables shall be made by assembling individual or twisted pairs of stranded wires in a cylindrical form using non-hygroscopic, flame and smoke resistant fibers and tape meeting the requirements of this Specification. For high temperature applications, the cable shall conform to MIL-C-27072, with Type V connectors, Style 4 sheaths, Class D jackets, if needed, and shields, if needed. All conductors in multi-conductor cables shall be color coded or otherwise permanently identified as approved. Materials used in the construction of multi-conductor cables shall meet the requirements below. In applications where current is not a factor in wire size selection, such as LED indicator lights or status displays, AWG No. 16 may be used between repeater devices and displays. If approved, flat ribbon cable may be used for internal wiring applications to equipment enclosures and electronic racks to interconnect different printed circuit boards.

22.16.4.2 Fillers

Where required to obtain a circular cross-section, fillers shall be made of non-hygroscopic materials compatible with the wire insulation and jacket, and shall be of the same or of a higher temperature rating than the wire insulation.

22.16.4.3 Tape

A binder tape shall be employed over the assembly of conductors in multi-conductor cables if needed to assist in cable manufacture, or as required to permit the cable to function as intended in its application. The binder tape material shall be non-hygroscopic and shall be of the same (or better) temperature class as the wire insulation, and shall be of a compatible material.

22.16.4.4 Shield

The shield, if required, shall consist of either copper braid, concentrically served copper, or aluminum/polyester tape with a drain wire, as is appropriate for the application. The shields shall have the following minimum properties:

- A. Copper shield shall be made of either tinned, coated copper strands which conform to ASTM-B-33, or silver-coated copper strands which conform to ASTM-B-298, as is appropriate for the wire insulation. Shield coverage shall not be less than 85%. Shield strand size and application shall be as recommended by the cable manufacturer for the particular application but shall not be smaller than AWG No. 38..

- B. Aluminum/polyester tape shields shall consist of a helical wrap of aluminum/ polyester tape with a nominal thickness of 0.0004 inch aluminum on a backing of 0.001-inch polyester. The tape shall have a minimum overlap of 10% of the tape width to ensure complete coverage. In contact with the aluminum side of the shielding tape shall be a No. 22 AWG 7/30 tinned copper drain wire conforming to ASTM-B-33 and B-174.

22.16.4.5 Jackets

The overall jacket of multi-conductor cables shall be of flame retardant, cross-linked, modified polyolefin; ETFE Tefzel or PTFE Teflon to match the wire insulation and application as approved. The coupler cable shall have a jacket of low temperature arctic grade neoprene per MIL-C-13777, with a wall thickness suitable for 600 volts. The jacket shall be extruded and vulcanized over the cabled conductors, and shall be well centered, with a smooth appearance without objectionable roughness or irregularities, consistent with good industry practice. The nominal jacket thickness shall be that shown below, with the minimum wall not less than 80% nominal value.

Cable Diameter Under Jacket	Modified Polyolefin	Teflon or Tefzel	Neoprene
0.000-0.250	0.045	0.010	0.072
0.251-0.500	0.045	0.015	0.087
0.501-0.750	0.060	0.021	0.1
0.751-1.000	0.080	0.021	0.1
1.000-1.500	0.080	0.025	0.115
1.501-2.000	0.11	-	0.135
2.001-2.500	0.13	-	0.152
2.501-3.000	0.14	-	0.195

22.16.5 Wire Wrap

Wire wrap connections may be used in selected electronic applications, where approved. Where used, the following standards, as a minimum, shall be followed:

- A. Only soft or annealed oxygen-free solid copper conductor shall be used.
- B. Wire size shall be No. 28 AWG.
- C. A silver conductor coating, with a minimum coating thickness of 40 micro-inches, shall be applied to the wire.
- D. Wire shall have "MIL-ENE" insulation, or approved equal manufactured to MIL-W-81822/1A. The insulation shall have a minimum 300 VAC/VDC voltage rating and shall allow a 135°C maximum conductor temperature.
- E. Wrapping shall be "modified" wrap, nominal 7-1/2 turns, including 1-1/2 turns for strain-relief.

22.17 WIRING

22.17.1 General

All car wiring shall be in conformance with Chapter 3 of the National Fire Protection Association's Publication NFPA No. 70, National Electric Code, and the AAR Manual of Standards, Section F S-538, "Wiring Practice and Rolling Stock Standard," except where otherwise specified, and except that all wire shall be as required in this Specification. Circuit protection shall be in conformance with Chapter 2 of NFPA publication No. 70, Article 240.

22.17.2 Wire Handling

All wiring shall be performed by qualified, experienced wiring personnel using appropriate tools for stripping insulation, cutting, tinning, soldering, harness making, attaching terminals, and other wire fabrication tasks. All wiring tools and equipment shall be used as recommended by the tool and equipment manufacturer.

Wire shall be protected from damage during all phases of equipment manufacture. Wire shall not be walked on, dragged across sharp or abrasive objects, kinked or twisted, or otherwise mishandled. The

ends of wire shall not be permitted to lay on wet floors or other damp areas where moisture may be absorbed into the conductors. Wire subjected to the above or similar damage shall be discarded or otherwise dispositioned subject to approval.

When removing insulation, wire strands shall not be nicked or broken in excess of the requirements of FAA Specification No. AC 43.13-1A, Section 449, "Stripping Insulation."

In addition, the following criteria applies:

Wire Size	Maximum Number of Nicked Strands*
Wires smaller than No. 10	None
No. 10 through 1/0	7.4%
Above 1/0 through 1600/24	4.4%
Above 1600/24	Graduated Scale

* Definitions:

1. A cutoff strand shall count as two nicked strands.
2. A nick is defined as 25% or more of the strand area damaged, or cut more than 33% of its diameter.
3. Longitudinal scratches in a copper strand are not considered cause for rejection.

22.17.3 Wiring Layout and Installation

22.17.3.1 Wire Harness

The layout of wiring, for both car and equipment, shall be designed in advance of its installation and in cooperation with the suppliers of the related equipment. Wiring shall be pre-fabricated into standard harnesses, wrapped and tied with a high strength, waxed lacing cord designed not to invade the wire insulation or nylon wire ties. Harnesses shall be installed with identical arrangement and location in each car having similar equipment. Separate harnesses shall be provided for major circuit groups or types, or as required for specified circuit separation. All circuits and branches shall be separable by means of terminal boards to isolate portions from others for troubleshooting and searching for undesired grounds. All circuits subject to periodic high potential tests shall be so arranged that they can be conveniently set up for the tests.

Alternative methods for fabricating and installing wiring, which are standard carbuilder practice, will be considered for approval.

Harnessed wires shall not be installed in conduit. Wires from different conduits or other openings shall not be harnessed together with wires running within the box or entering the box through another entrance point. Each harness, wire trough, conduit, or group of wires between equipment enclosures shall contain a minimum of 10% spares, but no fewer than two spares for each wire size.

22.17.3.2 Circuit Separation

Circuits shall be physically separated to reduce the possibility of unsafe conditions, interference, or equipment damage.

The following major circuit groups shall not be harnessed or bundled together, shall not run in the same conduit, and shall be physically separated and secured in enclosures, wire ducts, junction boxes, or other wire routing devices:

- A. ATC/ATS/Cab Signal circuits
- B. High voltage circuits
- C. AC circuits
- D. Communication circuits
- E. Battery voltage level circuits
- F. Semiconductor gating voltage level circuits
- G. Network circuits
- H. Third rail circuits
- I. Conductors carrying in excess of 100 Amps

Wires that are connected in circuits with potentials differing by 50 volts or more shall be separated by a physical barrier. Whenever possible, the wires shall not be cabled together and shall not be placed in the same conduit, junction box, or enclosure. Where a raceway, duct, junction box or enclosure is divided into two or more distinct areas by metallic partitions, each area may be considered separately in the application of this rule.

Where it is impossible to avoid having wires at different voltages in the same equipment enclosure, the wires shall be physically separated, bundled, and secured separately such that contact between wiring is not possible. All wiring within an enclosure shall be insulated for the highest voltage in the enclosure, unless approved otherwise. All wiring connected to a piece of apparatus shall be insulated for the highest voltage connected.

Wiring connected to transient-generating apparatus, such as unsuppressed contactor coils, shall not be run adjacent to wiring carrying signals to, from, or between semiconductor circuits, logic circuits, vital no-motion circuits, or communication circuits. In cases in which adequate physical separation is impossible, shielded wire shall be used for all conductors involved.

22.17.3.3 *Wire and Cable Runs*

Wire runs shall be continuous and unbroken between connection points, shall be supported at no greater than 2 foot (610 mm) spacing, and be protected at each support point against mechanical crushing and abrasion. A water-tight bushing and drip loop shall be provided on all exposed cable entries. All cable bundles and wires shall be routed a minimum of 1-inch (25.4 mm) above the bottom of equipment enclosures.

All undercar wiring smaller than No. 6 AWG shall be run in closed wire ducts, conduits, or open wire mesh wireways in an approved manner. Wire and cable shall be secured within ducts or open wireways, including each entrance and exit point, to prevent chafing movement. Wire ducts and conduits shall be of waterproof construction. Permanently retained watertight strain relief bushings, with insulated throat liners, of an approved design, shall be used at locations where wires, cables, or harnesses enter or exit conduit, ducts, apparatus, and equipment enclosures. In addition, strain relief bushings on equipment enclosures shall include a permanently retained O-ring type seal.

Lead wires to resiliently-mounted electrical apparatus shall be carried in conduit to a point as close to the apparatus as possible. The length of the leads between the end of the conduit and each piece of apparatus shall be as approved. Short runs of cables or harnesses entering or leaving conduit and apparatus shall have an approved guard mounted to the carbody to protect the wires from mechanical damage. Lead wires to solidly-mounted, electrical apparatus and equipment enclosures shall run in conduit connected to the apparatus or enclosure.

Any wiring run through the floor shall be run in ducts or conduit. Wiring, even if enclosed in loom, must not be run through partitions without suitable bushings being provided at such points of passage.

Cables shall be laid in place with sufficient slack at the bends so that cables will clear the inside bend surface of the wireway/wire duct.

All wire and cable shall be free of kinks, insulation damage, insulation abrasions, and nicked strands. Wire installation shall not be subject to accumulations of water, oil, or other foreign matter.

Wires or cables shall not pass through or over the battery compartment and shall not pass over heat generating equipment such as acceleration and braking resistors, even if the wires or cables are in conduit.

Harnesses exposed, short cable runs or harnesses entering or leaving exposed raceways shall have approved, fire-resistant flexible dielectric sleeving over the raceway edges and grommet-type insulation of any penetration holes. Wiring shall be retained to the sleeving with tie-wraps.

22.17.3.3.1 Cable Cleating and Support

All cable and wiring exiting wireways/wire ducts, or that which is not installed in conduit shall be cleated using fiberglass or molded neoprene rubber split-block cleats with clamp stops to prevent over-compression of the wire insulation. The cushioning material shall be fire retardant insulating material with a durometer of 50 to 60 meeting the requirements of Section 22.7. If neoprene rubber split-block cleats are used each cleat shall have a stiffener of at least 10 gauge material on the side away from the mounting bracket which shall act to spread the bolt clamping force over the entire length of the cleat. Bolts shall have lock nuts. The Contractor shall minimize the quantity of different configuration cable cleats.

No. 6 AWG or larger insulated wire may be cleated in place without conduit, duct or open wireway. However, in the areas over the truck, in the wheel wash and not protected by underfloor mounted equipment, the wire shall be mechanically protected by an open mesh, expanded metal or other type of approved guard. The guard may be attached to the bottom of each cleat with the cleat clamping bolts or other approved arrangement.

Cleats shall be designed to grip each cable individually and firmly, but without causing any damage to cable insulation, including cold flow of the insulation. Each cable in the cleat shall have its own cutout sized to the correct wire diameter. Cleated cables shall be routed and supported such that they cannot, under any combination of forces and car movement, touch each other or any other part of the car, except the cleat cushioning material.

Wire and cable runs shall be continuous and unbroken between terminations and shall be supported at not greater than 24-inch intervals in ducts, open wireways or when cleated. The wire shall be protected at each support point against mechanical crushing and abrasion.

Wire splices will not be permitted, except with express written approval and in accordance with the wire splicing requirements of Section 22.18.9.

Concealed wires, such as within conduits and wire ducts shall be such that wires may be replaced or added to without the removal of other than an access panel at each end of the wire. It shall not be necessary to disconnect or disassemble conduit to accomplish this task.

Wiring run in loom shall not be carried over a potential chafing hazard.

Wires entering any removable box shall be harnessed and secured to facilitate removal of the box.

All wires and cables shall be fully protected against any contact with any surface other than that designed specifically to support or protect them. This applies to all current carrying wires, cables or buses on the vehicle.

22.17.3.3.2 Wire Securement and Termination

All wiring shall be secured and protected against movement, chafing, and any contact with conductive, sharp, or abrasive objects including the inside surfaces of wire runs.

No wiring shall be secured directly to the car structure, equipment enclosures, or any metallic surface. Wiring securing devices shall be either completely non-metallic or metallic with a resilient, insulating member between the wiring and the metallic portion of the device.

All wiring shall be located and secured such that normal equipment motions, maintenance access, heat sources, and the environment do not damage or reduce the life of the wiring.

Junction boxes, with terminal boards, shall be used, as required, for wire terminations. Harness connections to the boxes, as well as internal wiring to terminal boards, shall be as specified in Section 22.18.2. Exterior junction boxes shall be weathertight.

In cases where it is necessary to anchor wires or cables to metallic parts of the car, cleats or approved stainless steel bottle clamps shall be used. Wires and cables shall not be allowed to chafe or rub against any part of the car or each other under any circumstances.

Wire and cable dress shall allow for sufficient slack at equipment terminals to provide for movements induced by shock and vibration, equipment shifting, alignment, cover removal and component replacement. Sufficient lengths shall be provided at points of termination for additional re-terminations without applying tension to the wire and without splicing the wire, as follows:

- A. No. 10 AWG and smaller: Three re-terminations
- B. No. 8 AWG and larger: Two re-terminations

A drip loop shall be provided on all exposed wires and cables and assemblies to prevent fluid runoff into connected equipment.

Spare wires, which are part of a wire harness, shall be bundled separately inside of the equipment box to which the harness is being terminated. Spare wires shall have enough length to reach any location within the box, including sufficient slack for the required number of re-terminations. The spare wire "break-out" bundle may be ty-wrapped to the main harness, but shall be easily removed from the main harness without disassembling it. The ends of the spare wires shall be insulated against inadvertent contact with any nearby conductive surfaces or terminals.

Wire tying devices shall be of such material and construction that they will adequately retain the wires for the life of the wiring and shall be resistant to ozone and ultraviolet light if they are installed outside of the carbody.

If approved, non-UV resistant and non-ozone resistant wire tying devices may be used in the interior of the car. Wire and cable ties shall be trimmed and located to eliminate any hazard to personnel from sharp edges. Wire tying devices shall be snug, but shall not be so tight as to cause indentation and cold flow damage to the insulation. Wire tying devices shall be mechanically fastened to a permanent structure. Adhesive-installed mounting bases shall not be used for ties or for cable support.

All wire bundles and cables within an enclosure shall be supported by the use of tape rails, shall be spaced away from the equipment box structure, metal edges, bolt heads, and other interference points, and shall have electrical clearance from the covers, regardless of the insulation properties of covers. Wire bundles shall be located above or alongside the apparatus rather than at the bottom of the box wherever possible. In all cases, wire shall be a minimum of

1 inch above the bottom of the box. Wire entry into control or junction boxes shall not be permitted through the bottom of the box.

Truck wiring shall be designed to ensure sufficient slack, and shall be provided with clamp supports and abrasion protection. T-splices will not be permitted.

All jumpers, jumper heads, and jumper receptacles shall be sealed in an approved manner to prevent the entry of water at any operational speed of the car.

Any wiring needed to calibrate and test car functions shall be a part of the permanent car wiring to enable SFMTA to conveniently maintain the equipment. This wiring shall terminate in approved connectors in the respective control groups and cabinets.

SFMTA desires to have wiring and cabling readily accessible for inspection and maintenance. Extensive wiring and cabling in the vehicle interior is contrary to accessibility, even though access panels, false floors, and other portals may be provided. To control this, the Contractor shall submit a complete wiring plan for approval.

22.17.3.4 *Circuit Shielding*

Wire shields used in trainline circuits shall be continuous up to the car's electrical coupler contacts, including contacts of the jumper cable connector at the intermediate couplers. The wire shields shall be connected through all applicable connectors and junction boxes. Circuits shall be categorized. Shields contained in one circuit category shall not be interconnected with shields contained in another category. Shields used to protect against interference shall not carry signal current.

Shields on low-level signal wires shall not be interconnected with shields on high-level signal wires in the same category. Each group of shields (other than at the electric couplers) shall be carried through on a connector pin or pins, or on terminal strips which shall be in the immediate proximity of the categorized group of circuits. Loops due to interconnections of shields shall not be permitted.

Coaxial cables used as constant impedance transmission lines shall be terminated as dictated by the circuit termination design and shall not be considered to be shielded conductors. Triaxial cables may be used as coaxial impedance transmission lines with the outer conductor employed as an RF shield.

The following three items shall be considered as guidelines and are not absolute requirements:

- A. Shields used to suppress electromagnetic interference (EMI) at all frequencies shall be terminated only at the low potential side of the interference circuit, at the termination which exhibits maximum susceptibility.
- B. Shields used to protect against the effect of, or to exclude, EMI at frequencies below 150 kHz, shall be terminated either to the low potential side or at the balance point of the protected circuit at the termination which exhibits maximum susceptibility.
- C. Cables requiring both audio frequency (AF) and radio frequency (RF) shields shall be electrically isolated from each other. The resistance between these circuits shall be at least 500 megohms when 500 volts dc is applied. Double shielding shall be required on circuits that are both AF-susceptible and RF-susceptible.

22.17.4 Insulation Resistance

Insulation resistance to ground at 500 or 1000 VDC, as applicable for each nominal voltage circuit group when measured with an insulation resistance tester (megger), shall give no less than the following resistances, on a vehicle with all circuit breakers closed, and all circuits complete:

Nominal Circuit Voltage (DC or AC rms)	Minimum Insulation Resistance
Below 90 volts	2 megohms at 500 VDC
90 volts to 300 volts	4 megohms at 1,000 VDC
Above 300 volts	5 megohms at 1,000 VDC

The Contractor shall ensure that these requirements will be met under the most severe conditions of temperature and humidity.

22.17.5 Marking

The Contractor shall devise, and submit for approval, a wire and terminal designation system that shall coordinate all electrical circuits in the car into a unified system. The system shall identify all wiring, including circuit return wiring, and terminals according to their respective circuit function(s) and shall accurately correlate with the car schematic diagrams. Each circuit shall be individually designated from point to point. Common designations for return circuits are not permitted. Alternative designations may be approved for small standard assemblies such as PA amplifiers.

All wires and terminals shall be clearly identified. Wires attached to terminal studs shall also have a marker indicating the terminal stud to which it is attached.

Identification of wires and terminals shall be by white or yellow permanent markers with black printing. All wires shall be marked every 6 inches within 12 inches of the end of the wire and every 12 inches along the entire length of the wire. Wire markers shall be stamped in two places, approximately 180 degrees apart, around the cylindrical portion, and should be consistently oriented for viewing throughout the vehicle and equipment to facilitate readability of the marking. Wires in multiple-conductor cables shall be color-coded.

For pre-manufactured, multi-conductor cables and for cases where individual circuit identification markers may be approved the following requirements apply:

- A. All wires and terminals shall be clearly identified. Wires attached to terminal studs shall also have a marker indicating the terminal stud to which it is attached.
- B. Identification of wires and terminals shall be by white or yellow permanent markers, with black printing or by continuous wire marking printed on the wire. All wires shall be marked 6 inches (152 mm) from of the end of the wire, every 12 inches (305 mm) within 10 feet (3.05 m) of the end of the wire, and every 24 inches (610 mm) over the remainder of the wire. Wire markers shall be stamped in two places, approximately 180 degrees apart around the cylindrical portion, and should be consistently oriented for viewing throughout the vehicle and equipment, to facilitate readability of the marking. Wires in multiple-conductor cables shall be color-coded.
- C. Wire markers shall meet the adherence and solvent resistance requirements as specified by MIL-M-81531 Sections 3.4.2 and 3.4.3, latest revision, and shall withstand all combinations of ambient and equipment temperatures. Hand printing is prohibited.
- D. For cable identification, the contractor shall use a basic identification system in conformance with ANSI/IEEE 200 and shall submit the system selected for review.

Color coded wires may be approved as an alternative to marking in small standard assemblies such as PA amplifiers. Also, approval may be granted for relief from the marker requirements, on a case-by-case basis, for electrical panels or around interconnecting jumpers within a panel.

22.17.6 Pulling Compound

Pulling compound shall be non-conductive, non-hygroscopic, non-odorous non-corrosive, non-flammable, shall not support bacterial activity, shall not attract vermin, and shall be compatible with all wiring insulation used.

22.17.7 Solder

Solder shall be in accordance with ASTM B 32, Grade Sn 60. A flux of non-corrosive type shall be applied immediately before soldering.

22.17.8 Tape

Electrical tape shall be polyvinyl chloride in accordance with AAR Standard S-540 of Section F of the AAR Manual Standards and Recommended Practices, or equivalent approved railway practice. Electrical tape shall meet or exceed the voltage rating of wire where the tape is applied.

22.18 WIRE AND CABLE CONNECTIONS

22.18.1 General

All equipment enclosures and junction boxes, except primary power circuits, shall be fitted with terminal boards or connectors. Primary power circuits shall be fitted with compression terminals and knuckle joint connectors as described herein.

The Contractor shall submit the proposed design and product line for all connections for approval. Terminal boards with M4 or Number 6 or smaller screws and quick-disconnect terminals, other than those stated herein, will only be permitted with approval.

22.18.2 Terminal Boards and Terminal Points

All electrical terminal points and terminal boards shall be one of the following types:

- A. Stud type in accordance with MIL-T-55164A
- B. Binding head screw type in accordance with MIL-T-55164A, only where approved
- C. An approved constant tension spring clamp type, for wire sizes not to exceed AWG No. 12.

Stud-type terminal points shall have brass studs and connections, each of which shall be locked using a single brass nut with flat brass washer and a plated spring-type lock washer. Studs, nuts, and washers may also be made of corrosion-resistant, plated steel, where approved.

Each board or connector shall have the necessary number of terminations plus a minimum of 10 percent spares, but not fewer than one spare unless approved.

Threaded studs shall have a minimum of 2-1/2 threads exposed beyond the final nuts and shall not project more than 2-1/2 threads plus 1/4 inch (6.4 mm) beyond the final nuts, unless otherwise approved. Adequate space shall be provided to permit connecting wire terminals with standard tools. All terminals shall be properly torqued and marked to ensure sound connections. Spacers shall not be used.

Jumpers between terminal board points shall be brass or plated steel. Wire jumpers between adjacent terminals of terminal boards will not be permitted.

An approved permanent marking strip on each terminal board shall be provided and attached adjacent to the wire junction point to identify the wires attached thereto and/or the wires connected to terminal boards shall have the terminal point location printed on the wire.

A maximum of two terminals shall be connected to any one binding screw. A maximum of four terminals shall be connected to any one threaded stud, provided that there is no interference between terminal barrels. On terminal boards, the wiring shall be arranged so that no more than two terminals are connected to a stud, from each side of the terminal boards.

22.18.3 Wire Terminations

Terminals and connections used throughout the car shall be the mechanical, solderless, crimp type made by AMP Incorporated only. All terminals for the same wire size shall be crimped with the same model tool. The Contractor shall minimize the total number of crimping tool types needed for all crimp connections. Terminals fitting wire sizes AWG No. 10-22 shall require no more than three tool models to provide certified crimp connections. The Contractor shall submit the proposed product line for approval as well as the contractor's standard training, certification, and testing procedures for crimping. Terminals to be approved shall be tested to Military Specification MIL-T-16366F for temperature rise, voltage drop, vibration, current overload, and corrosion. Test results shall be submitted for approval on a by part number basis.

Terminals and connections shall be attached to the wiring with proper crimping tools and dies as recommended by the manufacturer. The terminals used on conductors of size No. 10 AWG or smaller shall be of a type that securely grips and holds the insulation of the conductor, unless otherwise approved. Terminals shall be ring lugs in accordance with Military Standard MS-25036; spade and hook-type terminals shall not be used. Corrosive protection shall be provided for all base materials.

Conductors subject to motion relative to the terminal shall be protected by suitable means to prevent breakage of the conductor at or near the terminal. Sufficient slack shall be provided in all wires and cables to prevent breaking or pulling out of bushings and terminals. A maximum of one wire shall be crimped in any one terminal.

Wherever several wires are connected to terminals of a terminal strip on a device which is removable from the car for maintenance, the wires shall be terminated, with double ring terminations that shall be screwed to an insulating fanning strip which shall serve to keep the terminations in the correct relative locations while removed from the device, unless otherwise approved.

The use of cage-clamp type compression connections will be permitted on a case-by-case basis.

22.18.4 Power Cable Terminations

Power cables shall be terminated with an approved compression terminal (AMP only). Sufficient cable slack shall be provided to preclude breaking or pull-out from bushings or terminals and to allow two terminal changes. Cable conductors shall be clean prior to installation of terminals. Compression terminals shall be applied using tools and procedures recommended by the terminal manufacturer for that purpose. Swaging tools shall be of a type that ensures complete swaging in every case.

22.18.5 Motor Lead Terminals

Traction motor terminals shall be of the glad-hand type or the two bolt type, with crimped or soldered tube type lug. The termination shall be covered by an approved insulated sleeve, such as Mark Equipment Co. Part No. M105. The sleeve shall be clamped with stainless steel worm screw-tightened hose clamps. A neoprene bushing shall be used between the cable and sleeve, if required, to make a good fit for a water-tight seal between the sleeve and cable at the clamp.

22.18.6 Cable Connectors

All cable connector applications shall be approved.

All cable connectors shall conform to DIN 43 650A/ISO 4400, or an equivalent standard as approved. They shall employ removable crimp contacts of the correct size for the wire being terminated. Except as noted below, the connector contact area shall be plated with a minimum of 0.000030-inch of gold over a minimum of 0.000050-inch of low stress nickel. For high current applications, the connector contact area shall be plated with a minimum of 0.00010-inch of silver. Adjacent connectors shall either use different inserts or different insert orientations to prevent erroneous connections. The receptacle half of all cable connectors shall be rigidly mounted.

Where 1/4-turn, bayonet-lock connectors are specified they shall conform to all provisions in, DIN 43 650A/ISO 4400 or an approved standard, except for the screw coupling requirement.

All cable connectors used in exterior locations shall be of the environmental watertight variety. Cable connectors shall be equipped with sealing gaskets on the front mating surface and on the back where the cable enters. Bolts within the connector shall be long enough to ensure that there is sufficient room to terminate the cable wires within the connector body. The cable jacket shall be held by a clamp within the connector body. Unused connector pin/socket positions shall be sealed with either connector contacts or plastic sealing plugs designed for that purpose.

Plastic bodied connectors shall not be used in exterior locations.

Except as provided above all cable connectors in exterior locations, shall be 1/4-turn, bayonet-lock, quick disconnect type CIR connectors as made by Litton-Veam SPA, or approved equal.

Connectors in high vibration or high motion areas, such as speed sensors and trainline jumpers shall have the wire connections soldered and potted. A watertight jacket shall be molded over the cables and connectors to form a unitized assembly. The contractor shall conduct an approved vibration test on these unitized assemblies.

In waterproof interior locations, the use of non-weatherproof connectors will be allowed as approved. All other connector requirements specified in this section which do not directly apply to weatherproofing shall be met.

22.18.7 Quick-Disconnect Terminals

Approved quick-disconnect terminals shall be utilized to facilitate maintenance and inspection. They shall provide positive terminal engagement and be shock and vibration proof. All terminals shall be provided with insulation equal to that of the wire. No "push-to-fit" (FASTON) type terminals will be permitted. If "push-to-fit" type terminals are allowed they shall be the locking tab type. Application of these type terminals will be on a case-by-case basis and shall be limited to low voltage, excluding under car application, and non-heat generating resistors (above 10 watts).

22.18.8 Grounding Return Connections

22.18.8.1 *Grounding*

Grounding connections to the carbody and equipment shall be made through copper pads of an adequate area, silver soldered or brazed to the respective carbody and piece of equipment. All ground pads shall be visible and accessible for inspection and troubleshooting. The ground connections shall be attached by a bolt, washer, and nut designed for the purpose. The Contractor may propose alternate grounding connection methods with proven service history in similar environments.

All equipment enclosures and shock-mounted equipment shall be grounded with flexible, strap-type, grounding leads bolted between a carbody grounding pad and the equipment's grounding pad. Braided, strap-type leads shall be used where there is relative motion between the two items being connected. The ground strap termination method shall apply uniform pressure to the conductive surface and the current density shall not exceed the bonding requirements of Section 22.18.8.2.

The Contractor shall submit, for approval, a complete grounding scheme, which shall indicate the means by which it is proposed to prevent currents from passing through journal, motor, and truck-center bearings. Refer to other sections of this Specification (17.7) for ground brush and related requirements. Low voltage and high-voltage circuits shall not be grounded to the same ground.

22.18.8.2 *Bonding*

All grounding and bonding jumpers and straps shall be sized to handle fault current and lightning discharge current, for which the voltage drop shall not exceed 25 volts. The bonding method employed shall not produce a DC resistance in excess of 0.0025 ohms, or more than 0.025 ohms at 150 kHz for any applied AC voltage. Grounding and bonding jumpers, and brazed shunt straps shall be "extra-flexible." Bonding requirements shall conform to NEC regulations.

22.18.9 Wire Splicing

Splicing of conductors shall be prohibited except with approval, on a case-by-case basis. Splicing of conductors in conduit will not be permitted. In the event a splice is approved, it shall be in a junction box and the spliced joint shall be mechanically as strong and have the same conductivity as any other part of the conductor. The splice shall be an insulated permanent crimp splice in accordance with Military Specification MIL-T-7928G, Type II, Class I, and shall be installed with the crimping tool and die of the splice manufacturer. All splices shall be insulated with a self-sealing, weathertight, seamless shrink tubing. The outside diameter of the spliced portion of the cable after the insulation is applied shall not exceed the outside diameter of the unspliced portion by more than 40%. Splices shall be identified in the integrated schematic.

22.19 CONDUIT

22.19.1 Types

All conduit and conduit couplings shall be of an ANSI-approved type. With the exception of truck areas, all conduit shall be of the Aluminum Association's recommended aluminum alloy or galvanized steel (no EMT tubing is permitted). Conduit installed on the trucks or in underfloor areas over the trucks shall be standard weight, galvanized steel with threaded fittings. All conduit ends shall be deburred inside and out to remove sharp edges and all pieces shall be blown out with compressed air and cleaned before installation to remove filings and other foreign material.

Rigid aluminum conduit shall consist of seamless, rigid, aluminum alloy conforming to ANSI Standard C-80.5 and to the requirements of Underwriters Laboratory Standard UL-6. All threads shall be covered with an oxidation-inhibiting compound. Aluminum fittings shall be used to assemble aluminum conduit and shall be made to the same grade and alloy as the conduit.

Steel conduit shall be mild steel in standard lengths with threaded ends and hot-dipped zinc-coated exterior and interior surfaces. It shall be free of burrs and projections, circular in cross-section, of uniform wall thickness and shall conform to the requirements of ANSI Standard C-80.1. The threads per inch and length of threading shall conform to ANSI Standard B-20.1: 1983 on Pipe Threads.

Steel fittings shall be used to assemble steel conduit. Elbows, nipples, and couplings shall be made of the same grade of steel as that employed in the conduit. All fittings shall be treated, coated, and threaded according to the requirements for zinc-coated, rigid steel conduit and shall conform to Underwriters Laboratory Standard UL-6.

Flexible conduit, if used undercar in areas exposed to impact, shall be watertight and interlocking steel strip-protected, with an approved rust resistive coating. Non-steel strip protected flexible conduit may be used on interior applications where approved. PMA style conduit may be used only with application-specific SFMTA approval.

22.19.2 Size and Fill

Conduit shall be sized such that the sum of the cross-sectional areas of the conductors and their insulation does not exceed 40% of the cross-sectional area of the conduit for three or more conductors. For two conductors, a limit of 31% shall be used, while for a single conductor, a limit of 53% will be permitted. Where conduit having a length not exceeding 24 inches without bends of more than 15° are used between enclosures, a maximum fill of 60% will be permitted.

22.19.3 Installation

A run of conduit between junction boxes and/or pulling outlets shall not contain more than the equivalent of four quarter bends, 360 degrees total, including the outlet fittings. Bend radii at the inner surface of the bend shall be no less than eight times the nominal inside diameter of the conduit.

All conduit bends and offsets used shall be made by the use of special forms or tools and shall have the largest radius possible so that wires can be pulled without the use of tackle or power.

Conduit shall be securely clamped with all runs electrically grounded to make a continuous ground. Suitable approved insulation to prevent electrolysis shall be provided where steel and aluminum are in contact.

All conduit shall be arranged to prevent moisture traps and shall drain toward control boxes, except that all open-ended conduits shall be installed in such a manner as to ensure gravity drainage out the end. The conduit arrangement and installation shall be subject to approval.

22.20 CONDUIT FITTINGS AND JUNCTION BOXES

22.20.1 General

The conduit fittings and junction boxes for car wiring shall be as manufactured by the Contractor or by a supplier of a comprehensive line of parts. The Contractor shall submit the proposed product line for

approval. All conduit fittings and junction boxes shall be water-tight as required for the application and shall be provided with gasketed covers as described in Section 22.20.4 such that the box is environmentally sealed equivalent to NEMA Standard No. 250, Type 4. All conduits and their connections to electrical equipment shall be installed to make a continuous ground.

22.20.2 Boxes

All exterior junction boxes shall be fabricated of steel with a minimum wall thickness of 14 gauge. All exterior junction boxes shall be weatherproof and shall be connected in such a way that drainage from equipment groups will not pass through conduit into the junction boxes. Interiors of all junction boxes shall be primed and then protected with a white, insulating epoxy powder coating as specified in Section 22.23.4.

22.20.3 Conduit Interface

The open ends of conduit shall be provided with strain relief type fittings with extended rubber bushings, bell-mouth fittings, or insulated throat box connections as approved. All conduit entries into removable equipment boxes shall be secured by means of a bolt-on watertight access panel.

22.20.4 Covers

All junction box covers shall be retained by compressive spring-type latches or captive screws as approved on a location-by-location basis. All fasteners used in junction boxes shall be stainless steel. All covers shall be designed to accept or mate with a bulb-type clamp-on seal.

22.21 WIREWAYS

All wireways shall be of rigid steel or aluminum construction with an approved powder coat system to minimize the risk of oxidation and rust formation. The trays shall be adequately supported throughout their entire length in an approved manner. There shall be absolutely no sharp edges. The trays shall be completely de-burred before installation on the vehicles. Grommet clamps shall be provided at all locations where cables or wires enter or leave the wireways. Under no circumstances shall leads be draped over the edge of the wireways, with or without wireway edge protection.

The wireways shall be routed such that they avoid

- A. Sources of heat such as propulsion and dynamic brake grid resistors

- B. Wheel splash areas
- C. Areas along the vehicle where the trays may be subject to foreign object damage.

Wireways shall be located to provide access to the harnesses contained within for maintenance action.

Wireways shall be designed to prohibit the collection of dirt and debris, and shall be perforated, without compromising their requisite strength, to permit ventilation and drainage.

Bends in wireways shall be avoided; however, if they are required, approved protection shall be provided to avoid insulation chafing at the bends.

Wireways will be permitted in approved exterior and ceiling locations only. They shall be permitted in the carbody sidewall area only in areas that are accessible for maintenance. Only conduit will be permitted in the carbody.

Wireways shall not contain more than 30 current-carrying conductors at any cross-section. The sum of the cross-sectional areas of all conductors contained at any cross-section of a wireway shall not exceed 40% of the interior cross-sectional area of the wireway.

All wire and cable shall be securely fastened within wireways to eliminate movement and resultant chafing.

Grounding and bonding jumpers, in accordance with 22.18.8.1 and 22.18.8.2 shall be applied to all wireways carrying conductors greater than 70V.

22.22 WELDING, BRAZING, AND SOLDERING

22.22.1 General

The Contractor shall be responsible for the quality of their own welding and brazing and that done by their Suppliers and Subcontractors. Surfaces for welding shall be clean and free from paint, oil, rust, scale or other material which is detrimental to welding.

22.22.2 Structural

All structural welding shall be in accordance with the American Welding Society AWS D1.1/D1.1M:2008 "Structural Welding Code -Steel"; AWS D1.2/D1.2M:2003 "Structural Welding Code -Aluminum"; AWS D1.3/D1.3M:2008 "Structural Welding Code -Sheet Steel"; AWS D1.6/D1.6M:2007 "Structural Welding Code- Stainless Steel", or AWS C7.4/C7.4M:2008 "Process Specification and Operator Qualification for Laser Beam Welding", as appropriate for the materials, thicknesses and processes that are used in fabrication. The requirements for dynamically (cyclically) loaded structures shall be applied. Cast steel welding shall be according to ASTM A 488/488M "Steel Castings, Welding, Qualification of Procedures and Personnel." Resistance welding shall be in accordance with AWS D 17.2/D17.2M: 2007.

Prior to conducting any AWS C7.4/C7.4M:2008 Procedure Qualifications the contractor shall submit for approval the tests that are proposed for those qualifications and the technical justification for those tests.

Codes and standards other than those referenced in this specification may be submitted to SFMTA for approval only if they meet or exceed those that are referenced in this specification. The submittal shall include technical justification demonstrating that the proposed substitution meets or exceeds the Codes and standards referenced in this specification.

All structural welding procedures shall be qualified by testing. Pre-qualified welding procedures are not allowed. All submitted welding procedures must be accompanied by applicable procedure qualification records.

22.22.3 Welder Qualification

Welders shall make only those welds for which they have been qualified according to the requirements of the governing code or standard. Records of welder qualification tests shall be made available for review.

22.22.4 Inspection

The Contractor shall inspect all welds, brazed joints and soldered joints as required by the applicable Code as noted in paragraph 22.22.2, 22.22.7, 22.22.8, 22.22.9, 22.22.11 or 22.22.12. As a minimum, they shall be visually inspected to the acceptance criteria of that Code by personnel meeting the requirements of that Code.

The contractor shall submit for approval the qualification category and the justification for the selection of that category for each weld that is done in accordance with AWS C7.4/C7.4M:2008. (See AWS C7.4/C7.4M:2008 paragraph 1.2 for qualification categories) The Contractor shall also submit the discontinuity limits and their justification for those limits if they intend to deviate from those that are suggested by AWS C7.4/C7.4M:2008.

The Contractor shall inspect all I welds according to the applicable Code or standard. In addition to visual inspection specified for all welds, nondestructive surface inspection (dye penetrant, ultrasound, radiographic or magnetic particle methods, as appropriate and approved by SFMTA) shall also be used to inspect all first production welds. Subject to the approval of SFMTA, the Contractor shall specify a nondestructive inspection sampling rate for all subsequent welds.

On the first structure, all full penetration welds shall be nondestructively, volumetrically inspected (ultrasonic or radiographic methods) according to the applicable Code or standard's requirements. The Contractor shall specify a random sampling plan for volumetric inspection of subsequent full penetration welds for approval. The minimum acceptable inspection plan shall require inspection of one portion of a full penetration weld for every 200 production welds (one production weld is one foot in length) made. The proposed test welds shall be selected from among welds that are most critically loaded as decided by calculations or load test results. With approval, destructive sectioning and metallurgical examination may be substituted for some or all of the required volumetric inspection requirements for production welding.

On the first structure, all dissimilar metal welds or braze-welds (usually stainless to carbon or LAHT steel ring welds) shall be nondestructively inspected by magnetic particle or dye penetrant methods. Sample dissimilar metal welds shall be sectioned and examined metallographically to determine heat affected zone (HAZ) hardness. Stainless to carbon or LAHT steel weld HAZ shall not exceed 400 VH (Vickers Hardness). Other dissimilar metal welds or braze-welds shall be limited as determined by the Contractor and approved by SFMTA. The Contractor shall submit a random sampling plan for additional metallographic examinations of dissimilar metal welds for approval. The minimum acceptable sampling plan shall require inspection of one dissimilar metal weld sample for every 300 production welds made.

22.22.5 Post-Weld Cleaning Requirements

All welds shall be cleaned to remove flux and loose spatter. Welds exposed to passengers or on sliding contact surfaces of truck frames and bolsters shall be completely cleaned of all spatter.

22.22.6 Contractor Documentation

All welding and brazing documents and their subsequent revisions; such as, but not limited to Welding Procedure Specifications (WPS), Procedure Qualification Records (PQR), Resistance Spot Welding Schedules (RSWS), and Welder Performance Qualifications (WPQ) shall be submitted for approval before application. All structural WPSs shall be qualified to meet impact requirements of this specification. Specifications of welding electrodes, welding wires, shielding gases and base metals shall be submitted for approval before their application.

22.22.7 Special Welding

Welding Procedures Specifications and their Procedure Qualification Records for other combinations of metals or conditions, applications or processes not covered by the Codes and standards as listed in this document, shall be submitted for approval.

Galvanized steel shall not be welded to stainless steel.

22.22.8 Resistance Welding

Resistance welding of stainless or carbon steels shall be in accordance with AWS D 17.2/D17.2M: 2007, Class B for structural applications and Class C for non-structural applications. Contractor-proposed deviations from AWS D 17.2/D17.2M: 2007, including, but not limited to, weld nugget diameter, tension shear strength, and minimum spacing, shall be submitted and approved before application on production hardware.

Surface indentation for exterior resistance-welded areas exposed to passenger view, regardless of Class shall not exceed 10% of t or 0.005 inch, whichever is greater. For exposed welds, the Contractor shall vary welding parameters and conditions within their acceptable ranges to minimize indentations. Surface burn and discoloration shall be removed by chemical cleaning, or an approved equal method, and sanding or polishing to match the surrounding surface. Spot welds made with an electrode(s) on one side through the work piece to a grounded platen or fixture shall have the weld nugget formation and size verified by ultrasonic measurement on a sampling basis, as approved by SFMTA.

Design strengths higher than standard certification and production strength requirements shall be qualified according to AWS D 17.2/D17.2M: 2007 Section 4.5.6 for each thickness. This requires a test lot size of 180 Class B or 50 Class C spot welds. Additional thickness combinations with the same increased strength ratio may be qualified by 25 spot weld shear tests plus three macro-sections. Twenty (20) of the 25 shear test specimens may be recorded from production witness tests taken from 20 consecutive production days (not calendar days). The Contractor shall submit records of the welding parameters, ultimate shear strength, weld diameter, and weld penetration for approval.

22.22.9 Resistance, Spot Weld and Intermittent Weld Spacing

Spacing of resistance and spot welds shall be according to approved structural drawings. Spacing shall not exceed 2 inches plus twice the weld nugget diameter for any structural application, including carbody side sheets. RSW welds shall not be spaced closer than 2 diameters apart unless "close spaced" certification testing is performed in accordance with AWS D 17.2/D17.2M: 2007.

Intermittent fusion-weld spacing pitch shall not exceed five inches for 2-inch (minimum) weld lengths (40% minimum of length welded). Shorter pitches are permitted with shorter welds. All structural and non-structural intermittent welds shall meet the applicable AWS Code for minimum weld length and weld spacing.

22.22.10 Toughness of Welded Assemblies

The Contractor shall provide test results to prove that all welded steel structures are above the ductile-brittle transition temperature for the specified environmental exposure. Specifically, the weld metal, HAZ, and base metal shall resist service impact loads at -20 degrees Fahrenheit without brittle failure. In the absence of prior operating history, and if the Contractor's approved design does not require greater toughness, the minimum impact value for Charpy V-notch specimens shall be 15 ft-lbf. of absorbed energy at -20 degrees Fahrenheit.

22.22.11 Brazing

All brazing shall be conducted in accordance with either AWS C3.4/C3.4M:2007 "Specification for Torch Brazing," AWS C3.5/C3.5M:2007 "Specification for Induction Brazing," AWS C3.6/C3.6M:2008 "Specification for Furnace Brazing," or AWS C3.7/C3.7M:2007 "Specification for Aluminum Brazing" as applicable.

22.22.12 Torch Soldering

All structural (not electrical) soldering, defined as heating below 840°F, shall follow the recommendations contained in the AWS Welding Handbook, Volume 2 ninth edition. Procedures and personnel who do torch soldering shall be qualified through the preparation and testing of samples of production torch soldering. Test samples shall be prepared and submitted for approval before production torch soldering.

22.22.13 Welding Terms, Symbols and Definitions

All welding terms and definitions shall be as determined in AWS A3.0:2001 "Standard Welding Terms and Definitions" unless otherwise approved by SFMTA. All weld symbols shall be in accordance with AWS A2.4:2007 "Standard Symbols for Welding, Brazing, and Nondestructive Examination", International Standard ISO 2553, or JIS Z 3021 unless otherwise approved by SFMTA. The fabrication drawings will show the applicable welding symbol and identify which Welding Procedure Specification is used to make the weld.

22.23 PAINTS AND COATINGS

22.23.1 General

The exterior portion of the carbody receiving paint shall be painted as required by the Specification and in accordance with the specified color scheme, lettering and numbering. Any austenitic stainless steel portions of the carbody shall not be painted, unless otherwise specified by SFMTA for cosmetic reasons. Where stainless steel is painted, procedures shall be as recommended by the paint manufacturer for the application, and surfaces shall be properly prepared to ensure adhesion.

All painting to be applied on the carbody or any component is to be conducted in accordance with the paint manufacturer's recommendations. The Contractor and its paint supplier shall supply a touch-up procedure and assure that a continuing supply of touch-up paints in colors used on the car, suitable for spot application by spray roller or brush, will continue to be available in the United States.

22.23.2 Materials and Preparation

Preparation of the painted surface and application of painting materials for brushing or spraying shall be in accordance with the paint supplier's recommendations. All paint materials shall be used at the consistency recommended by the paint supplier. If thinners or reducers are necessary, they shall be approved by the paint manufacturer and shall be used only to the extent recommended. Painting shall be done by experienced labor, using proper equipment under competent supervision.

All painting materials for all surfaces shall be a high quality finishing system resistant to corrosion, chipping, and fading and shall retain the gloss level. All painting materials for exterior surfaces visible to the passengers or operating personnel shall be a two-part, high solids, low VOC, polyurethane paint system, or approved equal, with a solids content between 50 to 70 percent. Alternate paint systems, such as base coat-clear coat systems, or direct-to-metal paint systems will be considered if the paint performance equals or exceeds two part polyurethane. All paint and filler materials which are to be superimposed to form a finish shall be mutually compatible and shall be warranted for use as a system by the manufacturer of the components.

Metal portions of the carbody not constructed of austenitic stainless steel shall, after fabricating, be prepared for painting by grit blasting and immediately painted within a time frame suggested by the manufacturer, with an approved two-part epoxy primer, or washed with an alkaline solution, properly rinsed, phosphate coated or painted with a coat of wash (etch) primer, and then coated with an approved two-part epoxy primer. After erection of the framing structure and body sheets, all undercar metal, except stainless steel, shall receive a polyurethane finish as specified above. The color of the underframe paint shall match DuPont charcoal gray, Color No. 6334. The supplier shall submit color samples and corresponding tri-stimulus values for approval. The exterior finish shall have a gloss level greater than 80 as measured with a 60° glossometer. Three samples of each primer, color, and/or base coat clear coat paint for exterior, undercar, truck frames , and any paint or powder coat used for the interior of the vehicle or equipment shall be submitted to SFMTA for approval of gloss, adhesion, finish, and orange peel characteristics.

22.23.3 Exterior Painting

All exterior surfaces that are to be painted shall be prepared as specified and the paint shall be applied according to the paint manufacturer's recommendations. The paint shall be uniformly applied over all surfaces to be covered and shall be free from runs, sags, or other application defects. Painting shall be done in a clean, dry atmosphere at an ambient temperature as recommended by the paint manufacturer.

Before painting any car surface that is exposed to view, all dents, gashes, nicks, roughness, or other surface imperfections or depressions shall be removed so far as possible by straightening and shall be properly prepared to receive the filler material. These surfaces shall be wash primed following straightening. Any remaining dents or other surface imperfections shall then be filled with an approved epoxy-based filler and sanded smooth. The maximum allowable filler thickness shall be as recommended by the filler manufacturer for the environment and service to which it is to be exposed, but in no case shall it exceed 1/8-inch.

Exterior austenitic stainless steel shall be cleaned with an approved alkaline cleaning solution, which shall not damage any previously painted surfaces. All hidden aluminum or ferrous materials, except austenitic stainless steel, shall be given one coat of an approved two-part epoxy primer and one coat of an approved top coat.

The final painted surface shall be tested on the first car to the following criteria:

- A. Hardness. Pencil Hardness tests shall be performed according to ASTM D3363. The range of acceptance shall be between H and 2H and shall be the average of ten readings taken from

typical surface locations. This is a destructive test and shall require the tested surfaces to be repaired.

- B. Adhesion. Adhesion shall be tested per ASTM D4541 and achieve a minimum rating as provided by the paint manufacturer. This is a destructive test and shall require the tested surfaces to be repaired.
- C. Thickness. The minimum and maximum dry film thicknesses shall be provided by the paint supplier. Dry film thicknesses beyond the manufacturer's minimum and maximum recommendations shall not be accepted. Non-destructive testing shall be performed to verify final dry film thickness.
- D. Paint Cure. A solvent rub test shall be performed per ASTM D5402. The test procedure requires no less than fifty double finger rubs with a cloth wetted in acetone or methyl isobutyl ketone to the painted surface. No paint color should transfer to the cloth. After 72 hours the painted surface must retain all original characteristics such as gloss and hardness.

22.23.4 Apparatus and Underfloor Equipment

All underfloor apparatus (motors, control boxes, junction boxes, brake valves, and other equipment as specified) shall be primed and painted in accordance with the following requirements unless otherwise indicated. All other apparatus shall be painted in an approved color.

The exterior surfaces of undercar equipment enclosures and apparatus, other than propulsion control equipment, made from carbon steel shall be prepared, primed, and painted as specified in Section 22.23.3. The interior and exterior surface of all propulsion control equipment enclosures shall be coated with an approved insulating, thermosetting, resin-based, powder coating or approved equal. The interior of the boxes shall be white and the exteriors shall match the undercar paint scheme.

Parts of undercar equipment enclosures made from plastic or fiberglass shall be painted in accordance with the above requirements for metal portions except that the paint system shall be compatible with the plastic used, and an insulating coating need not be applied. An exterior finish of two-part polyurethane or approved equal shall be provided for equipment control groups. The color shall be as approved by SFMTA.

22.23.5 Painting Restrictions

Any equipment or parts of equipment which would be damaged or suffer impaired operation from painting shall not be painted and shall be corrosion resistant. The following parts shall not be painted:

A. General Parts:

1. Conduit and fittings
2. Copper tubing, piping and fittings
3. Wire and cable
4. Power resistors
5. Heat transfer surfaces
6. Electrical insulators
7. Elastomeric portions of air and refrigerant lines
8. Grounding pads.

B. Truck-Related Items:

1. Wheels
2. Axles
3. Elastomeric parts
4. Grease fittings
5. Linkages
6. Threaded parts used for adjustments
7. Electrical equipment
8. Wearing surfaces.

22.23.6 Interior Painting

All exposed interior surfaces, including molding and trim, shall be as specified in Section 10, or powder-coated metal.

Interior surfaces requiring painting shall be coated with an approved thermosetting powder coating. Parts which are to be powder-coated shall be cleaned and prepared in accordance with the recommendations of the powder supplier.

The Contractor and its powder supplier shall supply a touch-up procedure and ensure that a continued supply of touch-up paint in the proper colors suitable for spot application will continue to be available in the United States.

22.23.7 Corrosion Protection

Concealed surfaces capable of rusting or oxidation shall be properly cleaned, receive a wash primer, then primed with a two-part epoxy paint, and painted with an approved finish coat of paint.

Where arc welding is performed on joints between stainless steel and other materials, the joint shall be de-scaled and cleaned, and then painted in accordance with Section 22.23.3.

22.23.8 Acoustical Insulation

Acoustical insulating materials shall be applied to properly cleaned underframe, sides, ends, roof and floor sheets, as required in Section 8, to the supplier's recommendations. The materials shall be resistant to dilute acids, alcohols, grease, gasoline, aliphatic oils, and vermin. The material shall be unaffected by sunlight and ozone and shall not become brittle with age. It shall be Daubert Chemical Company's No. 368 sound deadening compound, Aquaplas No. DL-10, or approved equal. The Contractor may propose an alternative insulation system. The alternative acoustic insulation system shall be service proven for commuter rail vehicle application and shall demonstrate compliance with the design and performance requirements specified.

22.23.9 Trucks

All truck components to be painted shall be given a full coat of primer prior to assembly. Following assembly, all exposed surfaces of each truck, including machined mounting surfaces not used, shall be cleaned by blowing off with compressed air and solvent-wiped to remove all dirt and grease. All truck components not listed in Section 22.23.5 shall then be sprayed with one coat of primer and one coat of an approved black truck paint (a type that will not conceal cracks that may develop in service) and air dried.

22.23.10 Paint Process Documentation

The Contractor shall prepare a paint coating and application document containing procedures for surface cleaning and preparation, priming, surfacing, and painting for the carbody and all equipment that is painted or powder coated. A detailed paint schedule showing the equipment painted, paint type and manufacturers, recommended thickness, and other pertinent information shall also be included. This document shall be submitted to and approved by the paint component manufacturer(s) before being submitted to SFMTA for review and shall be made part of the maintenance manuals.

22.24 FLAMMABILITY AND SMOKE EMISSION REQUIREMENTS

22.24.1 General

All combustible material used in the construction of the car shall satisfy the flammability and smoke emission requirements cited in Section 4.2 and NFPA 130, "Standard for Fixed Guideway Transit and Passenger Rail Systems, 2007 Edition."

22.25 SECTION DELETED

22.26 ELECTRICAL AND ELECTRONIC DESIGNS

22.26.1 Section Deleted

22.26.2 Section Deleted

22.26.3 Hardware

Refer to Section 22.2.2 for general hardware requirements. All hardware associated with electronic and electrical control systems shall be protected against moisture, oxidation, and common airborne contaminants. Hinges and latches shall be of stainless steel.

22.26.4 Wiring

Wire selection, routing and securement shall be accomplished with the goal of having the wire and cable last the life of the carbody. All movement and chafing of wire and cable shall be eliminated. The use of additional wear material(s) to extend life without elimination of the movement, wearing or chafing will not be permitted. Refer to Sections 22.16 through 22.21 for additional wire and wiring requirements.

22.26.5 Optical Fibers

Any application of optical fibers shall be approved prior to implementation. This approval is not intended to discourage the use of optical fibers. Rather, it is to verify reliability and maintainability of the proposed

application. In no case shall the on-car repair of an optical fiber require sophisticated or complex polishing and alignment. The connections between optical fibers and car-replaceable units shall be via approved "quick disconnects."

22.27 SEMICONDUCTOR STANDARDS

22.27.1 General

Semiconductors shall be selected to withstand all continuous and transient voltage and power demands present in the circuit application without damage or reduction in life. All circuit designs shall provide for the presence of high current switching equipment on the vehicle and the resultant induced voltages and currents in electrical equipment.

All semiconductor devices shall be derated to operate within the acceptable region for electrical and temperature stress as specified in "Reliability Toolkit: Commercial Practices Edition." If there is a conflict between guidelines given elsewhere in the Specification and the "Reliability Toolkit," the more restrictive condition shall govern. Other service-proven devices may be submitted for approval.

22.27.2 Ratings

Discrete semiconductors shall have the following minimum voltage breakdown ratings:

- A. Semiconductors, except diodes (see below), operated from the battery supply, or those connected to trainlines, shall have minimum breakdown ratings of four times the maximum achievable circuit voltage. Suppression devices shall be provided as necessary to protect the devices and limit the circuit voltage.
- B. Diodes operated from the battery supply, used as suppression devices, or connected to trainlines shall have a minimum breakdown rating (PIV) of 1,000 V. Diodes with less than 1,000 V PIV rating may be used if adequate circuit transient protection is also provided.
- C. All discrete semiconductors operated from inverters or other isolating devices shall have a minimum breakdown rating of two times the maximum circuit voltage, except where specifically detailed otherwise. Suppression devices shall be provided as necessary to protect the devices and limit the circuit voltage.

All semiconductor junction temperatures shall be limited to 150°C (or to the maximum rated temperature for the device, whichever is less) or less at maximum ambient temperature and at maximum rated output power.

All semiconductors shall be operated at less than 50% of the maximum continuous current rating or 50% of the maximum continuous power rating, whichever is more restrictive. High power/current devices may be exempt from this requirement with prior approval, on a case-by-case basis. The Contractor shall submit complete device information, including all manufacturer's application recommendations, and calculated current and power demands with all waiver requests. If approved, such waivers do not reduce other requirements, including reliability.

Integrated circuits operated from the battery supply through inverters or other isolating devices shall be operated within the voltage and current ratings specified by the manufacturer, derated to less than 50% of the maximum stress level at the maximum operating temperature of the device as specified by the manufacturer.

Where the supplies to integrated circuits are regulated and surge protected, the voltage rating shall be 15% below the manufacturer's recommended maximum. In addition, the maximum power shall be limited to 50% of the manufacturer's specified maximum at the maximum operating temperature.

Silicon semiconductors shall be hermetically sealed and rated for operation over the temperature range of -40°C to +85°C. Non-hermetic devices are acceptable to SFMTA provided comparable reliability documentation is available upon request.

All Gallium Arsenide and similar optical semi-conductors shall be rated for operation over the temperature range of -40°C to +85°C.

22.27.3 Availability and JEDEC Registration

Except as approved, all semiconductor devices shall be JEDEC registered and numbered.

JEDEC registered devices with house numbers may be used only if a complete cross-reference is provided linking each house numbered device with a JEDEC registered device. House labeled devices shall be clearly labeled with the manufacturer's name or logo.

All semiconductors shall be available from at least two manufacturers and available from U.S. distributors. Single source devices, such as high voltage power devices, microprocessors, ASICs, and related support chips may be used only if approved. Such devices shall be essential to the proposed equipment, shall meet the proven service requirements, and shall be supplied by veteran manufacturers likely to support the device.

22.27.4 Other Prohibitions

Electronic equipment shall utilize stock components and shall function properly with the component manufacture's full range of tolerances such that after-purchase screening or testing of components shall not be required.

Matching of components is permitted only if the components are normally available from the manufacturer in matched sets.

Germanium semiconductors shall not be used.

22.28 PRINTED CIRCUIT BOARD STANDARDS

22.28.1 General

Printed circuit boards shall be designed, constructed and inspected to IPC-2221, latest revision, unless more stringent requirements are noted here. Traces shall be made as wide as practical, with the minimum width being based on a 10°C temperature rise. Run spacing shall conform to MIL-STD-275, latest revision.

Circuit board material shall be per MIL-P-13949, latest revision, with a minimum thickness of 1/16-inch using type GB or GH base material. Type GE material may be used for boards which have no components whose power dissipation is greater than two watts and when said board is not mounted adjacent to components dissipating greater than two watts. The copper laminate shall be firmly attached to the board and shall be resistant to blistering and peeling when heated with a soldering iron.

Components with pins shall be mounted only on one side. Connections shall be made to the other side or internal layers via plated through holes. SMT devices may be mounted on both sides if part of an approved existing design.

All circuit boards shall be inherently stiff or shall be reinforced to prevent damage due to vibration or handling. Circuit boards larger than 100 in² shall be centrally stiffened unless otherwise approved.

All printed circuit boards with the same function shall be interchangeable between equipment groups without additional adjustment.

All printed circuit boards shall be of the "plug-in" type, with positive support against vibration, except where approved otherwise.

Printed circuit boards shall be mounted in the vertical plane with positive retention by keeper bars unless otherwise approved. These retaining mechanisms shall be simple, easily applied/removed without tools and shall remain attached to the card rack. PCBs shall be fully inter-changeable without adjustment by the use of digital circuits, stable components, and tight tolerance components as applicable. Potentiometers shall not be permitted. All electronic control units, PCBs, major components and assemblies shall be serialized and contain a bar code label.

22.28.2 Marking

All circuit boards shall be labeled with a part number, serial number, and descriptive nomenclature.

All components shall be labeled on the board with component drawing references and such other information as may be required to repair and troubleshoot the board. The component and wiring sides of the board shall each be marked to indicate capacitor and diode polarity, and at least two leads or one lead and a graphic symbol indicating orientation of all transistors and thyristors.

Integrated circuits and other multi-terminal devices shall have an index mark on the component side of the board, visible with the component inserted, to indicate proper keying and insertion; the first pin on all IC packages shall be identified on the wiring side of the board.

For boards whose component density is greater than 2.25 components per square inch, the Contractor may submit an alternate marking plan for possible approval. Such a plan should include board marking, augmented by layout drawings.

22.28.3 Component Mounting

Components shall be fastened to the board in such a manner as to withstand repeated exposure to shock and vibration. Large components shall be supported in addition to the solder connections. Power resistors shall be mounted on standoffs so that the resistor bodies do not contact the board, spaced far enough away from the board so that resistor-produced heat will not discolor or damage the board.

22.28.4 IC and Device Sockets

IC and device sockets are prohibited except for components that must be removed for reprogramming or initial calibration procedures or devices that are available only in mounting in sockets. All socket applications are subject to SFMTA approval. All other components shall be soldered in place.

Where approved, IC sockets shall comply with MIL-S-83502C and MIL-S-83734, as is applicable for the device, and shall be made of the following materials:

- A. The bodies shall be molded from diallyl phthalate, PTFE Teflon, or approved equal.
- B. The contacts shall be fabricated from beryllium copper and shall be plated with a minimum of 0.000030 inch of gold over a minimum of 0.000050 inch of low stress nickel in the area of contact with IC pins.

22.28.5 Conformal Coating

Both sides of the assembled printed circuit boards shall be coated with a clear insulating and protective coating material conforming to MIL-I-46058 latest revision, or approved equal.

The coating shall be easily removed with a brush-applied solvent or penetrated by a hot soldering iron when a component must be unsoldered. The coating solvent shall not adversely affect board mounted components.

All IC sockets, connectors, and test points shall be masked when the coating is applied.

22.28.6 Keying

All printed-circuit boards shall be "keyed" to prevent insertion into the wrong socket.

22.28.7 Circuit Board Connectors

Printed circuit board connectors shall be heavy duty, high reliability, two-part type with a history of successful service in rail applications and shall be approved by SFMTA prior to commencing design.

Connectors which comply with MIL-C-55302, latest revision, and which have plated contacts as described below, are considered to comply with the requirements of this section.

The connector contact area shall be plated with a minimum of 0.000030-inch of gold over a minimum of 0.000050-inch of low stress nickel.

All connectors within one panel assembly shall be keyed to prevent damage or malfunction due to incorrect insertion.

Refer to Section 22.16.5 for wire wrap used and connection requirements.

22.28.8 Testing

Sufficient clearance shall be provided between components to allow testing, removal and replacement without difficulty due to lack of space.

Test points shall be provided in appropriate locations on modules and printed circuit boards. A negative return test point shall also be provided. The test points shall either accept and hold a standard 0.080-inch diameter tip plug, or shall be a turret lug similar to Cambion No. 160-1026-01-05, or approved equal, with sufficient clearance to permit it to accept a standard oscilloscope probe clip, and shall be identified by appropriate markings.

22.28.9 Plated-Through Holes

In addition to the general guidelines of the Institute of Printed Circuits (IPC), the following requirements shall be met:

- A. Plating Holes. Copper plate shall be a minimum of 0.001-inch minimum average thickness, and 0.003-inch maximum average thickness. Solder plates shall be 0.0003-inch minimum average thickness and 0.0015-inch maximum average thickness.

- B. Plated Hole Defects. No more than three voids per hole will be acceptable. Total area of the voids shall not exceed 10% of the total wall area. The largest void dimension shall not exceed 25% of the core diameter or the board thickness, whichever is smaller. There shall be no pits, voids or cracks at the junction of the whole wall and terminal area to a depth of 1-1/2 times the total copper thickness on the surface.

22.28.10 Multilayer Boards

Multilayer PC boards and high-density surface mount components will be permitted. To ensure repairability by SFMTA, the Contractor shall provide the following minimum documentation:

- A. Assembly and detailed layout drawings.
- B. Complete parts listing
- C. Schematics and interconnection diagrams
- D. Source control for any parts on the parts list that can not be directly ordered from an electronics catalog.
- E. Theory of operation.

The Contractor may propose, for SFMTA approval, alternate methods to ensure long term maintainability of equipment.

22.28.11 Enclosures

All circuit boards that are rack mounted shall plug into racks containing the mating half of the circuit board connector. The circuit board rack shall mount in an enclosure conforming to requirements in this document. The rack, circuit board, and circuit board hardware shall be designed as an integrated system.

The rack and enclosure shall provide environmental and EMI shielding as required to meet the requirements of this document.

Printed circuit boards shall be positively retained by means of keeper bars or other approved method. The enclosure or rack cover shall not be used to retain the circuit boards.

Each circuit board shall be fitted with an ejector or hand grip to assist in board removal. The rack and the edge of each board, or the card ejector, shall be labeled with corresponding numbers to identify board location within the enclosure.

Enclosure features specified above shall be presented for approval during preliminary design and prior to commencing final design.

22.28.12 Extenders

Printed circuit board extenders (six sets of each type) shall be provided by the Contractor for test purposes. At least two extenders of each type shall be available for use and evaluation throughout the design conformance and acceptance test programs.

22.29 MICROPROCESSOR-BASED SYSTEM HARDWARE

22.29.1 Hardware Platform

Carborne and custom computer hardware shall be designed and constructed in accordance with the general electronic design principles of Section 22. The microprocessor based control systems shall be based on an established family of microprocessors in wide use in the control system industry. They shall be supported by a full range of software development languages and diagnostic programs. Any use of commercially available computer boards must be specifically approved. Such approval will be based upon a technical review of the product, product documentation, and a commercial assessment of product availability.

22.29.2 Electrical Isolation and Pre-Processing

The control system shall be powered by dedicated transformer-isolated power supplies driven from the vehicle battery circuit.

All control system input and output signals shall be through isolation buffers. High voltage inputs and outputs shall be isolated external to the microcomputer card rack. Low voltage (battery and logic voltage level) inputs and outputs shall be isolated via buffer cards in or external to the microcomputer card rack.

The isolation buffers shall:

- A. Protect and isolate the control system from damage due to over-voltage, under-voltage, transients, shorts, and opens
- B. Perform necessary voltage translations
- C. Remove noise and undesired signals
- D. Limit, pre-process, discriminate and format those signals that would otherwise require excessive processor time
- E. Consist of optical isolators, transformer isolators, and other circuits appropriate to the application. Voltage divider circuits will not be allowed.

22.29.3 Section Deleted

22.29.4 Section Deleted

22.29.5 Section Deleted

22.29.6 Section Deleted

22.29.7 Section Deleted

22.30 ELECTRICAL DEVICES AND HARDWARE

22.30.1 General

All electrical devices shall be transit industry-proven.

22.30.2 Contactors and Relays

22.30.2.1 *General*

Unless otherwise approved, all contactors and relays shall meet or exceed the requirements of MIL-R-6106, MIL-R-5757 or IEC947-4 as applicable, with the following two qualifications:

- A. Devices shall be tested for proper functioning in orientations up to 30 degrees from the orientation in which they are mounted in the vehicle, in each of the three possible rotations: pitch, yaw, and roll.
- B. If adequate documentation exists demonstrating that during functional and operational testing of the vehicle the contactors underwent normal duty cycle tests, it shall be considered as an acceptable alternative to a burn-in.
- C. In selected applications, contactors and relays shall comply with the requirements of MIL-R-6106 (for ratings of 10 amperes or greater) and MIL-R-5757 (for ratings of less than 10 amperes) but need not be qualified to these documents if all of the following requirements are met:
 - 1. The device is service proven in the exact same application.
 - 2. The device is service proven in transit service.
 - 3. All other requirements of this Specification are met.
 - 4. SFMTA approves of this application.

All devices shall be constructed and utilized in a fail-safe manner; that is, all failures shall be in a direction so that neither the passengers, the crew, or the equipment are placed in jeopardy.

All devices shall be installed so that they are fully accessible for inspection, repair-in-place, or removal and replacement. All contactor terminals shall be fully accessible for trouble shooting purposes.

Contactors and relays shall incorporate means of visually determining whether they are picked up or dropped out. Relays on printed circuit boards or within electronic assemblies may be exempted from the requirement for a visual indication, as approved.

Unless specifically approved on a case basis, there shall be a maximum of no more than two wire terminations on any one contact of the device.

The coils of all devices shall be suppressed to protect the low-voltage network from generated transients.

Under no circumstances shall either the main or auxiliary contact tips of the devices be placed in parallel for the purpose of carrying a current load at or above the manufacturer's contact tip rating.

Contact tip ratings shall be stated for the worst condition of reduced surface contact which may result from tip misalignment during normal operation of the device.

Contactors shall be installed such that the arc spray is directed by an arc chute away from ground and any other electrical devices proximate to the Contactors.

Devices shall be constructed in a very heavy-duty fashion suitable for use in railroad service. SFMTA reserves the right to review and approve the design and selection of all contactors and relays.

Contactors shall not exceed 10% of the total number of tips at 90-day intervals.

All contactors shall be constructed so that the main contact tips make and break with a motion (wipe) that prevents deposits and pitting.

All contactors shall be built with series-fed blowout coils. The Contractor shall demonstrate the ability of each contactor type to reliably interrupt current over the full design operating range.

All devices shall be readily identifiable by means of a permanent, durable marking strip giving the device circuit designation. No identifications shall be obscured, or partially obscured, by wire routing. The identification strip shall be mounted adjacent to the mounting of said device.

Bifurcated contacts shall be used in low voltage applications, whenever necessary due to dry contacts or low current switching requirements.

All time delay relays shall be of the R-C delay or solid state type. No mechanical or pneumatic time delay devices will be permitted.

Where plug-in relays are approved, the relay shall be positively retained by means of a retaining clip or bar. This device shall be captive, of rugged construction and shall be easily positioned for relay installation and removal without the need for special tools. When the relay is removed, the retainer shall itself be retained so that it cannot come in contact with devices which may have exposed energized electrical circuits, and it shall not interfere with the operation of any other device when in this position.

Adequate gap and creepage distances shall be maintained from high voltage contactor tips and low voltage coil and auxiliary contacts to prevent entry of high voltage arcs or transients into the low voltage circuits. The same applies to grounded mounting surfaces.

Relays shall not be affected by the accumulation of airborne dust. Equipment boxes that contain relays or contactors must be ventilated to prevent ozone corrosion.

Solid State Relays shall be rated to meet the worst case environmental requirements of their installed location, meet the creepage and clearance requirements of this specification and have output stages that conform to the semiconductor requirements of Section 22.27.1 and 22.27.2.

22.30.2.2 *Section Deleted*

22.30.3 Switches

Under no circumstances shall poles of switches be placed in parallel in order to carry currents in excess of the contact pole rating given by the manufacturer.

Switches shall be provided with a "keying" feature so that after installation, the body of the switch is constrained from mechanical rotation.

All switches provided shall be of the highest quality procurable and shall be fully suitable for the rigors of SFMTA's service environment. The design and selection of all switches shall be subject to review and approval.

More than two wires connected to each terminal of the device shall be subject to approval. Switches shall be individually replaceable without disconnecting or removing anything other than the mounting fasteners and electrical connections of the switch to be replaced.

All control switches that are subject to water splash, which is defined to mean any switches mounted near windows or doors, or mounted on the Operator's control console, shall be environmentally sealed. Toggle and pushbutton switches shall be per MIL-S-3950, MIL-S-8805, MIL-S-83731, or equal, as approved.

All safety-critical switches, such as those that can cause door openings, shall be designed to withstand a high potential test of 1,500 volts for one second, in a clean, dry condition, without false conduction. The design and selection of all switches shall be subject to review and approval.

Switches shall be individually replaceable without disconnecting or removing anything other than the mounting fasteners and electrical connections of the switch to be replaced.

In addition to the above requirements, all switches and pushbuttons shall meet the following requirements:

- A. Contact resistance shall be less than 0.1 ohm at 3 VDC and a 10 milliamp load.
- B. Open circuit resistance shall be 50 meg-ohms minimum.
- C. Resistance to case shall be 1000 meg-ohms minimum at 500 VDC.

22.30.4 Circuit Breakers

22.30.4.1 General

All circuit breakers provided shall be rugged and fully suitable for the service intended.

They shall be of the highest quality procurable. Design and selection of all circuit breakers shall be subject to review and approval.

All circuit breakers of the same rating shall be of the same manufacture and model throughout the vehicle.

The ON, OFF, and TRIPPED positions of all circuit breakers shall be permanently marked on the handle or the case of the circuit breaker. The circuit breaker, when tripped, shall assume a distinct position between the ON and OFF positions to permit determination of the fact that it has been tripped by either its overcurrent or shunt trip elements.

All circuit breakers shall be mounted in the vertical direction with the ON position up.

Circuit breakers shall be individually replaceable without disconnecting or removing anything other than a faceplate, the mounting fasteners, and electrical connections of the breaker to be replaced.

Electrical connections to circuit breakers shall either be threaded to accept machine screws or use a threaded stud. Wires to circuit breakers shall use ring terminals.

Circuit breaker terminals shall not be used as junction points.

Each and every input power circuit shall be protected by an individual circuit breaker. Separate circuit breakers shall be provided for major assemblies or functions. No circuit breaker shall protect more than one circuit, nor shall any one circuit be protected by more than one circuit breaker.

All circuit breakers shall be sized by current rating and tripping time to protect both the associated equipment and the minimum size wire used for power distribution within the protected circuit without causing nuisance tripping.

High voltage circuit breaker poles may be connected in series if necessary to achieve the stated voltage interruption requirements.

Each circuit breaker pole shall be equipped with adequate means of arc extinction to prevent flashover.

The continuous current rating of thermal-magnetic trip circuit breakers shall be selected in accordance with ANSI C37.16 for the load and type of service specified.

All thermal-magnetic trip circuit breakers shall conform to the requirements of ANSI C37.13 and IEEE C37.14.

Circuit breaker current rating shall be clearly and permanently marked and shall be completely visible after installation.

Electrically operated circuit breakers shall be arranged for operation from the low voltage DC supply.

22.30.4.2 High-Voltage Circuit Breakers

All DC high voltage circuit breakers shall be three-phase AC medium voltage devices with not less than 3 poles connected in series.

All distribution-type, high voltage circuit breakers shall be Westinghouse Series C, FDB frame, Heinemann type GH, or approved equal.

The trip elements shall be thermal-magnetic, or magnetic, connected in series.

The circuit breaker handle shall protrude from the circuit breaker panel cover sufficiently to be manipulable in all positions.

22.30.4.3 *Low-Voltage Circuit Breakers*

Low voltage circuit breakers shall be either one-pole or two-pole devices depending on the intended function. Trip elements shall be thermal-magnetic, or magnetic, as is appropriate for the application.

All low voltage circuit breakers shall be:

- A. General Use. Westinghouse Series C, Quicklag C frame, or approved equal, front connection or approved access arrangement, and approved labeling
- B. Fast Operation. Airpax type IMLK, dust sealed, magnetic breaker, or Airpax type UP, hermetically sealed, magnetic breaker, or an approved equal.

22.30.5 Fuses

Fuses may be used only where specifically called for in this Specification or where the use of circuit breakers is not technically feasible, and only with specific approval. Fuses may be considered in applications as follows:

- A. To protect solid state equipment from catastrophic damage
- B. Where current or voltage levels prohibit circuit breakers

Fuses shall be used in car heater circuits only with the approval of SFMTA.

Fuses shall be permanently identified adjacent to the fuse. The rating of each fuse shall be permanently and clearly marked directly on each fuse.

Fuses shall be readily accessible. All fuses mounted in exterior equipment boxes shall be accessible without going under the vehicle.

Fuse holders shall contain fuse retention devices at both ends.

Air gap and creepage distances shall be as approved. Fuses used in nominal 750 volt circuits shall be rated for no less than 1,000 volts.

High voltage fuses shall be mounted in totally enclosed, dead front, fuseholders, with no exposed high voltage connections. The fuse shall be extracted from the circuit when the fuse holder is opened and the exposed fuse shall be safely isolated from any circuit connection.

Unless explicitly noted otherwise in this Specification, all fuse compartments shall have a spare fuse of identical size and rating for each "in-circuit" fuse, and shall be mounted next to the respective "in-circuit" fuse with the fuse holder clearly marked SPARE FUSE. The spare fuse holder shall not be enclosed and shall not consist of any loose parts.

22.30.6 Bus Bars

Bus bars are to be fabricated from OFE (Oxygen Free Electronic CDA 10100) or ETP (Electrolytic Tough Pitch CDA 10100) copper. The bus bar conductivity shall be 100% IACS. All bus bar joints shall be silver or tin plated.

Current densities, other than at joints, shall not exceed 1,575 amperes per square inch, and in any case shall not exceed a value which would cause a bus bar temperature rise greater than 30°C. Current densities in joints shall not exceed 600 amperes per square inch.

Bus bars shall be properly brazed together at joints unless bolted connections are found to be absolutely necessary for maintenance purposes and are approved. The overlap at busbar joints shall be no less than 10 times the thickness of the bus material. Bus bar connection bolts shall be torqued to obtain a uniform bus bar connection pressure of 200 psi. Bolting hardware shall be plated steel with belleville washers to maintain connection pressure.

Except for connection areas, bus bars shall be safety-insulated, using a high-dielectric, powder coating or other approved means. Tape is not acceptable. Bus bars that are behind insulating panels, and those

cases where there are suitable warning labels and maintenance procedures that prohibit opening the equipment case when energized, are exempt from this requirement.

22.30.7 Capacitors and Resistors

Hermetically sealed, dry tantalum capacitors, in metal cases, shall be used in place of aluminum electrolytics, except for very high values which are not commercially practical or available, in which case long life grade aluminum electrolytics shall be used.

Commutating capacitors shall be a paper or plastic film type, shall incorporate a non-toxic impregnant, and shall be chosen to give a service life of at least 20 years. Filter capacitors shall have high ripple current rating for long life.

Capacitors shall be derated 20% for voltage based on the nominal supply voltage and maximum case temperature. If filter capacitors are exposed to low ripple voltages, lesser values of derating may be accepted if it can be shown that reduced operating temperatures can be achieved due to lower dissipation; however, the sum of the DC and AC ripple voltages shall always be less than the capacitor's voltage rating at a maximum case temperature of 85°C.

Except for braking power resistors, all resistors shall be derated 50% for power dissipation. Other power resistor applications may be submitted for approval of lower derating, on a case-by-case basis.

22.30.8 Transformers and Inductors

Transformers and inductors shall be derated 10% for current.

Transformers shall:

- A. Have vacuum-impregnated windings.
- B. Be rated to withstand at least twice the maximum peak-to-peak voltage that they shall be subjected to in operation.
- C. Not emit audible noise in excess of 60 dB referenced to 20 micropascals at a distance of 2 feet (0.61 m) while operating at rated voltage and load. Not emit audible noise in excess of 60 dB

referenced to 20 micropascals at a distance of 2 feet (0.61 m) while operating at rated voltage and load.

- D. Be designed to minimize radiated and induced EMI.
- E. The location, orientation, mounting, cable connections and cable routing shall be in accordance to the overall EMI/EMC control plan for the vehicle.

22.30.9 Switch, Circuit Breaker and Fuse Panels

All switch, circuit breaker and fuse panels shall be dead front types mounted in the specified equipment enclosures.

Each switch and circuit breaker panel shall carry the necessary apparatus, arranged to be easily accessible to connections and designed to prevent operating or maintenance personnel from coming in contact with live parts when operating the switches or circuit breakers. Furthermore, all live portions of the protected circuitry shall be completely concealed so that no danger of electrocution or shock exists from the touching of the panel or any appurtenances or devices mounted thereto.

All switches, breakers, fuses, and indicating lights shall be provided with a nameplate of raised or recessed lettering on the dead front, clearly identifying the circuit which each controls and its circuit designation. The dead front panel shall conform to NFPA No. 70, Article 384. The dead fronts shall be made of moisture-proof, electrically insulating, laminated phenolic or fiberglass, of approved quality suitable for switchboards. Asbestos shall not be used.

A wiring gutter shall be provided along the top, sides and bottom, for the routing of high voltage leads to their designated circuit breakers.

The panel shall be secured by approved, captive fasteners and shall be configured for easy removal so that maintenance and repair action is not impeded.

Power distribution to circuit breakers and switches shall be from a bus bar or bus circuit. Distributing power by successive or "daisy-chained" connections between device terminals will not be permitted.

22.30.10 Battery Backup Circuits

Where individual electronic circuits require their own battery, the following conditions apply:

- A. Batteries shall be rechargeable nickel-cadmium , or nickel metal hydride, with a built-in charger or non-rechargeable lithium, unless otherwise approved.
- B. Batteries shall be easily replaceable, and must not be soldered in place.
- C. If a nickel-cadmium , or nickel metal hydride battery is used, the charge time vs. discharge time must be approved, for the specific application. In no case shall the battery life-span be less than 5 years.
- D. If a lithium battery is used, the calculated life-span and the assumptions for that calculation must be approved for the specific application. In no case shall the life span be less than 5 years.
- E. In order to properly assess the impact of distributed battery backup systems, the Contractor shall provide a complete list of battery locations, battery type, estimated lifespan, discharge time, and the impact of battery discharge failure. Approvals of items above may be affected by this total vehicle evaluation.

22.30.11 Section Deleted

22.31 SECTION DELETED

22.33 REFERENCED STANDARDS

AA	Aluminum Association - Aluminum Standards and Data
AA	Aluminum Association - Engineering Data for Aluminum Structures
AA	Aluminum Association - Specification for Aluminum Structures
AALA	American Association of Laboratory Accreditation
AAR	Specifications for the Construction of New Passenger Equipment Cars

AAR	Manual of Standards Section F S-538, Wiring Practice and Rolling Stock Standard
AAR 2518	Standard S-400
AAR M-101	Axles, Carbon Steel, Heat Treated
AAR M-107/208	Wheels, Carbon Steel
AAR M-201	Steel Castings
AAR M-601	Hose, Wrapped, Air Brake, End Hose
AAR M-618	Hose Air, Wire Reinforced
AAR M-620	Hose Air, Fabric Reinforced
AAR M-927	Hose Fittings and Hose Assemblies, Air, Wire Reinforced
AAR RP-585	Wire and Cable Specification
AAR RP-589	Rating for Specific Fuel Consumption of Diesel Electric Locomotives
AAR S-503	Fuel Additive Evaluation Procedure
AATCC Test 16A	Colorfastness
ALCOA Tech. Rpt 524	Specification Covering Use of Aluminum in Passenger Carrying Railway Vehicles
AMS-W-6858	Resistance Welding - Nickel & Cobalt Base Alloys.

ANSI B1.1	Unified Inch Screw Threads
ANSI B1.13M	Metric Screw Threads – M Profile
ANSI B16.18	Cast Copper Alloy Solder Joint Pressure Fitting
ANSI B16.22	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
ANSI B18.1.2	Large Rivets
ANSI B-20.1	Safety Standard for Conveyors and Related Equipment
ANSI B31.1	Code for Pressure Piping
ANSI C37.13	Low Voltage AC Power Circuit Breakers Used in Enclosures
ANSI C37.16	Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors Preferred Ratings, Related Requirements, and Application Recommendations
ANSI C80.1	Rigid Steel Conduit - Zinc Coated
ANSI Z26.1	American National Standard for Safety Glazing Materials for Glazing Motor Vehicles and Motor Vehicle Equipment Operating on Land Highways – Safety Code
ANSI/ASTM E94	Standard Guide for Radiographic Examination
ANSI/IEEE 730	Standard for Software Quality Assurance Plans
ANSI/IEEE 1016	Recommended Practice for Software Design Description

APTA SS-C&S-004	Standard for Austenitic Stainless Steel for Railroad Passenger Equipment
APTA SS-M-012-99	Standard for the Manufacture for Wrought Steel Wheels for Passenger Cars and Locomotives
ASME	Boiler and Pressure Vessel Code for Unfired Pressure Vessels
ASME FAP-1-1990	Quality Assurance Program for Fastener Manufacturers and Distributors
ASTM A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A176	Standard Specification for Stainless and Heat Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A262	Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
ASTM A275/275M	Standard Test Method for Magnetic Particle Examination of Steel Forgings
ASTM A480	Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

ASTM A488/488M	Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel
ASTM A502	Steel Structural Rivets
ASTM A504	Specification for Wrought Carbon Steel Wheels
ASTM A568	Standard Specification for General Requirements for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled
ASTM A588	Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi [345 Mpa] Minimum Yield Point to 4-in. [100 mm] Thick
ASTM A606	Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Steel Sheet, Strip Plate, and Flat Bar
ASTM A668A/668M	Specification for Steel Forgings, Carbon and Alloy for General Industrial Use
ASTM A710	Standard Specification for Age-Hardening Low-Carbon Nickel-Copper-Chromium-Molybdenum-Columbium Alloy Structural Steel Plates
ASTM A729	Specification for Alloy Steel Axles, Heat-Treated, for Mass Transit and Electric Railway Service
ASTM A736A	Standard Specification for Pressure Vessel Plates, Low-Carbon Age-Hardening Nickel-Copper-Chromium-Molybdenum-Columbian and Nickel-Copper-Manganese-Molybdenum
ASTM A763	Standard Practices for Detecting Susceptibility to Intergranular Attack in Ferritic Stainless Steels

ASTM A788	Standard Specification of Steel Forgings, General Requirements
ASTM A966/966M	Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current
ASTM B26	Standard Specification for Aluminum-Alloy Sand Castings
ASTM B32	Standard Specification for Solder Metal
ASTM B33	Standard Specification of Tinned Soft or Annealed Copper Wire for Electrical Purposes
ASTM B85	Standard Specification for Aluminum-Alloy Die Castings
ASTM B108	Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B172	Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors
ASTM B174	Standard Specification for Bunch-Stranded Copper Conductors for Electrical Conductors
ASTM B221B/221M	Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
ASTM B247	Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
ASTM B280	Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

ASTM B298	Standard Specification for Silver-Coated Soft or Annealed Copper Wire
ASTM B633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM C273	Standard Test Method for Shear Properties in Flatwise Plane of Flat Sandwich Constructions or Sandwich Cores
ASTM C297	Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions
ASTM C365	Standard Test Method for Flatwise Compressive Properties of Sandwich Cores
ASTM C393	Standard Test Method for Core Shear Properties of Sandwich Construction by Beam Flexure
ASTM C542	Standard Specification for Lock-Strip Washers
ASTM D256	Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension
ASTM D470	Standard Test Methods for Cross-linked Insulations and Jackets for Wire and Cable
ASTM D573	Standard Test Method for Rubber – Deterioration in an Air Oven
ASTM D618	Standard Practice for Conditioning Plastics for Testing
ASTM D638	Standard Test Method for Tensile Properties of Plastics

ASTM D648	Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
ASTM D673	Mar Resistance of Plastics
ASTM D695	Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D790	Standard Test Methods for Flexural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D785	Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials
ASTM D952	Standard Test Method for Bond or Cohesive Strength of Sheet Plastics and Electrical Insulating Materials
ASTM D1003	Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics
ASTM D1055	Standard Specification for Flexible Cellular Materials – Latex Foam)
ASTM D1149	Standard Test Method for Rubber Deterioration – Surface Ozone Cracking in a Chamber
ASTM D1499	Standard Practice Filtered Open-Flame Carbon-Arc Type Exposures of Plastic
ASTM D2261	Standard Test Method for Tearing Strength of Fabrics by the Tongue (Single Rip) Procedure

ASTM D2584	Standard Test Method for Ignition Loss of Cured Reinforced Resins
ASTM D2671	Standard Test Methods for Heat-Shrinkable Tubing for Electrical Use
ASTM D2724	Standard Test Methods for Bonded, Fused, and Laminated Apparel Fabrics
ASTM D3159	Standard Specification for Modified ETFE-Fluoropolymer Molding and Extrusion Materials
ASTM D3182	Standard Practice for Rubber – Materials, Equipment and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets
ASTM D3183	Standard Practice for Rubber – Preparation of Pieces for Test Purposes from Products
ASTM D3190	Standard Test Method for Rubber – Evaluation of Chloroprene Rubber (CR)
ASTM D3363	Standard Test Method for Film Hardness by Pencil Test
ASTM D3574	Standard Test Methods for Flexible Cellular Materials Made from Olefin Polymers
ASTM D3597	Specification for Woven Upholstery Fabrics
ASTM D3675	Standard Test Method for Surface Flammability of Flexible Cellular Materials Using a Radiant Heat Energy Source

ASTM D3775	Test Method for Warp End Count and Filling Pick Count of Woven Fabric
ASTM D3776	Standard Test Method for Mass Per Unit Area (Weight) of Fabric
ASTM D 4034	Test Method for Resistance to Yarn Slippage at the Sewn Seam in Woven Upholstery Fabrics
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D4966	Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Method)
ASTM D5402	Standard Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs
ASTM D 5034	Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
ASTM D5420	Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight
ASTM D5628	Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimens by Means of a Falling Dart (Tup or Falling Mass)
ASTM E94	Standard Guide for Radiographic Examination
ASTM E119	Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E162	Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source

ASTM E446	Standard Reference Radiographs for Steel Castings Up to 2 in. (5 mm) in Thickness
ASTM E662	Standard Test Method for Specific Optical Density of Smoke Generated by Solid
ASTM E648	Standard Test Method for Critical Radiant Flux of Floor-Covering Systems using a Radiant Heat Energy Source
ASTM E709	Standard Guide for Magnetic Particle Examination
ASTM E1354	Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter
ASTM F519	Standard Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments
ASTM F606	Standard Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets
ASTM F1344	Standard Specification for Rubber Floor Tiles
ASTM G23	Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
AWS	Welding Handbook
AWS A2.4	Standard Symbols for Welding, Brazing, Nondestructive Examination

AWS B2.2	Brazing Procedure and Performance Qualification
AWS D1.1	Structural Welding Code, Steel
AWS D1.2	Structural Welding Code, Aluminum
AWS D1.3	Structural Welding Code, Sheet Steel
AWS D1.6	Structural Welding Code - Stainless Steel
BSS-7239	Boeing Specification Standard
DIN 43 650A	Standards for Pins, Rivets, Keys, Adjusting and Retaining Rings
FAA Spec AC 43.13-1	Acceptable Methods, Techniques and Practices - Aircraft Inspection and Repair
Fed Spec QQ-B-654	Brazing Alloys, Silver
Federal Spec. TT-P-38	Paint, Aluminum, Ready
Federal Spec WW-T-799	Tube, Copper, Seamless (Use with Solder-Flared/CMPRS)
FRA 49CFR Part 223	Safety Glazing Standards – Locomotives, Passenger Cars and Cabooses
ICEA S-19-81	Rubber-Insulated Wire and Cable for the Transmission
ICEA S-66-524	Cross-Linked-Thermosetting-Polyethylene-Insulated
ICEA S-95-658	Non-Shielded Power Cables Rated 2000 V or Less

IEC 947-4	Low-Voltage Switchgear and Control Gear, Part 4: Contactors and Motor-Starters
IEEE-383	Class 1e Electric Cables, Field Splices, & Conn.
IEEE C37.14	Low-Voltage DC Power Circuit Breakers
IPC 2221	General Guidelines
ISO 2553	Welded, Brazed and Solder Joints Symbolic Representation on Drawings
ISO 4400	Fluid Power Systems and Components – Three-Pin Electrical Plug Connectors With Earth Contact – Characteristics and Requirements
JIS Z 3021	Symbolic representation of welds
MIL-C-5015	Connectors, Electric, Circular Threaded, AN Type, General Specification for
MIL-C-7438	Core Material, Aluminum, for Sandwich Construction
MIL-C-13777	Cable, Special Purpose, Electrical
MIL-C-27072	Cable, Power, Electrical and Cable, Special Purpose Electrical, Multi-conductor and Single Shielded
MIL-C-55302	Connectors, Printed Circuit Subassembly and Accessories
MIL-HDBK-132	Protective Finishes - For Metal and Wood Surfaces
MIL-HBK-217	Reliability Prediction for Electronic Systems

MIL-HBK 338	Electronic Reliability Design Handbook
MIL-I-46058	Insulating Compound, Electrical (for Coating Printed Circuit Assemblies)
MIL-M-81531	Marking of Electrical Insulating Materials
MIL-P-13949	Plastic Sheet, Laminated Metal Clad (For Printed Wiring Boards)
MIL-P-23469	Pin-Rivet, Grooved and Collar, Grooved Pin-Rivet, Swage-Locked (Lockpin)
MIL-PRF-6106:	Relays, Electromagnetic (TP15.31.2.1)
MIL-R-5757	Relays, Electromagnetic
MIL-S-3950	Switches, Toggle, Environmentally Sealed
MIL-S-8805	Switches and Switch Assemblies, Sensitive and Push (Snap Action), General Specification for
MIL-S-83502	Socket, Plug-In Electronic Components Round Style
MIL-S-83731	Switches, Toggle, Unsealed and Sealed Toggle, General Specification For
MIL-S-83734	Sockets, Plug-In Electronic Components, Dual-In-Line Packages (Dips) and Single in Line Packages (Sips), General Specification for
MIL-T-6845	Tubing, Steel, Corrosion-Resistant (530400), Aerospace Vehicle Hydraulic System 1/8 Hard Condition

MIL-T-7928	Terminal, Lug Splices, Conductors, Crimp Style, Copper
MIL-T-8504	Tubing, Steel, Corrosion-Resistant (304), Aerospace Vehicle Hydraulic Systems, Annealed, Seamless and Welded
MIL-T-16366	Terminals, Electrical Lug and Conductor Splices, Crimp Style
MIL-T-55164	Terminal Boards, Molded, Barrier, Screw and Stud
MIL-W-16878	Wire, Electrical, Solderless Wrap, Insulated, and Uninsulated
MIL-W-22759	Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy
MIL-W-81822	Wire, Electrical, Solderless Wrap, Insulated, and Uninsulated
MIL-STD-410	Qualification and Certification of Inspection Personnel in the European Aerospace Industry
MIL-STD-883	Test Methods and Procedures for Microelectronics
MIL-STD-275	Printed Wiring for Electronic Equipment
MIL-STD-25036	Terminal, Lug, Crimp Style, Copper, Insulated, Ring Tongue, Bell Mouthed, Type II, Class 1 (for 105 Degrees C Total Conductor Temperature)
NASM 21044	Nut, Self-Locking, Hexagon, Regular Height, 250 Degrees F, 125 KSI and 60 KSI
NBS PS 1-95	Construction and Industrial
NEMA LD-3	High-Pressure Decorative Laminates

NEMA STD 250	Enclosures for Electrical Equipment
NEMA WC3	Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC70	Cross Linked Thermosetting Polyethylene Insulated Wire and Cable for Transmission and Distribution of Electric Energy
NEMA WC 27500	Standard for Aerospace and Industrial Cable
NFPA 70	National Electric Code
NFPA 130	Fixed Guideway Transit and Passenger Rail Systems
SAE J343	Tests and Procedures for SAE 100R Series Hydraulic Hose and Hose Assemblies
SAE J356	Hose Clamps
SAE J516	Hydraulic Hose Fittings
SAE J517	Hydraulic Hose
SAE J524	Seamless Low Carbon Steel Tubing Annealed for Bending and Flaring
SAE J533	Flares for Tubing
SAE J1273	Selection, Installation, and Maintenance of Hose and Hose Assemblies

SAE J1405	Flex-Impulse Test Procedures for Hydraulic Hose Assemblies
SMP-800C	Toxic Gas Generation
UL-6	Electrical Rigid Metal Conduit - Steel



appendix twenty-three

Light Rail Vehicle DVAS Technical Specifications

Appendix 23
Light Rail Vehicle Digital Visual and Audio System Upgrade
Technical Provisions

1	INTRODUCTION.....	112
2	BACKGROUND	113
3	ABBREVIATIONS AND DEFINITIONS	113
4	EXISTING LIGHT RAIL VEHICLES AND ON-BOARD SYSTEMS.....	115
5	PRE-PROPOSAL VEHICLE INSPECTIONS.....	117
6	DIGITAL VISUAL AND AUDIO SYSTEM (DVAS)	117
6.1	General.....	117
6.2	Functional Requirements.....	119
6.3	On-board Sign and PA Requirements	123
6.4	Fallback Levels.....	123
6.5	Data Provisioning and Management	124
7	INTERNAL AND EXTERNAL INTERFACES	124
7.1	Wireless Bulk Data Transfer Subsystem.....	124
7.2	Visual and Audio Recording and Development Environment.....	125
7.3	Vehicle Local Area Network and Wireless Interface	125
8	INSTALLATION	126
9	TESTING.....	126

**San Francisco Municipal Transportation Agency
Light Rail Vehicle Digital Visual and Audio System**

Contract 1240: Radio System Replacement Project - Technical Provisions

INTRODUCTION

The Light Rail Vehicle Digital Visual and Audio System shall be implemented for San Francisco Municipal Transportation Agency's (SFMTA) (151) Light Rail Vehicles (LRVs). Currently a digital voice annunciation system exists on SFMTA LRVs, and the rubber-tired fleet. On the LRVs, this system is available in the Advanced Train Control System's (ATCS) territory underground, when the train operates in ATCS auto mode. As part of this system, the function of the existing digital voice annunciation system on the LRVs shall be upgraded as specified within this document. The Contractor shall design, develop, install, integrate, test, and make operational all equipment associated with the DVAS, and provide equipment warranty support. The Contractor shall provide all equipment, assemblies, mountings, wiring, cabling, hardware, software, special tools, diagnostic equipment, spare parts, training to SFMTA staff, and training manuals as identified in these documents. The Contractor shall also ensure that the DVAS interfaces and functions as intended with the existing, and future equipment to be procured by the SFMTA. The Contractor shall interface the Digital Visual and Audio System with the equipment procured under the Muni Radio System Replacement (MRSR) Project.

The DVAS shall announce audio messages to passengers and concurrently shall also display messages on internal passenger facing signs as specified in this document. As part of its function, the DVAS shall also control the destination signs, run number signs, and interfaces to transfer and activate data/voice/audio on trailing cars. The DVAS shall also interface with a Wireless Bulk Data Transfer Subsystem furnished as part of the MRSR, and shall function as specified in these documents. The SFMTA shall be able to add, change, and delete both audio and visual messages using the Contractor supplied software and hardware. The new equipment shall interface with the existing on-board equipment and also the equipment to be procured in the future as part of the MRSR Project.

All vehicles shall be equipped with identical and exchangeable DVAS equipment to achieve the intended functions. The DVAS shall interface with the following existing and the planned new vehicle-borne equipment under the MRSR Project as described throughout this document including the following:

- Microphone
- The coupling/uncoupling trainlines
- Current radio system and future radio system

- Passenger doors
- Existing LonWorks network(if needed)
- Internal and external speakers
- Destination signs
- Run number signs

BACKGROUND

The SFMTA operates the San Francisco Municipal Railway ("Muni"), which is the seventh largest public transit system in the United States. SFMTA has approximately 700,000 riders on an average weekday. Its fleet of about 1,000 vehicles, over half of which are electric, consists of subway-surface light-rail vehicles (Metro streetcars), electric trolley buses, diesel buses, the world-famous cable cars, and a unique collection of historic streetcars. The first publicly owned streetcar system in a major city in the U.S., Muni has been serving the people of San Francisco since 1912. More information about SFMTA can be obtained at <http://www.SFMTA.com>.

Currently, SFMTA operates two sets of LRVs, LRV2s, and LRV3s, supplied by AnsaldoBreda in conjunction with the Advanced Train Control System (ATCS) equipment supplied by Alcatel Transport Inc. (now Thales Rail Signaling Solutions, Inc). Currently, all of SFMTA's LRVs are equipped with an internal Digital Voice Annunciation System which functions only in the ATCS territory, when the vehicle operates in auto mode. Currently no provisions exist for automatic announcements in street running territory, and there are no passenger information on-board signs that could display the next stop or other information. To improve passenger information, SFMTA is planning to replace the existing Digital Voice Annunciation System with a new DVAS which shall announce the stations within the subway regardless whether vehicles operate in ATCS auto or cutout modes, as well as in the street running operations. Additionally, the system shall also automatically display messages on the internal signs of the vehicles in accordance with the ADA requirements. The DVAS shall also control the destination and run number signs to display destination and run number based on the parameters entered by the operator.

ABBREVIATIONS AND DEFINITIONS

Where any word or phrase defined below, or a pronoun used in place thereof, is used in any part of the contract documents, it shall have the meaning set forth herein.

ADA: Americans with Disability Act

ATCS: Advanced Train Control System

Automatic Vehicle Location (AVL): A subsystem of DVAS where all active components to determine vehicle location are installed and operating on-board. This applies to both street running and subway operations.

CCP: Communications Control Panel.

Consist: A group of coupled LRVs which make up a train.

DMS: Digital Visual and Audio System Management System

Download, Data: To transfer data from the yard installed Wireless Bulk Data Transfer Subsystem to LRV or LRVs.

DVAS: Digital Visual and Audio System. A current existing system on-board the LRVs is also known by this abbreviation, but is spelled as Digital Voice Annunciation System.

Interim DVAS Announcement System : Optional, interim announcements only system.

Log-on: The act of activating the DVAS functions and interfaces and entering the required parameters.

Log-off: The act of deactivating the DVAS functions and interfaces.

Logover: The process of maintaining all parameters in the DVAS after key-off or key-down.

LRV: Light Rail Vehicle, also known as a Car or a Vehicle.

Internal signs: Passenger facing electronic signs installed within the interiors of the LRVs to display passenger information.

Route Pattern: A Route Pattern carries the following information: destination, stop/station sequence, and supporting data such as distance between stops/stations, stop/station location; and any other information required by the DVAS.

Train: Consist of up to four LRVs

Trainline: Communication link crossing the coupler

Upload, Data: To transfer data from the LRV or LRVs to the Wireless Bulk Data Transfer Subsystem.

EXISTING LIGHT RAIL VEHICLES AND ON-BOARD SYSTEMS

The LRVs are equipped with the following elements or subsystems:

- Carbody
- Operator's Cab
- Propulsion
- Friction brakes
- Doors
- Steps
- Communications
- Couplers
- Auxiliary electric
- Air comfort

The LRVs are bi-directional, electrically propelled via overhead contact wires and pantograph interface, and with a fully functional operator's cab at each end. The cars are designed to run in up to four vehicle consists, and the LRV DVAS system shall be able to operate all functions in such a configuration. When coupled, the trainline signals are transmitted from one vehicle to another which provides the control of the entire consist from either end. When uncoupled, each vehicle operates independently. The carbody is divided into two sections, section A with the pantograph on the roof, and section B without pantograph. Currently there are no spare trainlines for the Contractor's use.

The on-board communications system includes the following:

- a. Operator/Passenger audio subsystem
- b. Cab-to-cab audio subsystem
- c. Radio Communications Subsystem

The Operator/Passenger Audio Subsystem consists of the following equipment:

- Communications Control Panel (CCP), two (2) per vehicle
- Gooseneck Microphone, two (2) per vehicle
- Communications Amplifier and Control Unit (CACU), one (1) per vehicle in the A cab
- Passenger Intercom Unit (PIU), two (2) per vehicle
- Interior Speakers, eight (8) per vehicle
- Exterior Speakers, two (2) per vehicle

The Radio Communications Subsystem includes:

- Radio Set, for vehicles 1400 through 1476, one (1) per vehicle located in the A end cab; for vehicles 1477 through 1550, two (2) per vehicle
- Radio power supplies, coinciding and adequate for the number of radios.
- Mobile Communication Terminal, two (2) per vehicle
- Radio Silent Alarm Switch, two (2) per vehicle
- Radio Antennas

Function of the key elements of the communications system is as follows:

- a. Cab-to-Cab Voice Communications – Enables two way voice communications between any active and inactive cab.
- b. Passenger Intercom – Enables passengers to communicate with the operator.
- c. Public Address (PA) – Allows one-way voice announcements from energized cab to all vehicles in the train or consist. As part of the PA function, train controllers can make announcements via mobile radio on a train or a consist, when the operator selects Radio/PA mode. The PA is also used to broadcast within a train a chime or tone signal to alert passengers that doors are being closed. In addition, the PA interfaces with the ATCS equipment to broadcast automatic announcements within the subway. Currently, announcements by central control, received through the mobile radio, have the highest priority, followed by ATCS triggered announcements and last, vehicle operator announcements.
- d. Radio – Allows the train operator to communicate with the Central Control dispatcher and maintenance personnel. The train radio also transmits a train-operator initiated “silent alarm”.

In the current configuration, the ATCS driven audio signal is provided to the CACU, which drives the speakers. The operator controls this unit through the CCP located at each end of the vehicle.

The LRVs are also equipped with outward facing run and destination signs, which are controlled by an existing LonWorks Control Panel located at each end and are communicated through the vehicle trainlines, using the existing LonWorks network.

Currently the LRVs are equipped with one Digital Voice Annunciation System unit located in the "A" cab. The Digital Voice Annunciation is the interface between the CACU and the Vehicle On Board Computer (VOBC). It is powered through the vehicle's low voltage supply of 37.5 VDC, and shall be replaced.

SFMTA shall make all the available drawings and manuals available to the Contractor for reference. SFMTA does not guarantee the accuracy or completeness of these documents. The Contractor shall verify the accuracy of these documents and shall direct any issues, questions, comments to SFMTA in writing.

The Contractor shall ensure that the equipment installed under the Awarded Contract shall have adequate and Approved EMI/RFI mitigation measures through shielding, grounding and other Approved means. The mitigation efforts shall be employed for emissions/interferences including, but not be limited to radiated emissions, conductive emissions, inductive emissions, and radio frequency/wireless interferences. As part of the Awarded Contract, the Contractor shall identify power needs, conduit needs, and other needs of the system being provided.

Existing equipment and waste removed during the installation shall be decommissioned and disposed in accordance with the requirements of Appendix 12, section 1.

PRE-PROPOSAL VEHICLE INSPECTIONS

The SFMTA will make one sample vehicle available for the Qualified Proposers' inspections as part of the pre-proposal conference only. This shall be an opportunity for the Qualified Proposers to review the vehicles, space available, wiring/cabling prior to submitting their proposals. The sample vehicle will only be a typical representative of the fleet. SFMTA does not assure that all vehicles have identical configurations, and the Qualified Proposers are encouraged to not assume that to be the case. Any issues noticed by the Proposers during this pre-proposal inspection shall be reported to SFMTA in writing. Based on the complexity of the issue, SFMTA may release an Addendum to the RFP, if necessary.

DIGITAL VISUAL AND AUDIO SYSTEM (DVAS)

GENERAL

The Contractor shall supply all equipment and shall install and test a fully functional Digital Visual and Audio System (DVAS), even if the specific equipment, parts, hardware, software, or

assemblies are not specified within this RFP. The objective of this system shall be to improve passenger information and to comply with the requirements of the ADA. The DVAS shall also control the destination and run number signs.

The Contractor shall provide a vehicle test setup of the equipment installed within the operator's cab, including a quantity of (1) of each visual and audio component installed as part of the DVAS, connected to the vehicle test setup.

When installing the fleet, the Contractor shall include adding controls, warning audio/visual alarms within the cab to meet the needs of the DVAS. However, the equipment shall not interfere with operating functions and the equipment shall not interfere or block the view of the operator's field of vision.

The DVAS shall comply with all applicable standards, regulations, codes, laws, and requirements whether identified herein or not. To the maximum extent possible, the Contractor shall utilize the existing equipment such as cabling, conduits, speakers, microphones, handsets, mounts, brackets, and assemblies. In SFMTA's opinion the current speakers and conduits can be utilized. However, the SFMTA cannot assure that all the equipment is in working order or fit for the application, and the Contractor shall verify and record the availability and function of existing equipment. Based on this verification, the Contractor shall reuse or replace the existing equipment. As part of their proposal, the Qualified Proposers shall include a budget for the replacement of existing equipment.

The Contractor is encouraged to submit alternate designs if such designs may benefit SFMTA. SFMTA shall have the latitude to choose any design or technology which is deemed most beneficial to SFMTA. The following is a sample list of equipment and does not necessarily imply any specific technology. The use of active wayside components such as signposts, hub odometers, or obsolete technologies such as LORAN-C or inductive loops are not acceptable. The DVAS shall include, but shall not be limited to the following:

- Automatic Vehicle Location (AVL) equipment needed to sufficiently drive the automatic passenger information functions
- Wireless Bulk Data Transfer equipment (vehicle-borne and at fixed side at yards)
- Operator Control Unit (OCU)
- DVAS Logic and Control Unit
- Audio Pre-amplifier
- Audio Amplifier
- On-board message signs
- Memory
- Wiring, Cabling, and Support Mounts

- Software and firmware
- On-board computers, routers, access points, modems
- Wireless bulk data transfer equipment at yards
- Manuals, training material, system administration, diagnosis and analysis tools, and test equipment
- Any interfacing equipment for the integration with the ATCS, if needed

Single points of failures shall be minimized in the DVAS. In an event the DVAS Logic and Control Unit fails, the vehicle operator shall still be able to make manual announcements over the PA and the passenger activated “Stop Request” in the internal sign shall remain functional, destination signs shall also remain functional.

The Contractor shall provide all data to achieve functions identified herein including, but not limited to basic data, schedules as needed, audio recordings, initial parameter sets, on-board sign messages, and OCU display texts. All data as part of the Awarded Contract shall remain or become the property of SFMTA and the Contractor shall have no rights on any supplied or generated data associated with the Awarded Contract.

The Contractor shall ensure that the available power shall be used for powering the new and existing equipment. The power utilization scheme shall be submitted by the Contractor for review and approval as part of the design report.

FUNCTIONAL REQUIREMENTS

The SFMTA LRVs operate in both street running operations and within subway tunnels. The existing Digital Voice Annunciation System relies on input from the ATCS for automatic announcements. The DVAS shall use on-board AVL, which shall be based either on one technology such as DGPS, or a combination of technologies such as, for example, DGPS and RFID. Location information is also available from the ATCS when vehicles operate in the ATCS territory. On-board AVL to drive DVAS and all other functions shall be provided regardless whether trains are operating in auto, or cut-out mode.

Upon key-on, the MDT shall prompt and enable the operator to input the following information:

- Enter Operator ID (badge number)
- Select Route pattern
- Enter Run number

This may include additional data elements, depending on the design of the MTMS. These inputs shall not be lost upon key-down. In addition to these inputs, the MDT shall also enable the following functions:

- Manual overrides to set destination signs selectable on the entire train or consist and on a per-car basis
- Manual triggering of pre-defined announcements
- Operator logover, to keep the selected route pattern and run at operator relieve
- Pre-departure self test and diagnostics
- Log off

During operations, the DVAS shall announce the following:

- Next stop/station message, when the LRV leaves a stop/station at a distance configured by SFMTA
- Stop approaching message, when the LRV is approaching a stop/station at a distance configured by SFMTA
- Left or right side where doors open. Note: LRVs can be run with the A or B section forward. The DVAS system shall correctly determine which side the doors open, in relation to the direction of travel.
- On the external speakers: Route and destination when doors are open at a stop/station. These shall be played at the side where the vehicle doors open.
- Other public service messages, as defined by SFMTA
- Warning message of steps movement (up or down)
- Door closing
- The operator triggered messages based on the input from the MDT

The internal sign shall display the following:

- Next stop/station name following departure at the previous stop/station
- Route and destination when the vehicle is stopped with doors open at a stop/station
- Other public service messages, as defined by SFMTA
- Operator ID (badge number) with a SFMTA configurable text message
- Current time
- Message corresponding to the operator triggered annunciation

Using the Digital Visual and Audio System Management System (DMS), the SFMTA shall be able to add, delete, modify, change, edit all audio and visual messages. This data shall be downloaded to the vehicle via the wireless bulk data transfer subsystem. Each SFMTA defined audio and visual message shall be controlled by an SFMTA defined start and end date and time.

SFMTA shall also be able to define repetition intervals for each of the SFMTA defined automatic audio and visual messages.

The DVAS shall announce audio messages via the existing, or replaced, internal and external speakers on the LRVs. Two separate ambient noise sensor mechanisms shall control the audio volume levels to the internal and external speakers. The SFMTA shall also be able to control the external and internal volume levels through software configuration that is downloaded to the fleet as part of the wireless bulk data transfer. SFMTA shall have the capability to define audio levels on a vehicle by vehicle basis, overriding the global default volume level. When set at any level, the ambient noise sensor shall pick up noise levels from interiors and exteriors as applicable and shall be able to adjust the output levels accordingly. The DVAS shall have an automatic time-based volume output level controller for both interior and exterior PA. This time-based volume output controller shall be independent from the ambient noise sensors. In the event of a conflict between the output levels between the ambient noise sensors and output level controls, the time-based volume output controller shall have a higher priority and shall override the ambient noise sensing. Once the time-based volume output controller is set to control noise levels on specific days and specific times, operator intervention to change announcement volume levels shall not be required and not allowed. The time-based volume output control data, shall be downloaded to the fleet through the Wireless Bulk Data Transfer Subsystem.

The passenger next stop request signal shall be used as input to light up a visual sign that may be integrated in the internal sign, and that shall replace the next stop request signs currently installed on board of the LRVs. The stop request indicator shall be based on LED technology. Activation and clearing of the replacement stop request sign shall replicate the existing sign's logic.

When LRVs are coupled, the DVAS of the leading car shall control the function for the entire consist. When uncoupled, each vehicle based DVAS shall function independently.

The signs, background colors, text size and fonts shall be compliant with ADA requirements and shall be Approved by SFMTA. The DVAS shall include manual vehicle operator overrides for on-board signs to clear existing messages and manually set new messages. The selection process as presented to the vehicle operator shall be simple, via push-buttons, and the message selection shall be self explanatory via menu-driven or similar Approved method.

The DVAS shall replace the existing amplifier unit. This shall include all necessary pre-amplifiers, and amplifiers, and shall have the exact same output levels throughout the fleet,

regardless whether vehicles are coupled, or not. The current power amplifier unit key data is known as follows:

- Supply voltage: +37.5 VDC
- Output: 70.7 Vrms, with 250 ohm load
- Frequency response: ± 1 db., 200 to 5000 Hz. At 70.7 Vrms
- Distortion: Less than 1%, 250 ohm load, 200 to 5000 Hz

Further details, including the circuit diagrams of the communications system will be made available by SFMTA to the Contractor. The SFMTA cannot guarantee the accuracy or correctness of the data provided. It shall be the Contractor's responsibility to verify all output voltages, power levels, and any other data.

ON-BOARD SIGN AND PA REQUIREMENTS

The Contractor shall supply four (4) new internal signs for each LRV and four (4) new stop request signs, which may be included in the new internal signs. The placement and use of single and double-sided signs shall be such that passengers on board of the vehicle can see and read the internal signs.

The Contractor shall design the system such that the existing CCP shall be replaced, as part of the radio system replacement. When two or more vehicles are coupled, the PA audio related control signals shall be transmitted via the existing LonWorks (or through existing TransLite signs that on the LonWorks network) network to the trailing vehicle. The control signal shall enable the trailing LRV to play the exact same message as played in the lead car. The process shall not introduce perceivable delays. The messages played on the PA in the leading and trailing cars shall be at the same time.

In coupled consists, the on-board signs shall be interfaced with the existing LonWorks network (or through existing TransLite signs that on the LonWorks network). The existing LonWorks network controller shall control all destination, run number, on-board signs in the leading and the trailing cars.

The DVAS shall have adequate memory to include all of SFMTA's existing stops/stations, plus the capacity of adding 100% more stops/stations by SFMTA using the Wireless Bulk Data Transfer. The memory shall be commercially available from at least 3 different suppliers and shall be expandable by SFMTA to add total 200% plus the original number of stops.

FALLBACK LEVELS

In an event that the DVAS Logic Unit either fails completely or partially, or in case it is removed, or is not functioning, or is inoperable due to failing internal/external interfaces, the DVAS shall revert to fallback level operation. The DVAS shall also include a manual override function, which when activated shall result into fallback level. While the DVAS is in the fallback level, the following functions shall be available without the DVAS Logic Unit:

- Operator PA announcements
- Next stop request including the sign and audible signal
- Door closing tone
- Destination signs through the existing LonWorks Control Unit
- Passenger intercom
- Cab-to-cab intercom

When the DVAS Logic Unit (VLU) is either replaced, repaired, or begins to function normally, the Unit shall revert to normal level unless the system is forced into fallback level by manual override.

DATA PROVISIONING AND MANAGEMENT

The data provisioning and management shall be integrated and included in the data management of the MTMS. The following types of data shall be included and integrated:

- Trapeze transit data import for stops/stations, route patterns, destinations
- Management of multiple datasets with activation dates
- Management of vehicles: Selectively and globally enable and disable announcements and signage
- Validation of datasets to assure proper function of the DVAS
- Backfill of relevant data which is not part of Trapeze import such as vehicle lists, system parameters
- Access to software status and data load reports
- Staging of data download and software updates
- Managing of data upload
- Management of recording and internal sign functions
- Pre-departure vehicle status report
- Wireless bulk data transfer subsystem status report
- Automatic vehicle location and announcement and electronic signage trigger reporting

This is not an all inclusive list.

INTERNAL AND EXTERNAL INTERFACES

WIRELESS BULK DATA TRANSFER SUBSYSTEM

Data provisioning and offload shall be included and integrated with the wireless bulk data transfer subsystem that will be installed with the MTMS.

VISUAL AND AUDIO RECORDING AND DEVELOPMENT ENVIRONMENT

As part of the Awarded Contract the Contractor shall supply a completely functional audio recording and on-board sign message development environment.

The environment shall include, but shall not be limited to the following:

- Recording equipment including microphones, workstation with monitor

The vehicle test setup shall be utilized to test recordings and internal sign messages, including:

- Test sign(s) which represent the current configuration of vehicle installed internal signs
- Test speaker(s) which represent the current configuration of internal and external speakers
- Wires, cables, harnesses
- Fully functional VLU and MDT
- DVAS Logic and Control Unit
- Wireless Bulk Data Transfer subsystem equipment

The vehicle test setup shall be integrated in a portable enclosure. It shall be capable of performing the functions of the DVAS.

The SFMTA shall be able to create, record, change, modify, update the audio and service messages and shall be able to download them to the vehicles. The download process shall be a simple select, click and download type process and shall not take more than 15 minutes to update all data to a vehicle. The upload process from the LRV to the Wireless Bulk Data Transfer server shall not take more time.

In the test and analysis environment, the Contractor shall provide a tool that allows SFMTA to visualize and analyze the vehicle location performance and triggering of announcements and electronic signage, and, as a result, to confirm proper function of the DVAS, or to troubleshoot defects reported from the field. This tool shall put SFMTA in a position to determine root causes of non conforming announcement and electronic signage, such as AVL problems, inaccurate data or insufficient operator training.

The Contractor shall submit for SFMTA Approval the design of the Visual and Audio Recording and Development Environment, including narrative, drawings, datasheets, and product specifications.

VEHICLE LOCAL AREA NETWORK AND WIRELESS INTERFACE

The Contractor shall provide a Vehicle Local Area Wireless Network Interface as required in Appendix 12, section 3.2.4.

The Contractor shall submit for SFMTA Approval the design of the Vehicle Local Area Network and Wireless Interface, including narrative, drawings, datasheets, and product specifications.

INSTALLATION

Material and Workmanship standards are listed in Appendix 22.

TESTING

As part of the Awarded Contract, the Contractor shall initiate, develop, and conduct a comprehensive test program to test the DVAS. General Test Program Requirements are listed in Appendix 12 Section 7.

The entire LRV DVAS test program shall be documented in details in the Testing Plan which shall be submitted by the Contractor for SFMTA's review and Approval. The Plan shall include all details necessary for informing SFMTA about the Contractor's testing process, repair/replacement, documentation control related to testing, and any other relevant information.

The testing process shall be divided into following categories:

- a. Factory Testing For Vehicle-Borne Equipment
- b. Factory Testing For fixed side Equipment
- c. Static Vehicle-Borne Equipment Testing
- d. Dynamic Vehicle-Borne Equipment Yard Testing
- e. Dynamic Vehicle-Borne Equipment Revenue Service Testing
- f. Fixed side Equipment Testing
- g. System Integration Testing
- h. Vehicle logs and diagnosis environment to confirm the proper function or to identify defects in AVL and on-board passenger information functions
- i. Other Testing

This is a minimal list and does not necessarily include all types of tests. It is the Contractor's responsibility to include all necessary tests to ensure a complete functional system as identified within this specification. SFMTA reserves the right to request additional information, additional tests, or other information as necessary. The Contractor shall provide all tools, equipment, labor and technical personnel to perform and complete all test. During the design phase, the contractor and SFMTA will mutually agree on a rating system a failure to determine whether or not a failure requires a stoppage in test.

a. Factory Testing For Vehicle-Borne Equipment

This category shall include all tests conducted by the equipment designer, supplier, vendor in their factory on the vehicle-borne hardware, software, firmware, and other equipment. The SFMTA at its discretion may witness these tests. These tests shall follow the Quality Control/Quality Assurance program. Upon successful completion of the factory testing, the Contractor shall issue either a Certification of Successful Test Completion, or test results clearly show that the test has passed successfully. These documents shall be submitted to SFMTA for review and Approval.

b. Factory Testing For Fixed Side Equipment

This category shall include all tests conducted by the equipment designer, supplier, vendor in their factory on the fixed side hardware, software, firmware, and other equipment. The SFMTA at its discretion may witness these tests. These tests shall be conducted at assembly level and shall follow the Quality Control/Quality Assurance program. Upon successful completion of the factory testing, the Contractor shall issue an either Certification of Successful Test Completion or test results clearly stating that the test has passed successfully. For Common-Of-The-Shelf (COTS) commercially available equipment such as servers, operating systems, this test shall not be necessary. However, if the COTS equipment is interfaced with other equipment, then the test results or certificates are required. These documents shall be submitted to SFMTA for review and Approval.

c. Static Vehicle-Borne Equipment Testing

The Contractor shall conduct static vehicle-borne equipment testing on SFMTA's facilities. The testing shall include verification of function of all vehicle-borne equipment identified in the functional requirements. During this static testing, the vehicle shall remain stationary. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and test shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval. The SFMTA at its discretion may witness these tests.

d. Dynamic Vehicle-Borne Equipment Yard Testing

The SFMTA shall permit the Contractor's use of their test track within the Muni Metro East (MME) facility for a limited number of hours to be confirmed by SFMTA. The Contractor shall setup the equipment around this test track to conduct the DVAS testing within the yard. This shall include the testing of all requirements of the DVAS. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and the test shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval. The SFMTA at its discretion may witness these tests.

e. Dynamic Vehicle-Borne Equipment Revenue Service Testing

The Contractor shall test the vehicle-borne equipment in revenue service during SFMTA authorized hours. The objective of this test shall be to verify that the equipment functions correctly in revenue service. This test shall include single vehicle testing, coupled (in all combinations) vehicle testing, coupling/uncoupling, on-board sign functions, PA function, stop requested function, fallback level, and all other functional requirements identified in this specifications. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and test shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval. The SFMTA at its discretion may witness these tests.

f. Fixed Side Equipment Testing

The Contractor shall plan and conduct the fixed side equipment testing. This shall include, but shall not be limited to, the Wireless Bulk Data Transfer Subsystem, visual and audio recording and development environment, all hardware, software, firmware, and equipment. The testing shall include creating messages, transmitting messages over the SFMTA network, storing messages at the maintenance facilities, data upload/download to the vehicles, simulated failures, power loss, and other functions of the DVAS. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and the test shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval. The SFMTA at its discretion may witness these tests, and this test shall be conducted at the SFMTA's facilities.

g. System Integration Testing

The Contractor shall plan and conduct a comprehensive system integration test. The objective of this test shall include, but shall not be limited to verifying and validating the entire DVAS and all fixed side equipment concurrently in its entirety, against the requirements of this specification. The test shall be conducted to demonstrate that the equipment functions as specified in actual revenue service, maintenance, and the operations environment of SFMTA. At its discretion, SFMTA may attend this test. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and the test shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval. This test shall be conducted on Muni's LRV routes.

h. Other Testing

The Contractor shall also conduct other tests on both the vehicle-borne and fixed side, hardware, software and firmware equipment. These tests shall include, but shall not be limited to Megger tests, Continuity Tests, Electromagnetic Interference Tests. At its discretion, SFMTA may attend these tests. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and the test shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval.

Any deficiencies, problems, issues noticed during the testing process as a result of design, defective equipment, defective hardware, incompatible software, shall be immediately corrected by the Contractor and the test shall continue until successfully completed. Based on the nature of corrective action, the SFMTA may request the Contractor to repeat the entire test.

These are minimum requirements. The Contractor shall include additional items and topics as necessary to provide all information to SFMTA to demonstrate the DVAS meets the requirements of this specification. The SFMTA reserves the right to request additional information if needed.

After the Test Program is completed, the Contractor and SFMTA jointly shall ensure that the vehicle is returned to the SFMTA without damage, wiring problems, or missing equipment. It shall be the Contractor's responsibility to verify and report in writing any equipment missing from the vehicles prior to the equipment installation.



appendix **twenty-six**

Codes & Standards

INTRODUCTION	1	
REFERENCE DOCUMENTS	1	
CIVIL AND ELECTRICAL	1	
COMMUNICATIONS AND INFORMATION TECHNOLOGY		3
OSI MODEL STANDARDS & PROTOCOLS	3	
VOIP STANDARDS	5	
APCO P-25 STANDARDS	6	
INTELLIGENT TRANSPORTATION SYSTEMS (ITS)		6
RELATIONSHIP OF ITS ARCHITECTURE TO STANDARDS		6
SELECTION OF APPLICABLE NATIONAL ITS STANDARDS		7
ITS STANDARDS RELATED CONSIDERATIONS	8	
ON-BOARD SYSTEMS	10	
OTHER CODES, STANDARDS AND GUIDELINES		11
GLOSSARY OF STANDARDS ACRONYMS	11	

Introduction

This document lists the codes and standards applicable to the Radio System Replacement Project.

The codes and standards are divided into the following categories and is related to design, construction and installation as applicable:

- Civil and electrical
- Communications and information technology
- Intelligent Transportation Systems (ITS)
- Other

Reference Documents

- [1] Interface Control Document for Onboard Devices and the TransLink® Driver Console, Version 0.3
- [2] MTC 511 regional real-time transit system XML DTDS for JMS implementation

Civil and Electrical

The following codes, industrial standards and regulations apply to the design and construction of the surface and underground facilities:

1. State of California, Public Utilities and Commission:
 - a) General Order No. 95 Rules for Overhead Electric Line Construction
 - b) General Order No. 128 Construction of Underground Electric Supply and Communications Systems
 - c) General Order No. 143B Safety Rules and Regulations Governing Light-Rail Transit
2. National Electrical Code (NEC)
3. The Institute of Electrical and Electronics Engineer, Inc. (IEEE)
4. City and County of San Francisco Electrical Code
5. American Society for Testing and Materials (ASTM)
6. National Electrical Manufacturers Association (NEMA)
7. American National Standards Institute (ANSI)
8. Underwriter's Laboratories, incorporated (UL)
9. City of San Francisco, Department of Public Works, Bureau of Engineering Standard Specifications
10. American Concrete Institute (ACI)
11. Insulated Cable Engineers Association (ICEA) S-66-524
12. Safety-Cal/OSHA

13. San Francisco Building Code
14. American Institute of Steel Construction
15. San Francisco Traffic Code
16. American Railway Engineering and Maintenance Association (AREMA).

Communications and Information Technology
OSI Model Standards & Protocols

Layer		Misc.	IP Suite	SS7[5]	OSI Suite	IPX Suite	SNA	UMTS
#	Name	Examples						
5	Session	Named Pipes, NetB IOS, SAP, Half Duplex, Full Duplex, Simplex, <u>SDP</u>	Sockets. Session Establishment in TCP. SIP. (Not a separate layer with standardized API.), <u>RTP</u>		ISO/IEC 8327, X.225, ISO/IEC 9548-1, X.235	<u>NWLink</u>	<u>DLC</u> ?	
4	Transport	<u>NBF</u>	<u>TCP, UDP, SCTP</u>		ISO/IEC 8073, TP0, TP1, TP2, TP3, TP4 (X.224), ISO/IEC 8602, X.234	<u>SPX</u>		
3	Network	NBF, Q.931, IS-IS	IP, IPsec, ICMP, IGMP	SCC, MTP	ISO/IEC 8208, X.25(P LP), ISO/IEC 8878,X.223, ISO/IEC 8473-1,CLNP X.233.	IPX		RRC (Radio Resource Control) Packet Data Convergence Protocol (PDCP) and BMC (Broadcast/Multicast Control)

Layer		Misc.	IP Suite	SS7[5]	OSI Suite	IPX Suite	SNA	UMTS
#	Name	Examples						
2	Data Link	802.3 (Ethernet), 802.11a/b/g/n MAC/LLC, 802.1Q (VLAN), ATM, HDLC, Fibre Channel, Frame Relay, HDLC, ISL, PPP, Q.921, Token Ring, CDP, ARP (maps layer 3 to layer 2 address)	OSPF, PPP, SLIP, PPTP, L2TP	MTP, Q.710	ISO/IEC 7666, X.25(LAPB), Token Bus, X.222, ISO/IEC 8802-2 LLC Type 1 and 2	IEEE 802.3 framing, Ethernet II framing	SDLC	LLC (Logical Link Control), MAC (Media Access Control)
1	Physical	RS-232, V.35, V.34, I.430, I.431, T1, E1, 10BASET, 100BASETX, POTS, SONET, SDH, DSL, 802.11a/b/g/n PHY		MTP, Q.710	X.25 (X.21 bis, EIA/TIA-232, EIA/TIA-449, EIA-530, G.703)		Twinax	UMTS L1 (UMTS Physical Layer)

VoIP Standards

Signaling

H.323	H.323
Megaco	H.248 Gateway Control Protocol
MGCP	Media Gateway Control Protocol
RVP over IP	Remote Voice Protocol Over IP Specification
SAPv2	Session Announcement Protocol
SGCP	Simple Gateway Control Protocol
SIP	Session Initiation Protocol
Skinny	Skinny Client Control Protocol (Cisco)

Media

DVB	Digital Video Broadcasting
H.261	Video stream for transport using the real-time transport
H.263	Bitstream in the Real-time Transport Protocol
RTCP	RTP Control protocol
RTP	Real-Time Transport

H.323 Protocols Suite

H.225	Covers narrow-band visual telephone services
H.225 Annex G	
H.225E	
H.235	Security and authentication
H.323SET	
H.245	Negotiates channel usage and capabilities
H.450.1	Series defines Supplementary Services for H.323
H.450.2	Call Transfer supplementary service for H.323
H.450.3	Call diversion supplementary service for H.323
H.450.4	Call Hold supplementary service
H.450.5	Call Park supplementary service
H.450.6	Call Waiting supplementary service
H.450.7	Message Waiting Indication supplementary service

H.450.8	Calling Party Name Presentation supplementary service
H.450.9	Completion of Calls to Busy Subscribers supplementary service
H.450.10	Call Offer supplementary service
H.450.11	Call Intrusion supplementary service
H.450.12	ANF-CMN supplementary service
RAS	Manages registration, admission, status
T.38	IP-based fax service maps
T.125	Multipoint Communication Service Protocol (MCS).

SIP Protocols

MIME

SDP Session Description Protocol

SIP Session Initiation Protocol

APCO P-25 Standards

Please refer to Appendix L of the *Radio System Alternatives Analysis Report* for the list of applicable APCO

Project 25 standards.

Intelligent Transportation Systems (ITS)

Relationship of ITS Architecture to Standards

The National ITS Architecture provides a mapping of architecture flows to individual ITS standards. Since the architecture flows of the National ITS Architecture form the basis for information exchanges of statewide or regional ITS architectures, this mapping of interfaces to standards is available for these architectures as well.

ITS standards address the interfaces between ITS systems. These interfaces and the information flows between the interfaces are identified in the regional ITS architecture. Based on the identified data flow and interfaces, the regional ITS architecture indicates what standards may be applicable. The regional ITS architecture list of applicable ITS standards is not directly applicable to specific ITS projects, but is rather a starting point for further project analysis.

Selection of Applicable National ITS Standards

The following standards are identified as those that are relevant to this project:

Table 1 – Relevant Standards to the Project from the National ITS Architecture

ITS Standard	Applicable Architecture Flow
APTA TCIP-S-001 3.0.0: Standard for Transit Communications Interface Profiles	transit vehicle location data transit vehicle schedule performance transit vehicle operator information transit fare coordination transit fare information alarm notification alarm acknowledge personal transit information transit traveler information transit traveler information coordination transit information user request transit schedule information transit vehicle loading data
IEEE IM: Incident Management Standards	transit emergency data incident response status
NTCIP C2C: NTCIP Center-to-Center Standards	transit fare coordination transit emergency data incident response status transit traveler information coordination
ITE TMDD: Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	incident response status

ITS Standard	Applicable Architecture Flow
ATIS General Use: Advanced Traveler Information Systems (ATIS) General Use Standards	transit fare information personal transit information transit traveler information transit information user request
NTCIP C2F: NTCIP Center-to-Field Standards	signal control status signal control data
NTCIP 1201: Global Object Definitions	signal control status signal control data
NTCIP 1202: Object Definitions for Actuated Traffic Signal Controller (ASC) Units	signal control status signal control data
NTCIP 1210: Field Management Stations (FMS) – Part 1: Object Definitions for Signal System Masters	signal control status signal control data
NTCIP 1211: Object Definitions for Signal Control and Prioritization (SCP)	signal control data

Additional information including descriptions and status updates about these standards is available at the ITS Joint Programs Office Standards Website (<http://www.standards.its.dot.gov>)

ITS Standards Related Considerations

APTA TCIP-S-001 3.0.0: Standard for Transit Communications Interface Profiles

Description: Transit Communications Interface Profiles allows for transit devices, systems, and subsystems to exchange information.

Applicability to Project: The APTA TCIP standard is insufficiently mature for implementation.

Justification: This standard has only been available for a year and a half, has not been tested to show that the standard is useful or will perform as expected in the field, nor are there vendors that have implemented the standard in their product.

IEEE IM: Incident Management Standards

Description: The IEEE IM standards provides a comprehensive and consistent message set for emergency management amongst stakeholders.

Applicability to Project: These standards will be used if used regionally.

Justification: Due to the need to communicate with other regional agencies, the project will use the regional standard for transit emergency data and incident response status.

NTCIP C2C: NTCIP Center-to-Center Standards

Description: The C2C standards provide the protocols, objects, data elements, and messages necessary to exchange information between a transportation management center, the ITS field devices it manages, and other centers.

Applicability to Project: At the applications level, XML is being considered for the project in which case NTCIP 2306 - Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications (C2C XML) will be consulted. At the transport level TCP/IP will be used according to NTCIP 2202 - Internet (TCP/IP and UDP/IP) Transport Profile. At the subnetwork level NTCIP 2104 - Ethernet Subnetwork Profile will be used.

Justification: Due to the recent publication of NTCIP 2306 as a standard, it has not been tested nor are test guides available for the standard, guidance from the ITS JPO may be needed for implementation.

ITE TMDD: Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)

Description: The TMDD and MS/ETMCC standards contains data elements for roadway links and for incidents and traffic-disruptive roadway events

Applicability to Project: These standards will be used if used regionally.

Justification: Due to the need to communicate with other regional agencies, the project will use the regional standard for transit emergency data and incident response status.

ATIS General Use: Advanced Traveler Information Systems (ATIS) General Use Standards

Description: A basic message set using the data elements from the ATIS data dictionary needed by potential information service providers to deploy ATIS services and to provide the basis for future interoperability of ATIS devices.

Applicability to Project: ATIS messages will be used for transit fare information, personal transit information, transit traveler information, transit information user request where existing legacy messages are not already defined within SFMTA and the region.

Justification: Some messages for exchanging transit fare information, personal transit information, and transit traveler information are already defined in existing regional standards such as MTC 511 which will take precedence. Additionally, messages used in the legacy ITS systems may need to be carried over to the new system.

NTCIP C2F: NTCIP Center-to-Field Standards, , NTCIP 1201: Global Object Definitions, NTCIP 1202: Object Definitions for Actuated Traffic Signal Controller (ASC) Units, NTCIP 1210: Field Management Stations (FMS) – Part 1: Object Definitions for Signal System Masters, NTCIP 1211: Object Definitions for Signal Control and Prioritization (SCP)

Description: The NTCIP C2F standards and associated object definitions provide the protocols, objects, data elements, and messages necessary to exchange information between a transportation management center and one or multiple field devices managed by that center.

Applicability to Project: The C2F standards apply to the signal control status and signal control data architecture flows of the MRSR project, which are already defined in the SFMTA SFgo project.

Justification: The MRSR will use the existing SFgo specifications for the signal control status and signal control data.

SAE 1708: Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle

Applications and SAE J1939 Series: Recommended Practice for a Serial Control and Communications Vehicle Network

Description: The SAE 1708 and 1939 standards guide design of systems in heavy-vehicles that have bidirectional, serial communication link among modules containing microcomputers. The standards defines the interface requirements and connecting devices necessary for the transmission of signals and information among electronic components in trucks and buses.

Applicability to Project: SAE 1708 and SAE 1939 series will be used for on-board communications to the extent possible, where new systems are specified and not limited by legacy equipment.

Justification: SAE 1708 and the SAE 1939 series have been implemented in other transit agencies and has resulted in reduction in procurement costs and facilitate system expansion and technological upgrade.

On-board systems

The onboard systems shall be designed using components that have interfaces that are fully documented and, based on a standard that is recognized by a standards-making body such as IEEE, ANSI, EIA, SAE, and ITU-T. If a proprietary interface is used it shall be fully documented and available to SFMTA for current and future system integration. The following standards apply to the design and implementation of the onboard ITS systems:

- SAE J1939
- SAE J1708
- SAE J1587
- SAE 1455 (humidity, vibration)
- NEMA IEC Enclosure 13 (IP54)
- EIA-485
- EIA-232
- IEEE 802.3
- IEEE 802.11
- IEEE 802.11i-2004

- File Transfer Protocol (FTP)
- Interface Control Document for Onboard Devices and TransLink® Driver Console (OASIS)

Other Codes, Standards and Guidelines

The following list includes the applicable standards and guidelines that do not fit in the categories above:

Muni Project Operations Manual (POM) Construction Division

Drawings shall be submitted in AutoCAD version 2003

Project working documents shall be exchanged in Microsoft Office 2003, Microsoft Visio 2003 and Microsoft

Project 2003

FTA QA/QC guidelines¹ - http://www.fta.dot.gov/printer_friendly/publications_3876.html

Glossary of Standards Acronyms

- APC** – Automatic Passenger Counting
- API** – Application Programming Interface
- ATCS** – Automatic Train Control System
- AVL** – Automatic Vehicle Location
- BCD** – Binary Coded Decimal
- CAD** – Computer Aided Dispatch
- CASR** – Computer Aided Service Restoration
- CCTV** – Closed Circuit Television
- CER** – Conceptual Engineering Report
- COTS** – Commercial off the Shelf
- DC** – Driver Console
- DT** – Department of Technology
- DSL** – Digital Subscriber Line
- DTD** – Document Type Defintion
- DTIS** – Department of Technology and Information Systems
- DMZ** – Demilitarized Zone
- DGPS** – Differential Global Positioning System

¹ The project Quality Assurance Plan follows the FTA QA/QC guidelines.

DVAS – Digital Vehicle Announcement System
EA – Emergency Alarm
ECM – Electronic Control Module
FTA – Federal Transit Administration
ICD – Interface Control Document
INS – Inertial Navigation System
IP – Internet Protocol
ISSI – Inter RF Subsystem Interface
IT – Information Technology
ITS – Intelligent Transportation Systems
LAN – Local Area Network
LRV – Light Rail Vehicle
MDT – Mobile Data Terminal
MOU – Memorandum of Understanding
MRSR – Muni Radio System Replacement
MTC – Metropolitan Transportation Commission
NEMA – National Electrical Manufacturers Association
NTD – National Transit Database
OCC – Operations Control Center
OCD – Operational Concept Document
QA – Quality Assurance
QC – Quality Control
PA – Public Address
PBX – Private Branch Extension
PDS – Platform Signs
PRTT – Priority Request to Talk
PSTN – Public Switched Telephone Network
P25 – Project 25
RFP – Request for Proposal
RTT – Request to Talk
QoS – Quality of Service
SAE-J* - Society of Automotive Engineers J standards (e.g. J1708)

SAN – Storage Area Network
SCADA – Supervisory Control And Data Acquisition
SFMTA – San Francisco Municipal Transportation Agency
SLA – Service Level Agreement
SNMP – Simple Network Management Protocol
TEP – Transit Effectiveness Project
TSP – Traffic Signal Priority
Telco – Telecommunications Provider
UTA – Urban Transportation Associates, Inc.
VHM – Vehicle Health Monitoring
VMS – Variable Message Sign
VOBC – Vehicle On-Board Computer
VoIP – Voice over IP
VAN – Vehicle Area Network
VPN – Virtual Private Network
VLU – Vehicle Logic Unit
WAN – Wide Area Network
XML – Extensible Markup Language



appendix **twenty-seven**

Permit Process

Permit Process

Permits shall be acquired for the proposed work prior to construction at each site. The proposed construction drawings and documents shall be stamped, signed and submitted for review by the respective jurisdiction's planning department, building department, fire department and other relevant agencies are required prior to approval of the permit application.

The purpose of the plan review process is to ensure that the proposed construction work meets planning/zoning, life safety, accessibility, structural safety, mechanical and electrical requirements of the code. Typically, the planning department reviews the plans to ensure that planning/zoning regulations are met prior to review by other agencies for building, fire, mechanical, electrical and other requirements. The planning process may require public notification and hearings involving owners and residents of the surrounding area adjacent to the site.

In the City and County of San Francisco, a pre-application process can be explored to determine the major requirements of the proposed project without the need for a full set of working plans and occurs before the application for a permit. The pre-application application will also minimize complications in the subsequent permit process by establishing policies, procedures and requirements for the project. The procedures for the pre-application process are laid out in Administrative Bulletin AB-028 of the 2007 San Francisco Building Code.

The agencies reviewing the proposed construction drawings and documents may issue comments. The comments will need to be addressed to the satisfaction of each agency at each stage of the permit process. Each jurisdiction has procedures in place that will determine if the project will be reviewed in serial or parallel with other agencies. Parallel review will generally ensure a more efficient review and approval of the project. Once all comments have been addressed satisfactorily a special inspection and structural observation form shall be completed by the Engineer of Record and approved by the building department; a permit will be issued when the fees have been paid.

The following websites contain additional information regarding the permit process for the City and County of San Francisco and City of Daly City, respectively:

www.sfdbi.org

www.sfgov.org/site/planning_index.asp

www.ci.daly-city.ca.us/city_services/depts/e cd/building/index.htm

www.ci.daly-city.ca.us/city_services/depts/e cd/planning/index.htm

SFMTA Replacement Radio System

**HARRIS CORPORATION
CONTRACTOR TO
San Francisco Municipal Transportation Authority (SFMTA)**

STATEMENT OF WORK

Contract #: 1240

**Prepared by:
Harris Corporation**

**Approved by:
Harris, Inc.**

Revised 3-29-12

Proprietary

Unless and until the Contract is awarded, this Statement of Work along with all attachments hereto is part of Harris Corporation's Proposal and is therefore proprietary and should be handled in a manner consistent with confidential data.



SFMTA Replacement Radio System

Contents

1	INTRODUCTION/PURPOSE	8
2	PROJECT MANAGEMENT AND PROFESSIONAL SERVICES	9
2.1	Project Management Plan	9
2.2	Implementation Plan	10
3	PROGRAM	11
	Major Project Milestones	11
	PHASE 4.1 – DESIGN ENGINEERING SERVICES	12
	System Site Surveys –	14
	Phase 4.1.1: Intermediate (65%) Design	14
	Phase 4.1.2: Final (100%) Design	15
	PHASE 4.2 – SYSTEM DEVELOPMENT, FACTORY TESTING, SITE CONSTRUCTION	16
	Phase 4.2.1: Integrated System Test Plan, Test Procedures, and Cutover Plan	16
	Phase 4.2.2: Site Construction Above Ground	18
	OCC Sites	18
	RF Sites	21
	Maintenance Facilities	25
	Phase 4.2.3: Installation and Testing of all in-building/below ground transmission lines	26
	Phase 4.2.4: Procurement of Stationary Equipment	27
	Phase 4.2.5: Factory Acceptance Test	27
	PHASE 4.3 - EQUIPMENT INSTALLATION, SYSTEM CONFIGURATION, AND TRAINING PROGRAM PLANNING	29

SFMTA Replacement Radio System

Phase 4.3.1: Installation, configuration, and functional testing of all Stationary Equipment at all City Sites..... 29

 Underground Sites 29

 OCC Sites 29

 RF Sites - 32

 Network Solution 35

 Information Assurance 35

 Reliability..... 36

 First of Kind Vehicle Installation 38

Phase 4.3.2: Training Plan (Final)..... 39

Phase 4.3.3: Training Schedule (Draft) 40

Phase 4.3.4: Training Manuals and Agendas (Draft) 41

PHASE 4.4 - INTEGRATED SYSTEM TESTING..... 42

 Phase 4.4.1: Field Performance Test Report (FATP) – (Appendix 12, 7.9.5)..... 42

 Phase 4.4.2: Radio Coverage Acceptance Test Report (CATP) 43

 Phase 4.4.3: Mini-Fleet Test Report – (Appendix 12, 7.9.6) 44

 Phase 4.4.4: Training Schedule (Final) 44

 Phase 4.4.5: Training manuals and agendas (Final)..... 44

 Phase 4.4.6: Database Dictionary and User Manuals..... 45

PHASE 4.5 – TRAINING, SYSTEM CUTOVER, AND AVAILABILITY DEMONSTRATION..... 46

 System Cutover 46

 Preparations for System Cutover 46

 Cutover Execution..... 47

 Site Cleanup 47

 Phase 4.5.1: Completion of Training Program 47

 Phase 4.5.2: Installation of Mobile Equipment in all revenue and non-revenue Vehicles..... 48

 Phase 4.5.3: Configuration and distribution of all Portable Equipment..... 49



SFMTA Replacement Radio System

Phase 4.5.4: All As-Built H/W documentation, S/W documentation, and Maintenance Manuals 50

Phase 4.5.5: Delivery of all Program Source Code; execution of the S/W Escrow Agreement..... 50

Phase 4.5.6: System Availability Test Report (RFP Appendix 12, 7.9.7)..... 51

4 SPARE PARTS53

5 WARRANTY ERROR! BOOKMARK NOT DEFINED.

6 OPTIONS.....55

7 ATTACHMENT DOCUMENTS.....65



SFMTA Replacement Radio System

1 Introduction/Purpose

For the purposes of interpreting this Statement of Work, the following order of precedence applies:

- SOW – Master Document
- Attachments 1-4, 6 (attachment no. 5 not used)

This is the Statement of Work (SOW) for the effort to be performed by Harris for the implementation of the MTMS and PSVRN communications, in compliance with the System performance requirements set out in the Design Criteria Package (Document 0900).

The description of the Work in this SOW supplements and clarifies Harris' Proposal, provided to the SFMTA in response to the RFAP ("RFAP Proposal"). It provides a high-level overview of the Equipment and services Harris' is to provide under the Contract. In addition, this document modifies Harris' Proposal based on discussions between the parties to clarify System performance requirements. But if and to the extent that any part of this SOW is in conflict with any other Contract Document(s), the other Contract Document(s) shall govern.

Upon completion of the Final Design Review (100%), this Statement of Work will be modified to reflect agreed changes to the design that create functionality or requirements not provided as Work under the Contract will be incorporated into the Agreement in accordance with the Change Order process as addressed in Document 0700 of the Contract. Changes to the design must be documented in the design documents, but only changes that rise to the level of Additional Work that is requested by the SFMTA shall be memorialized in formal Change Order.

Where the Party responsible for performing work described in this SOW is not specifically indicated, (irrespective of the use of sentence tense, subject or object), Harris shall be responsible for performing that work, task, deliverable, or other action described, which shall be Work included under the Contract. Where the SOW describes a new Radio System function in the present tense, that description shall be understood to mean functionality that will be included the System design, not as Additional Work.

SFMTA Replacement Radio System

2 Project Management and Professional Services

HARRIS shall appoint a Project Manager (PM) to act as the single point of contact for all administrative, technical, and scheduling concerns related to this Project. The HARRIS PM has the overall responsibility for the delivery and implementation of the System as well as management of the HARRIS responsibilities pursuant to the Project schedule.

Harris requires that all of the SFMTA Stakeholder's needs have been identified during the design phase and that the SFMTA has full authority for all acceptance procedures, CDRL approvals that are required.

In order to complete the Project Work on a timely basis, Harris and the SFMTA agree to perform all of their tasks and responsibilities on a timely basis as set forth in the Contract, including the statement of Work and the division of responsibilities included in *Attachment 2 –Responsibility Matrix*. Harris will submit Project Management Plan and Implementation Plan in accordance with the provisions of Documents 00520, 00530, 00700 and 00800.

Following NTP, Harris will submit a final Project Management Plan and Implementation Plan for the SFMTA's review in accordance with the Project Management and Project Schedule Requirements outlined in Document 00833 and PMI Project execution best practices. The documentation will include all necessary information and details of the System as proposed for installation.

2.1 PROJECT MANAGEMENT PLAN

The Project Management Plan will include details of the training and experience and contact information for all Key Personnel.

The Project Management Plan will encompass all aspects of standard Project planning and execution, including but not limited to:

- Preliminary Baseline Schedule
- Personnel and Resources
- Procurement and Logistics
- Scope Management
- Cost Management and Control
- Quality Control
- Risk Identification and Management
- Key Personnel lists and Qualifications
- Final Responsibility Assignment Matrix (RAM)
- Change Management
- Configuration Management Plan
- Communications/Governance Plan
- Inspection Plans

SFMTA Replacement Radio System

Throughout the execution of the program, Harris will assign resources as provided in the Contract and as necessary to complete the Project within the Project Schedule for the purpose of responding to the requirements as defined in Article 1.2 of the Criteria Package.

Weekly and monthly reporting:

Attachment #4 (to this SOW) is a representative sample of a typical Monthly Report, which includes a compilation of typical Weekly Reports; weekly reports will be of the same basic information and format.

2.2 IMPLEMENTATION PLAN

The Implementation Plan will include a detailed work plan indicating required tasks and resources, organized by Site and according with the Project Schedule. The Plan will clearly identify critical Milestones in the implementation of the Project, including:

- Project Kickoff
- Customer Design Review Meeting(s)
- Acceptance of Final Design
- Equipment Ordering and Manufacturing
- Site Infrastructure Preparation
- System Configuration Documentation and Talk-groups
- Factory Acceptance Testing
- Phased Shipments, Installation, and Testing
- Equipment Installation
- Functional Testing
- Coverage and Performance Testing
- Mini-Fleet Testing
- Training
- Vehicle Installation and Cutover
- System Availability
- Final Acceptance

The Implementation Plan will also include detailed documentation of all required Test Plans: Factory Component and Integration, Staging, Functional, Site Acceptance, Dispatch, and Coverage. The Test Plans must fully demonstrate the compliance of the installed Radio System to the requirements of the Contract.

SFMTA Replacement Radio System

3 Program**MAJOR PROJECT MILESTONES**

As Harris completes Project Milestones, Harris will utilize a test methodology to sequentially demonstrate the ability of the System to meet the System requirements as defined in the Contract. The test sequence will use a format such that testing moves from a very detailed level in Phase 4.2 and culminates in a logical subset of the detailed test in Phase 4.4 and Phase 4.5. The Harris test philosophy is that acceptance testing is a method to obtain approval of the activities of a particular phase of the Project. This means that the same tests do not need to be repeated in their entirety in a subsequent phase with the exception of an agreed upon subset of tests for non-critical functions or items assigned to the punch list under agreement with the SFMTA. Harris will proceed with each subsequent Phase only after Notice-To-Proceed has been issued by the SFMTA. In the event of a failure to meet a non-critical requirement following a Conditional Acceptance of a test, Harris will perform an appropriate regression test at no additional cost to the SFMTA to demonstrate that the System meets Contract requirements. The SFMTA's Conditional Acceptance of any test results or Milestone completion shall not relieve Harris of its obligation to meet the System performance requirements of the Contract. Critical System functions, as determined by the SFMTA in its sole discretion, shall not be put over for testing in a later phase.

The table below shows the acceptance sequence of the significant test procedures throughout the SFMTA program.

Test or Exercise	Dependent Event(s)	Validation
Phase 4.2 Factory Acceptance Test (FAT)	Completion of Phase 4.1	Detailed Vendor testing (COTS and subsystems) Integrated FAT Procedures
Phase 4.4 Field Performance Test (FATP)	Completion and SFMTA Conditional Acceptance of FAT Installation Checklist and completion of MTMS and PSVRN installation (Phase 4.2/Phase4.3)	Functional Field Performance Test (subset of FAT procedures)
Phase 4.4 Coverage Acceptance Test (CATP)	Completion and SFMTA Conditional Acceptance of Field Performance Test	Coverage Acceptance Test Procedure

SFMTA Replacement Radio System

Test or Exercise	Dependent Event(s)	Validation
Phase 4.4 Mini-Fleet Test	Completion and SFMTA Conditional Acceptance of Coverage acceptance Test	Mini-Fleet Test (subset of FATP procedures)
Phase 4.5 System Availability Test Completion of the System Availability Test is the same as Substantial Completion	Completion of and SFMTA Conditional Acceptance of Mini-Fleet Test Completion of Vehicle Installation and Cutover	Successful completion of System Availability Test Procedure – typical SFMTA operation
Final Acceptance	Completion of Punch-List Final Completion Certificate	Customer Signature on open Punch-List items

Project HARRIS will submit to the SFMTA, monthly Milestone completion reports documenting status of the Project and Work completed, in a format substantially similar to the format in Attachment 4 of this SOW. HARRIS will submit the reports in accordance with the Milestone schedule and monthly reporting requirements. Harris will not provide Earned Value Management System reporting. Instead, these Milestones will encompass all Work completed and discussed during weekly progress meetings.

Phase 4.1 – Design Engineering Services

Scope – Harris will provide design engineering and related services for a complete Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) and all other related components as described in Design Criteria Package (Document 0900).

During the Design Phase, Harris will implement a number of studies and detailed surveys as described in the Design Criteria Package to bring the proposed System design to finalization. The SFMTA will have the opportunity to both recommend and review any potential design changes, and then collaborate with Harris to bring any necessary changes to final approval through the Change Order process, as necessary. Change orders for design work shall serve only to document the final design and design changes. Unless the SFMTA requires Harris to provide additional System functionality than is described in the Contract Documents, such Change Orders shall be at no additional cost to the City. Following the 65% Intermediate Design Review, Harris and its key subcontractors may need to submit requests to procure Long Lead Items, all in accordance with Document 0700, as necessary to meet the defined Project Schedule.

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SFMTA Replacement Radio System

At the Intermediate Design Review and Final Design Review (FDR), Harris will present in detail the design and will explain how related legacy systems and integration to identified System functions (such as but not limited to ATCS, AVLS, Trapeze scheduling, Cubic farebox functions, and signal priority) will be integrated and operate with the new Radio System. Harris will explain its reasoning supporting its design decisions, and the Project Manager and key subcontractors will present their Site development plans required at each Site. The SFMTA is encouraged to openly discuss each of these subjects with Harris and key subcontractors and recommend changes to the design. At the end of the FDR, the SFMTA will review the materials submitted by Harris and provide written comments or approval to Harris within the time frames specified in Document 0800. For the purpose of maintaining the Project Schedule, open issues that are not critical to completion of the design and do not involve critical System performance requirements (as determined by the SFMTA) may be put on an issues list for resolution a later time when additional information and design solutions are completed. Wherever possible, Harris will consolidate CDRL submissions for administrative efficiency. Harris will group CDRL requirements into common design, testing and documentation deliverables and wherever possible will utilize standard processes, design templates and typical vendor documentation to meet CDRL requirements.

During the Design Phase 4.1, Harris will provide a Project Schedule produced in Primavera Project Schedule Software, which will be provided as part of deliverables after NTP on Phase 4.1. During Phase 4.1 Harris will provide training for Primavera as described in the proposal.

Written acceptance of the final designs by the SFMTA shall be required before commencing any further Work or procurement or manufacture of any Equipment. The Contractor shall also prepare and provide complete installation plans, test plans and procedures, MTMS and PSVRN cutover plans and procedures, training plans and materials, and an integration plan [CDRL 12-1-3 Installation Plans, Test Plans and Procedures].

Expectations and assumptions for the SFMTA furnished materials and support shall be clearly stated in the Design Criteria. The Contractor shall incorporate comments received from the SFMTA into the design documentation. It is understood that the SFMTA's acceptance of designs, including, but not limited to, Final Design, does not relieve the Contractor to any degree from the Contractor's responsibility to meet the requirements of Document 0900- Article 1.2.

Contractor shall develop and provide a new system that integrates with the legacy system, including NextBus, Trapeze (OPS and FX), TransitSafe, 511, Cubic, and ATCS, such that data will be automatically

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SFMTA Replacement Radio System

exchanged (bi-directional if required) using web service or point-to-point database table updating to transmit data in real time or on a subscribed interval.

SYSTEM SITE SURVEYS –

Prior to the intermediate design review, Harris and its team will conduct appropriate detailed Site Surveys for the following locations:

- OCC, RF Sites and Maintenance Facilities
- Vehicle Fleet Surveys
- Microwave Path/Site Surveys
 - Immediately following Site Surveys, Harris will prepare, file with FCC and pay the application fee for the FCC application for the Microwave license
- Tunnel BDA Surveys*

*Prior to any Tunnel surveys, SFMTA will conduct a Track Safety Training Course for all Harris personnel required to be in the tunnels. Harris will provide a list of personnel required to attend this event. Certification of training is valid for 3 years..

PHASE 4.1.1: INTERMEDIATE (65%) DESIGN

Harris will complete the following deliverables:

- Intermediate System Description Document
- Preliminary Drawing Package
- Vendor Spec-Sheet Package
- Interface Control Document Package
 - *Note: Each interface will have a separate document*
- System Charts and Tables (Excel Sheets)
 - Internet Protocol (IP) Plan
 - Frequency Plan* and Inter-modulation Analysis
 - Fleet Map
 - Material List
- Survey Report Package
 - Wireless Bulk Data Transfer System
 - Above Ground Site Calculations and Reports
 - Below Ground Site Calculations and Reports
 - Vehicle Survey Reports
- Updated Project Quality Document (original Project Quality Document submitted after Notice to Proceed)
- Installation Plans for each Facility

SFMTA Replacement Radio System

- Microwave Analysis – include path survey and frequency coordination

*Note:

Frequency Licensing for Harris provided Equipment and Software is included for both base and optional items including dispatch workstations, terminals, base stations, and network infrastructure Equipment. The design currently requires 6-800 MHz and 9-700 MHz for both the MTMS and PSVRN system. Further, an additional 8-700 MHz channels are required for the optional PERS system. Harris is able to provide the following support the SFMTA for the preparation of the appropriate FCC application for the required one additional frequency for the System as well as for adjustments to the existing licenses if necessary to match the final design:

Tasks done by Harris:

- Recommend alternate Site locations if necessary for the System to meet performance criteria
 - This would enable reallocation of an existing SFMTA channel to another Site
- Provide ERP, antenna model and pattern at each Site
 - This includes providing 40 dBu contours
- Provide interface to third party frequency coordinator
- Channel planning for the System

Tasks done by third party coordinator (3rd party services to be provided by the SFMTA):

- Determine available channel(s) for the SFMTA
- Provide help in filling out the FCC applications
- Provide consulting on how to fill out the application, i.e. what goes where

Tasks done by the SFMTA:

- Work with third party coordinator and Harris to fill out the FCC application
- Send in the application and track it
- NOTE: FCC licenses need renewal at regular intervals and failure to do so can cause loss of use of channels. Harris strongly recommends setting in place processes to assure regular renewal.

PHASE 4.1.2: FINAL (100%) DESIGN

The Final Design Review will review the following: Finalized System Description Document

- Finalized Drawing Package
- Finalized Vendor Spec-Sheet Package
- Finalized Interface Control Document
 - *Note: Each interface will have a separate document*
- System Charts and Tables (Excel Sheets)

SFMTA Replacement Radio System

- Installation Plan
- Frequency Plan and Inter-modulation Analysis
- Fleet Map
- Material List
- Finalized Project Quality Document
- Availability/Reliability Report
 - Failure Modes Report
 - Availability Report
- Test Plan Package
 - Factory Test Procedures
 - Integrated Test Schedule
 - Finalize System Cutover Plan
 - Preliminary System Cutover Schedule
- Installation Plans for each Facility

Phase 4.2 – System Development, Factory Testing, Site Construction

Upon completion of Phase 4.1, Harris will proceed with Phase 4.2 based upon the approved design.

Scope - Development, customization, configuration, procurement of Stationary Equipment, and fabrication of materials for all Equipment and Software, and finalization of all test plans and procedures as described in the Design Criteria. Phase 4.2 shall also include construction at all Sites (above and below ground), installation of in-building transmission lines, component testing, device testing, module testing, and factory acceptance testing of all subsystems.

PHASE 4.2.1: INTEGRATED SYSTEM TEST PLAN, TEST PROCEDURES, AND CUTOVER PLAN

Test procedures listed below will identify the step-by-step activities associated with each test. The CDRLs are identified in Document 00900; e.g.:

- Factory Test Procedures (CDRL 12-7-2)
- Integrated Test Schedule (CDRL 12-7-1)
- Finalize System Cutover Plan (CDRL 12-5-23)
- Preliminary System Cutover Schedule (CDRL 12-5-24)

Phase 4.2.1 includes the required development identified in the Final Design. The following development, and feature clarifications are included in this phase.

- For the LRV on-board System design, the real-time vehicle location is provided by the ATCS interface onboard (if available) and through the fixed end server for tunnels, and the GPS location outside of the tunnels. Harris will investigate the application of on-board systems to retrieve ATCS and distance traveled for consideration in the design.
- The existing signs will be used in the Rubber Fleet for the AVA system upgrade.

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SFMTA Replacement Radio System

- For vehicles that do not have an embedded Vehicle Logic Unit (VLU) (Historic Street Cars, and Cable Cars), an alternative GPS reporting method (cellular GPS or embedded radio GPS) will provide vehicle location and mapping at the dispatch positions.
- The following table contains a list of interfaces associated with this program:

Interface	Base Offering
511.org	Harris to provide same 511 interfaces as deployed to an existing ACS customer. The existing version of the interface is to include the resolution of a previously identified issue with the dynamic trip ID design. This is to be superseded with a static trip ID design.
311 Workstations	Harris is providing 311 (Customer Service) operators (as described in Document 00900, Appendix 14) with OrbCAD Citrix Licenses.
NextBus	Harris will provide a System database that will contain the real-time location status of all the revenue vehicles in the System that the Next Bus system can access.
TransitSafe	Harris to provide standard incident reports on paper to be used to manually create TransitSafe reports. Harris will not provide an interface to the TransitSafe system.
DVAS – Reference proposal Section 4.8.1.3 and 4.9.2.	<p>Harris will provide a complete replacement of the PA and the replacement of the Communications Control Panel (CCP). The DVAS replacement includes the Audio Visual Announcement (AVA) Card, PA Amp, Audio Switch, 2 Phones, Cabling, and 640 signs/brackets.</p> <p>All Equipment and services associated with the interim DVAS solution have been removed (Section 4.9.2).</p>

SFMTA Replacement Radio System

Interface	Base Offering
Cubic – Reference proposal Section 4.8.1 (Vehicle Solutions)	<p>Harris shall provide an interface and cable for a J1708 interface with a J1587 protocol. The Farebox upgrade includes the modification of up to 1229 Cubic Fareboxes to add the J1708 connector, and Software upgrade. In addition, the Radio System shall communicate to the Cubic Nextfare system when any of the following Farebox alarms are triggered:</p> <ul style="list-style-type: none"> • Cashbox Opened in Service (Emergency Condition) • Farebox in Manual Bypass (Coin Bypass Set) • Farebox Reset to Automatic Mode (coin bypass cleared) • Maintenance Access in Service (Top Cover Opened; Emergency Condition) • Maintenance Access Out of Service (Top Cover Opened)
ATCS – Reference proposal Section 4.6.5.7.	Harris shall design the System to accept data from the ATCS system in an SFMTA approved format to provide LRV location and predictive arrival functions for LRV in the tunnels.
Trapeze Interface	The SFMTA will provide standard Trapeze licenses and Harris will conduct the integration as described in the Proposal, Section 4.6.5. The interface for FX and OPS will be the interface previously developed and supported by ACS.

PHASE 4.2.2: SITE CONSTRUCTION ABOVE GROUND

Harris is responsible for providing permitting and construction drawings for all Harris performed construction tasks.

OCC Sites**1455 Market Street****Harris Activities**

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SFMTA Replacement Radio System

No Construction Activities are included at 1455 Market. The SFMTA shall perform the work described in the following section before Harris begins its installation activities at 1455 Market Street. Harris installation activities are described in Phase 4.3.1 including microwave installation.

SFMTA Construction Activities

1455 Market Control Station (SFMTA)

The SFMTA will obtain any required permits and will prepare any required construction drawings for all construction work performed by the SFMTA.

SFMTA will install two (2) runs of 7/8" coaxial cable (LCF78-50JA) from the rooftop to the 7th floor equipment room:

- Coaxial cable should be weather protected and terminated with an N-type male connector (NM-LCF78-022).
- Coaxial cable should be connected to a Polyphasor (VS-FL-014812) as close to the roof top penetration as possible and the Polyphasor should be mounted on grounded copper bus bar.

The SFMTA will install two (2) 4-footlong pipe mounts - to hold the specified antenna (Proposed Antenna Model is omni-directional, 0 dBd gain 746-960 MHz, Comprod model 401-70 or equivalent) with minimum of 5' separation between pole mounts.

The SFMTA will ensure Harris has access to a ground-loop on the roof top. Harris will install ground kits for each antenna upon installation.

1455 Market Street Microwave Hop (SFMTA)

The SFMTA will install two (2) runs of runs of Alcatel provided or approved Cat 5 Ethernet cable from the rooftop to the 7th floor (one run is for the primary radio and the second run is for the stand-by radio).

- Ethernet cable should be weather protected and terminated with an RJ-45 male connector.
- SFMTA to use materials (Alcatel proprietary Cat5e cable and connectors) as defined in the Alcatel MW quotation as it is specific to the Equipment due to the special power requirements of the ODU Equipment. Alcatel Cat5e cable must be installed by an Alcatel certified installer.

The SFMTA will install one four-foot long pipe mount with a clear path to the CRS.

The SFMTA will ensure that Harris has access to a ground-loop on the roof top. Harris will install ground kits when it installs the microwave dish. SFMTA will provide a copper ground bar mounted on or close to the pipe mount to ground the cables and the ODUs upon installation.

SFMTA Replacement Radio System

Note: Power to the roof top unit will be provided via a combined power and Ethernet cable specified by Thales. Surge arrestor is built into the radio Equipment in the ODU and Indoor Equipment and therefore no separate Ethernet surge suppression is required.

The pipe mounts described above must be attached to the building wall or some part of the building super structure to provide sufficient support for the microwave dish and control station antenna. The pipe mounts should conform to Section 5.2 Structural Design Requirement, Section 5.2.1 Seismic Design Criteria and Section 5.2.2 Wind Design Criteria of Appendix 12 of the RFAP. Harris shall inspect the pipe mounts and shall immediately communicate any deficiencies in them to the SFMTA, but Harris is not responsible for the quality of work performed by others.

The SFMTA will provide conduit (at a minimum for the Alcatel microwave cable) that is installed to meet safety, electrical, and fire codes in the building.

Dispatch Position

The SFMTA to provide the following connections at each dispatch location:

- 5 x RJ – 45 Jacks for each console position
- Quad box of outlets connected to the UPS (limit of 20A to quad-box)

Server Equipment Room

- SFMTA will provide an electrical outlet located within a 10' distance to intended location of the Equipment to be installed. .

Lenox Way

Equipment Overview

Install Interoperability Gateway.

Harris Activities

- Electrical Load Study including the entire complex. SFMTA to provide electrical circuit for the interoperability gateway Equipment and router.
- HVAC Load Study including the entire complex.
- Generator Loading Study to support both the SFMTA equipment room and the City Radio Equipment room with the existing electrical system.
- Prepare the results of the conducted studies along with design recommendations including any additional Civil/Architectural or Mechanical Work required as part of completing any recommended Site development and/or Equipment installations.
- Harris assumes that a 5 ohm grounding test is achievable by connection to building steel at the closest location to the proposed new Equipment locations. Harris has only included the scope of services to

SFMTA Replacement Radio System

analyze the existing grounding system using standard commercial practices in accordance with NEC. Harris has no way at this point to adequately assess these deficiencies and cannot take responsibility for grounding updates.

RF Sites

Central Radio Station

Equipment Overview

Install 3-OpenSky base stations (2 stations + 1 hot standby) and 9-P25 base stations, microwave connection to 1455 Market and a backup Network Switching Center.

Harris Activities

- Electrical Load Study (including the City Radio equipment) to determine if the existing UPS has sufficient capacity to support the new SFMTA radio Equipment.
- Based upon the results of the electrical load study, Harris will provide and install an appropriately sized UPS.
- Provide a separate circuit from the main panel, for the new Equipment to be provided by Harris.
- HVAC Load Study to determine if the existing HVAC equipment is sufficient to support the new SFMTA radio Equipment heat load and if new ductwork is required to provide more cooling to proposed equipment room. Harris has assumed that no new HVAC will be required (beyond the existing HVAC system), but will install the ductwork necessary to provide HVAC from the existing HVAC system in main equipment room into the new Radio System Equipment room Generator Loading Study to support the new SFMTA radio Equipment including City Radio Equipment.
- Tower Structural Analysis based on ANSI/TIA-222-G to determine the structural adequacy of existing Tower #3 to support additional antennas and feed lines and proposed antenna mounting hardware and attachment methods.
- Prepare report of results of load studies and design recommendations including any additional Civil/Architectural or Mechanical Work required as part of completing any recommended Site development and/or Equipment installations.
- Install necessary circuits and wiring from electrical room, through distribution panel to DC Plant rectifiers.
- Install new RF Entry Port.
- Harris assumes that a 5 ohm grounding test is achievable by connection to building steel at the master ground bar. Harris has only included the scope of services to analyze the existing grounding system using standard commercial practices in accordance with NEC. Harris has no way at this point to adequately assess these deficiencies and cannot take responsibility for grounding updates.
- Provide four (4) Portable CO2 fire extinguishers and install them on the available walls near the LMR equipment. Harris' understanding is that the existing fire alarm system covers the MTA occupied radio room

SFMTA Replacement Radio System

Bernal Heights

Equipment Overview

Install 1-OpenSky base station

Harris Activities

- Electrical Load Study to include both the new System Equipment and existing City Radio Equipment.
- Harris will provide a separate electrical circuit for new SFMTA Equipment
- HVAC Load Study to confirm whether the existing HVAC system can accommodate the new Radio System Equipment..
- Generator Loading Study to support both the SFMTA equipment room and the City Radio Equipment room.
- Tower Structural Analysis.
- Provide a report of the results of the load studies and design recommendations including any additional Civil/Architectural or Mechanical Work required as part of completing any recommended Site development and/or Equipment installations.
- Harris will not install an FM-200 system or a new generator. Harris assumes, based on existing condition described in the Design Criteria Package that the existing generator will be sufficient for the required load.
- Harris assumes that a 5 ohm grounding test is achievable by connection to building steel at the master ground bar at the Site. Harris has only included the scope of services to analyze the existing grounding system using standard commercial practices in accordance with NEC. Harris has no way at this point to adequately assess these deficiencies and cannot take responsibility for grounding updates.

One Market Plaza

Equipment Overview

Install 3-OpenSky stations (2 stations + 1 hot-standby) and 9-P25 base stations.

Harris Activities

- Detailed Electrical Load Study to include the City Radio Room.
- Disposal of existing equipment in the Communications Equipment Radio Room adjacent to the Mechanical room.
- HVAC load calculation using the Harris designed Equipment.
- Generator Loading Study to support both the SFMTA equipment room and the City Radio Equipment room with the existing electrical system.
- Structural calculations of existing penthouse to support additional antenna and the proposed antenna mounting hardware and attachment methods based on ANSI/TIA-222-G.
- Structural adequacy of existing equipment room floor.
- Prepare report of results of load studies and design recommendations including any additional Civil/Architectural or Mechanical Work required as part of completing any recommended Site development and/or Equipment installations.

SFMTA Replacement Radio System

- Provide and install an FM-200 chemical suppression fire protection system and connect it to the building fire alarm system.
- Utilize building emergency power for the new Site by connecting to an existing generator located in the basement of the adjacent Stuart Tower and install to the new Site. Provide and install a new ATS, transformer, TVSS and power distribution panel for the new radio System.
- Provide and install an HVAC system based on the existing SFMTA preliminary Design Dwg # ME-24 titled: "One Market Plaza Mechanical Plan". The HVAC system will be based on two units in a redundant configuration, utilizing the building chilled water system and supported by the emergency generator.
- Provide and install a room grounding system (Halo ground) tied to building steel and building electrical ground.
- Provide and install new lighting and cable ladder.
- Harris assumes that a 5 ohm grounding test is achievable by connection to building steel at the closest location to the proposed new Equipment locations. Harris has only included the scope of services to analyze the existing grounding system using standard commercial practices in accordance with NEC. Harris has no way at this point to adequately assess these deficiencies and cannot take responsibility for grounding updates.

South Hill

Equipment Overview

Install 2 OpenSky stations (1 station +_1 hot standby) and Install 9-P25 base stations.

Harris Activities

The following scope is based upon the assumption that the SFMTA and appropriate stakeholders will approve the location of the new Radio Equipment shelter, which is to be installed directly in front of the gated fence surrounding the existing tower. Harris will not perform any work associated with replacement of the existing antenna tower and any associated cutover that was related to the previously considered tower replacement. The replacement of the tower is included in this Contract as Optional Work.

- Perform a detailed subsurface investigation of the Site in preparation for designing the foundation for a new radio Equipment shelter to include:
 - Ground Resistance Tests.
 - Sub-Soil Hazard inspection.
 - Soil Stability Report.
 - Concrete Hardness.
- Detailed Electrical Load Study including the existing City Radio Shelter.
- Generator loading study.

SFMTA Replacement Radio System

- Prepare report of results of load studies and design recommendations including any additional Civil/Architectural or Mechanical Work required as part of completing any recommended Site development and/or Equipment installations.
- Remove the existing generator and Automatic Transfer Switch and install a new 70KVA generator with an ATS to support both the new SFMTA shelter and the existing City Radio Equipment shelter.
- Dispose of the existing generator and ATS in an SFMTA approved location.
- Provide power to the new shelter by performing the following:
 - Install a new power cable in conduit from the existing shelter to the new shelter and install a fused disconnect on the new shelter for the incoming power.
 - Provide a portable generator terminal on the new shelter for additional backup power.
- Provide and install a 12' x 18' shelter that includes access control, internal environmental regulation, lighting, cable management, seismic restraint, fire suppression, and fire detection and alarm. The new shelter will be placed longwise next to the gate of the existing tower.
- Install a complete Site ground system that integrates the new shelter and the existing tower grounding system.
- Provide and install a new "H" frame tower (shorter leg of 20 ft and longer leg of 40 ft.) next to NE side of new shelter .
- Install an antenna cable bridge between the new shelter and the "H" frame.
- Ground the new shelter using a buried perimeter ring system and connect to the existing shelter and tower ground ring.
- Provide a minimum of four (4) fire extinguishers, carbon dioxide, 20 pounds, rated 10-B:C, rechargeable.
- New security alarm system shall notify the SFMTA Operations Control Center, City staff at CRS Twin Peaks, and the third party monitoring company listed as Central Station, Proprietary, or Remote Station by a nationally recognized listing agency.
- New fire alarm system shall notify the SFMTA Operations Control Center, City staff at CRS Twin Peaks, and the third party monitoring company listed as Central Station, Proprietary, or Remote Station by a nationally recognized listing agency.
- Provide fiber optic cable and related equipment to connect the existing radio equipment shelter to the new Equipment shelter.

Forest Hill

Equipment Overview

Install 9-P25 base stations.

Harris Activities

- Electrical Load Study (including the City Radio Equipment)
- Provide a separate circuit from the main panel, for the new Equipment to be provided by Harris.
- Prepare for installation of the outdoor enclosure for the DC power system to include concrete slab.

SFMTA Replacement Radio System

- HVAC Load Study to determine if the existing HVAC equipment is sufficient to support the new SFMTA radio Equipment.
- Generator Loading Study to support the new SFMTA radio Equipment including City Radio Equipment. Based upon information received from the SFMTA, Harris assumes that the existing generator will be sufficient to meet the capacity of the new Equipment.
- Prepare report of results of load studies of the load studies and design recommendations including any additional Civil/Architectural or Mechanical Work required as part of completing any recommended Site development and/or Equipment installations.
- Provide and install an FM-200 fire protection system.
- Slide all of the SFMTA existing equipment together towards the HVAC wall opening up room for one (1) row of four (4) racks to be installed.

Clay Jones – No Harris Scope

No work at the Clay Jones facility is provided this Contract; said work may be required as Additional Work.

Maintenance Facilities

Harris has optimized the design shown in the 'Maintenance Facilities - Network Schematics' drawings of Appendix Nine (9) provided by the SFMTA for reference only. The design baseline for the maintenance facilities are shown in the diagrams in *Attachment 3*. *Attachment 1* identifies the Equipment being provided at each facility. The Equipment includes all the network equipment, cabling, wireless access points, network clocks, servers and dispatch quantities.

Harris requires that a dedicated electrical circuit be available for the proposed new Equipment locations. If no such dedicated circuit is available, Harris' responsibility is limited to installation of required wiring and conduit to a maximum distance of 100' and connection to the nearest electrical panel. Additionally, Harris is not responsible for the adequacy or the upgrading required of any electrical panel that is upstream from the panel to which Harris connects. Any work required in addition to that described herein to provide the required electrical circuit to the new Equipment may result in a change order to the Contract.

Harris will be responsible for installation, configuration, testing of all network-core and edge Equipment from the connection to the SFMTA and CCSF provided demarcation points at each location throughout the System.

Harris assumes that a 5 ohm grounding test is achievable by connection to building steel at the closest location to the proposed new Equipment locations or master ground bar if available. Harris has only included the scope of services to analyze the existing grounding system using standard commercial practices in accordance with NEC. Harris has no way at this point to adequately assess these deficiencies and cannot take responsibility for grounding updates.

SFMTA Replacement Radio System

For the MME facility, the SFMTA will provide network connectivity between the connected rooms at the facility using existing network cabling routing. Single roof access directly to Network Room 226 equipment in Room 182, 108, 138 and 265 is not needed for wireless infrastructure.

PHASE 4.2.3: INSTALLATION AND TESTING OF ALL IN-BUILDING/BELOW GROUND TRANSMISSION LINES

This Work consists of purchasing, installing and testing all below ground transmission Equipment in the Sunset, Market Place and Twin Peaks tunnels as described in this section 4.2.3 and the Design Criteria..

- 1-5/8" Radiating Coaxial cable supply (Model # is RCT7-WBC-2A-RNA)
- 1-5/8" Radiating Coaxial cable Installation and testing
- Fiber-optic cable Installation and testing including patch panels (29,125ft of 24-strand armored cable) Harris has provided the SFMTA with an option to go from 24-strands of fiber to 312-strands. (See Options Section)
- AC Power Installation and Grounding testing; DC Power installation and testing; Install UPS Backup Power to 24 BDA's

Additional Equipment details can be found in Attachment #1 to this SOW.

Site	Site Type	Equipment Type	Location
Embarcadero	Rail Station, Portal	Headend, Remote Node	HE - Station Telecom Room
Montgomery	Rail Station	Remote Node	Station Telecom Room
Powell	Rail Station	Remote Node	Station Telecom Room
Civic Center	Rail Station	Remote Node	Station Telecom Room
Van Ness	Rail Station	Remote Node	Station Telecom Room
Church	Rail Station	Remote Node	Station Telecom Room
Castro	Rail Station	Remote Node	Station Telecom Room
Forest Hill	Rail Station	Remote Node	Station Telecom Room
West Portal	Rail Portal	Headend, Remote Node	HE - Station Telecom Room
East Portal	Rail Portal	Headend, Remote Node	HE - Station Telecom Room
Carl Street Substation	Rail Portal	Headend, Remote Node, Antennas	HE - Station Telecom Room
Yerba Buena (Option)	Car Portal	Headend, Remote Node	HE - Wall in each portal area

SFMTA Replacement Radio System

Site	Site Type	Equipment Type	Location
Broadway (Option)	Car Portal	Headend, Remote Node	HE - Wall in each portal area
Stockton (Option)	Car Portal	Headend, Remote Node	HE - Wall in each portal area
MacArthur (Option)	Car Portal	Headend, Remote Node	HE - Wall in each portal area
Cable Barn - BDA system for the basement (Option)	Facility	Head End	HE - Facility Telecom Room

PHASE 4.2.4: PROCUREMENT OF STATIONARY EQUIPMENT

Procurement of Equipment as finalized in the material list (See *Attachment 1 – List of Equipment* for details).

Advanced Vendor material procurement and manufactured Equipment required for long lead items related to implementation such as P25, OpenSky, CAD/AVL, Wireless Bulk items, as identified in Attachment 1 and above will be ordered after approval at Intermediate Design Review (IDR) in Phase (4.1) is received from the SFMTA. Harris will procure all the remaining Equipment and 3rd party vendor materials required for Site construction and Equipment installations following written Notice to Proceed for Phase 4.2. Material shipments not required for Factory Acceptance Testing (FAT) will be coordinated with the vendors and the Project Schedule will be shipped to a Harris provided staging warehouse in San Francisco to ensure availability of parts as they are needed at the Sites.

PHASE 4.2.5: FACTORY ACCEPTANCE TEST

The Factory Acceptance Test (FAT), as developed in Phase 4.1 will be conducted in multiple locations. The MTMS CAD/AVL & Wireless System FAT will be conducted at the ACS facility in Columbia MD. The MTMS & PSVRN LMR radio System FAT will be conducted at Harris in Lynchburg VA. The Tunnel radio network Equipment FAT will be conducted at the FiberSpan facility. After the completion of the MTMS CAD/AVL & Wireless System FAT, the CAD/AVL infrastructure Equipment to support the radio System will be shipped to Lynchburg VA for a combined radio and CAD/AVL staging. Prior to SFMTA witnessing of the integrated factory test (FAT) and the MTMS feature test (ACS FAT), Harris and its partners will conduct an informal dry run of the test procedures. The integration of the final systems shall be completed in the Harris San Francisco Depot facility before installation. Factory staging testing will consist of:

1. CAD/AVL FAT & OrbCAD functions, with the Wireless Bulk Data Transfer system and temporary RF system.

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SFMTA Replacement Radio System

2. LMR Radio FAT with the integrated RF voice and data communications with CAD/AVL.
3. Head End and Donor equipment functions.

Shop Location	Content	Validation	Upon Completion
Factory Acceptance Test (FAT)			
FiberSpan Facility	Typical FiberSpan Testing of Head End and Donor Sites	FiberSpan FAT Procedure	Equipment is shipped and stored until installation
Alcatel Facility	Typical Alcatel Testing of Microwave Link* This is a vendor component test and is not designed for customer witnessing	Alcatel FAT Procedure	Equipment is shipped and stored until installation
ACS Facility	Typical CAD/AVL test; OpenSky development system for MTMS, CAD/AVL and C3 Maestro Dispatch integration test	ACS FAT Procedure Harris Integrated Test Procedure	Subset of Equipment is shipped to Harris for Integrated testing
Harris Facility	Typical LMR (P25, OpenSky, C3 Maestro) test Subset of Integrated Equipment	Harris LMR FAT Procedure	Equipment is shipped and stored until installation

Note: NextBus, 511, ATCS, Cubic Farebox, DVAS interfaces will be emulated during factory testing but the actual interfaces will be tested upon integration in the field. (See *Phase 4.3.1 Functional Test*)
Factory Acceptance Test (FAT) will be an appropriate subset of the approved Field Performance Test (FATP) to be finalized as part of the CDRL 12-7-1. Successful completion of the Factory Acceptance Test will be based upon the completion of the approved Integrated Test Procedure.

The SFMTA reserves the right to witness these tests as well; however, end customer participation is not required with the exception of the integrated FAT as conducted at the Harris facility. For any witnessed test, the SFMTA will cover any cost associated with their attendance.

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SFMTA Replacement Radio System

Testing Timelines:

- MTMS system testing at ACS Facility, Columbia, MD. Duration approximately 10 days, including travel
- LMR System testing at Harris Facility, Forest, VA. Duration approximately 05 days, including travel

Phase 4.3 - Equipment Installation, System Configuration, and Training Program Planning

Scope - Delivery, installation, configuration, and testing of all Stationary Equipment at the SFMTA and City Sites. The Training Plan shall be finalized, including the Draft Training Schedule, Draft Training Manuals, and Draft Training Agendas.

PHASE 4.3.1: INSTALLATION, CONFIGURATION, AND FUNCTIONAL TESTING OF ALL STATIONARY EQUIPMENT AT ALL CITY SITES

Underground Sites

- Harris shall install: Headend Equipment; Wall-mount BDAs; Station Antenna System Materials; Donor Antennas and Materials, Grounding.
- Harris shall install the Equipment in the portals and stations as described in the Tunnel tab Attachment 1: List of Equipment.

OCC Sites

1455 Market Street

Equipment Overview

Install the primary Network Switching Center, CAD/AVL Servers, microwave connection to CRS and dispatch workstations. Refer to *Attachment 3* for the network and Equipment configuration. *Attachment 1* describes the dispatch Equipment.

The microwave link between 1455 Market Street and CRS is intended to replace the original Microwave link that Harris proposed between Forest Hill and CRS (which has now been deleted). The updated Link Design will be provided as part of the Design Phase. See *Attachment 6- Microwave Feasibility Study*. Please reference Microwave Equipment detail in Attachment 1 – Equipment List. The proposed MW solution includes a redundant 9500 Multipurpose Outdoor Unit (ODU). Harris shall separate this unit into a radio to be installed on the roof and a dish to be separately installed and connected with waveguide onto the roof top monopole.

The Fixed End Equipment to be provided is described in Section 11.7.2 of the Proposal. The Equipment is to be geographically separated between 1455 Market Street and Central Radio Station.

SFMTA Replacement Radio System

The 1455 Market Network Switching Center Equipment List is below:

- Network Clock/GPS Clock
- Network Switch (NSS) with Monitor, Keyboard and Mouse
- P25 IP Simulcast Control Point
- Exacom Logging Recorder
- Regional Vida Manager (RVM) with Monitor, 20in Flat Panel, Keyboard and Mouse
- Laser Printer Black/White
- Regional Site Manager with Printer, Color Laser, 110V
- Transcoder Server
- RSA VPN Server
- ISSI Gateway
- Router, Cisco ASR1001, AC Pwr, IP Bs, Adv IP
- Switch, Cisco 3560X-48T-S, 48 Port
- Cisco ASA5510
- Unitrends DPU 720
- Server, Dell R610, Active Directory Server
- Router, 2921, AC, Security, w/Ether Switch
- Switch, Cisco 3560v2, DC
- Server, Dell R610, SUMS Automation server
- HIDS
- LogLogic ST
- LogLogic SEM
- IDS, SourceFire DC1000

MTMS Hot Standby System Fixed End Hardware Software (Primary Equipment to be included at 1455 Market and Backup at Central Radio Station)

- Primary/Backup ORBCAD Application Cluster - 2 Servers
- Primary/Backup Active SQL Cluster - 2 Servers
- Primary/Backup LTDB SQL Cluster - 2 Servers
- Primary/Backup SAN
- Primary/Backup Reports Server
- Primary/Backup DCC Server - 2 Servers
- Primary/Backup GTRMD Server - 2 Servers
- Primary/Backup Domain Controller Servers - 2 Servers
- Primary/Backup MDC (Citrix) Server Farm - 4 Servers
- Primary/Backup Network Equipment
- Digital KVM
- Primary/Backup SmartTraveler Server – Signs (Optional)
- Primary/Backup SmartTraveler Server – Web (Optional)
- Primary/Backup SmartTraveler Server – SMS (Optional)

SFMTA Replacement Radio System

An Exacom "Hindsight-Net XPlus/G2" Archival Digital Logging Recorder System with P25 and OpenSky-VNIC Integration is installed at 1455 Market. The following features are included:

- 120 Mixed-Ch Recorder w/DVD
- Raid 5 Array Hard Drive
- P25 Phase II Interface Module
- OpenSky-VNIC Interface Module
- Recorder Assistant Playback License (Qty 12) (optional)
- Recording of AES encrypted voice (optional)
- Redundant Logging Recorder (optional)

Installation Activities

- Install five (5) equipment racks in the equipment room on 7th floor.
- Install the 13 dispatch positions and one (1) supervisor position. Each dispatch position has three displays – one (1) Harris display and two (2) ACS displays. The supervisor position has two (2) ACS displays.
- Install five (5) backup control stations. The output of these control stations will go back to a control station combiner in the equipment room. Harris to utilize coax as installed and tested by SFMTA. Installation to include mounting the antennas on the rooftop and grounding any newly supplied jumpers.
- Installation of the ISSI gateway – the SFMTA will be responsible for providing liaison or external consultant support to assist and coordinate Harris' connection of the System to any non-Harris P25 system.
- Installation of Microwave equipment. Harris to utilize Alcatel provided ethernet as installed and tested by SFMTA. Harris to terminate and verify Ethernet cable connectivity. Harris to mount dish to existing pole and ground roof top transceiver to building ground. Harris to test Microwave functionality upon completion of CRS installation of the Microwave Equipment. Rack mount, connect and install lower unit into the 7th floor of 1 South Van Ness Avenue.

Lenox Way

Equipment Overview

Install Interoperability Gateway.

Installation Activities

- Install one (1) equipment rack including grounding to the interior halo ground system or master ground bar in the facility and power distribution using seismic restraint methods.
- The SFMTA will provide technical assistance during cutover to support interconnection between the legacy audio path and the interoperability gateway (which will allow the new System to operate in parallel with the legacy radio system).
- Provide a single outlet connected to the facility provided UPS.

SFMTA Replacement Radio System

RF Sites -

The Equipment and installation services associated with each above ground RF Site are described below. For the DC Power Systems described below, all Sites with an included DC power system have been sized to provide a (4) four hour backup power battery system. The back-up systems are designed to provide for an additional 25 percent equipment load capacity. The racks installed at each Site must provide space for said 25 percent equipment load expansion.

Central Radio Station**Equipment Overview**

Install 3-OpenSky base stations (2 base stations + 1 hot standby) and 9-P25 base stations, and 8-P25 additional base stations (optional PERS equipment), microwave connection to 1455 Market and a backup Network Switching Center and a geographically separated backup MTMS fixed end equipment.

The Fixed End equipment to be provided is described in Section 11.7.2 of the Proposal. The equipment is to be geographically separated between 1455 Market Street and Central Radio Station.

The back-up Central Radio Station Network Switching Center Equipment List is below:

- Network Clock/GPS Clock
- Network Switch (NSS) with Monitor, Keyboard and Mouse
- Regional Vida Manager (RVM) with Monitor, 20in Flat Panel, Keyboard and Mouse
- Laser Printer Black/White
- Regional Site Manager with Printer, Color Laser, 110V
- Transcoder Server
- Router, Cisco ASR1001, AC Pwr, IP Bs, Adv IP
- Switch, Cisco 3560X-48T-S, 48 Port
- Cisco ASA5510
- Unitrends DPU 720
- Server, Dell R610, Active Directory Server
- Router, 2921, AC, Security, w/Ether Switch
- Switch, Cisco 3560v2, DC
- IDS, SourceFire 3D2500

Installation Activities

- On Tower #3, install three (3) antenna mounts and one (1) Sinclair SC479-HF1LDF antennas at a height of 160' using 1-5/8" cable, one (1) Sinclair SC479-HF1LDF antennas at a height of 140' using 7/8" cable for OpenSky Hot Standby, one (1) SC479-HF1LDF antenna with Tower Top Amplifier at a height of 180' using

SFMTA Replacement Radio System

7/8" cable and one (1) 1/2" test cable to existing tower including coax jumpers and grounded to the existing tower ground ring.

- Install seven (7) equipment racks and one (1) DC Power System including grounding to the interior halo ground system or master ground bar in the facility, power distribution and cable ladders using seismic restraint methods.

Bernal Heights

Equipment Overview

Install 1-OpenSky base station

Installation Activities

- Install one (1) antenna mount @ 50' and (1) Andrew DB844G65ZAXY antenna to existing tower with 7/8" coax cable and a coax jumper and ground to the existing tower ground ring.
- Secure antenna cables to an existing cable tray routed to the existing cable entry port.
- Install one (1) equipment rack and one (1) DC Power System including grounding to the interior halo ground system or master ground bar in the facility, power distribution and cable ladders using seismic restraint methods.

One Market Plaza

Equipment Overview

Install 3-OpenSky base stations (2 base stations +_1 hot standby) and 9-P25 base stations and 8-P25 additional base stations (optional PERS equipment).

Installation Activities

- Install nine (9) new equipment racks and one (1) DC Power System including grounding, ground bar and power distribution structurally restraining all hardware including racks and cable ladders in a manner that satisfies local seismic requirements.
- Ground all radio racks to the interior halo ground system.
- Ground antennas, antenna mounts and coax cabling to building steel using building management's approved methods.
- Provide and install four (4) antenna mounts on to the penthouse structure designed for one (1) Amphenol/Antel BCR-75013-EDIN-3-25 antenna using ~150' of 1-5/8" cable, one (1) Sinclair SC479-HF1LDF antenna using ~150' of 1-5/8" cable, one (1) SC479-HF1LDF antenna for TX and RX OpenSky Hot Standby, one (1) Sinclair SC479-HF1LDF antenna and TTA using ~150' of 7/8" and 1/2" test cable each complying with ANSI/TIA-222G.
- Install and secure antenna lines to existing cable trays on penthouse.
- Install all racks, pipes, cable ladders and tanks using seismic bracing methods.

SFMTA Replacement Radio System

- Install conduit and run copper (or equivalent) connection between CCSF MPLS network and separate conduit for the microwave
- DC Power System to be sized for 2 hour battery back-up run time, not the 4 hour run time specified for other Sites.

South Hill

Equipment Overview

Install 2 OpenSky base stations (1 base station +1 hot standby) and 9-P25 base stations and 8-P25 additional base stations (optional PERS equipment).

Installation Activities

- Install 3 antenna mounts and one (1) Sinclair SE414-SF3PALDF antenna on "H" frame at an ~ height of 20' using 1-5/8" cable , one (1) SE414-SF3PALDF for OpenSky hot standby antenna for TX and RX, and one (1) Sinclair SE414-SF3PALDF antenna and TTA at an ~ height of 50' using 7/8" and 1/2" cable each complying with ANSI/TIA-222G.
- Install five (5) equipment racks and one (1) DC Power System including grounding to the interior halo ground system or master ground bar in the facility, power distribution and cable ladders, pipes and tanks using seismic restraint methods.
- Ground radio racks to the interior halo ground system.
- Attach the new radio system's halo ground to the master ground bar that will be connected to the ground ring.
- Ground the new antenna and coax cables to the existing ground ring.
- Ground all new antennas, antenna mounts and coax cabling to the H-frame.

Forest Hill

Equipment Overview

Install 9-P25 base stations. and 8-P25 additional base stations (optional PERS equipment)

Installation Activities

- Install two (2) antenna mounts and one (1) Sinclair SC479-HF1LDF antennas using ~150' of 1-5/8" cable at a tower height of 60', one (1) Sinclair SC479-HF1LDF antenna and TTA using ~170' of 7/8" and 1/2" coax cables at a tower height of 80' including coax jumpers and grounding to the existing tower ground ring.

SFMTA Replacement Radio System

- Install four (4) equipment racks and one (1) DC Power System including grounding to the interior halo ground system or master ground bar in the facility, power distribution and cable ladders, pipes and tanks using seismic restraint methods. DC Power system to include outdoor enclosure.
- Shift existing SFMTA equipment in the shelter to make space for the new RF equipment racks. SFMTA is required to provide technical support during this equipment shift.

Network Solution

The network configuration will use the existing SFMTA backhaul network with the addition of a microwave link, and additional fiber connectivity in the Market Street and Twin Peaks Tunnels. The backhaul network and Site network configuration is shown in *Attachment 3*. The SFMTA backhaul network will be evaluated during Phase 4.1. The SFMTA shall provide a WAN connection at the network demarcation points as indicated in the Maintenance Yard diagrams in Attachment 3, and as indicated in the 'Maintenance Facilities - Network Schematics' drawings of Appendix Nine (9) provided by SFMTA for reference only.

The availability, reliability and maintenance of the existing SFMTA network (as identified as SFMTA infrastructure in the drawings in Attachment 3 to this SOW) are the responsibility of the SFMTA. The System reliability and availability requirements set out in the Contract apply only to the Equipment and backhaul infrastructure provided by Harris. However, it is Harris' obligation to determine whether the existing backhaul network has the sufficient capacity and is sufficiently robust to meet the new Radio System requirements. If the existing CCSF and SFMTA network operates as stated and according to design material provided by the SFMTA, and modifications to the network are required to meet the Harris proposed design, then Harris must provide a network solution to remedy at no additional cost to the SFMTA. If there are any deficiencies with the operation of the CCSF and SFMTA provided network as defined by Attachment #3 of this SOW, then the SFMTA shall remedy.

Information Assurance

Reference Section 4.3 of the Proposal.

In order to meet the availability requirements as described in the Design Criteria, Harris has provided the following components to meet the SFMTA security requirements:

- Access Control for restricted access
- Active Directory with Windows AD and Quest Authentication Services
- Two-factor (or Strong) Authentication with RSA SecureID
- Host and Network Intrusion detection system with Sourcefire and McAfee (during the design phase Harris will investigate reuse of existing HIDS system)
- Centralized Log Management with LogLogic ST for 3 year retention
- Disaster Recover Retention with Data Protection Units

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SFMTA Replacement Radio System

- Patch Management - Security Update Management Service (SUMS) Automation Server
- LogLogic Security Event Manager

During the Design Phase 4.1, the information assurance plan and configuration will be re-evaluated with the SFMTA and the City's IT Department to align security policies and leveraging existing equipment and licenses. Licenses actually required will be described as part of the CDRL deliveries of Phase 4.1, but typical System licenses may include:

- NSS, RVM, SyBase Software License,
- NSS, RSM License, Sql 2008 Enterprise Edition
- Cisco Advanced Security OS, License
- Microsoft Windows Server 2008 Enterprise R2, 64 bit
- Microsoft Windows Server 2008 Client Access License
- Microsoft Windows Server 2008 Standard R2
- Microsoft SQL 2008 Processor license
- Crystal Reports Server 2008, 10 CALs
- Crystal Reports Server Developer Advantage
- Citrix Presentation server w Subscription Advantage
- Microsoft Terminal Server Cals
- EMC Recover Point/CE
- Exacom Logging Recorder - assistant licenses (priced option)

Finalized list of licenses to be provided as part of the CDRL 12-1-1 IT Equipment List.

Reliability

Reference Section 4.4 of the Proposal.

The System design Harris has proposed will be designed meet the availability criteria the SFMTA has specified to ensure appropriate levels of redundancy and System resiliency with a two-pronged approach: coverage and infrastructure redundancy. Harris will incorporate System design recommendations for Harris-provided Equipment and backbone infrastructure. This section describes the reliability design basis to be evaluated during Phase 4.1.

In addition to overlapping RF coverage, redundant communications between radio Sites are provided over the SFMTA's existing fiber and microwave network. In the event that communications to either a Site or the entire Radio System is disrupted, the Site(s) will go into Fallback mode (as described in Section 11.18.5), where OpenSky and P25 Equipment revert to stand-alone trunking operation. There is no need to fall back to conventional or non-trunked operation, which is less efficient and supports far fewer users.

Network Access Reliability

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SFMTA Replacement Radio System

Harris' System design will meet the following the SFMTA network access reliability requirements:

- System registration interval of less than 2 seconds in 99% of attempts.
- No less than 0.01% of voice message access shall exceed one second from initiation of a push-to-talk.

Coverage Redundancy

In reference to Section 4.4.4 of the Proposal

700 MHz PSVRN System Coverage Redundancy

The non-revenue 700 MHz coverage maps in the System description show the impact of removing any one Site entirely from service to mobile talk-out coverage. Coverage remains at 95% within the service area boundary at a 99% test confidence when removing any one Site.

800 MHz MTMS System Coverage Redundancy

The revenue mobile talk-out coverage maps shown in the System description show the impact of removing any one Site entirely from service. Coverage remains at 95% within the service area boundary at a 99% test confidence when removing Bernal Heights or One Market Plaza from the System. Removal of South Hill yields coverage at 94% at a 97% test confidence and removal of Central Radio Station delivers coverage of 93% at 95% test confidence.

In addition, hot standby OpenSky base stations are included at the three most important Sites in this design: One Market Plaza, Central Radio Station and South Hill. Hot standby stations deliver base station redundancy at Sites, additional capacity by either moving channels from one Site to another, or by the SFMTA procuring additional channels. Servicing of Site base stations can occur with no loss of service by being able to take a station out of service and having the hot standby station take over.

Infrastructure Redundancy

The Harris infrastructure design for the SFMTA has the following multiple levels of redundancy:

Redundant Routers and Network Redundancy

The design provides redundant routing over both the SFMTA fiber and microwave paths to the RF Sites. Dual routers have been included at the RF Sites to provide further redundancy. Redundant routing is also included for the critical IP Simulcast Control Point. Automatic cutover occurs if either router fails allowing for continued communications to a Site.

Antenna System Fault Tolerance

Harris has included fault tolerant TTAs and multicouplers with automatic bypass to meet the redundancy requirements of the RFP. These are designed so a failed amplifier is automatically bypassed and an alarm is sent to the Network Management System resulting in the Site continuing to operate albeit at a slightly degraded performance level.

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SFMTA Replacement Radio System

Fault tolerance is further provided by splitting the RF channels between two combiners at each Site. Sites having more than one OpenSky channel are also split between two combiners.

Load Distributed MASTR V Ethernet Connections

The P25 MASTR V stations connect to the Site via an Ethernet connections. Fault tolerance is provided by having stations alternate connecting to the backhaul network through different Ethernet switches.

High Availability Network Switching Center

Harris is providing the SFMTA with a geographically split hot standby Network Switching Center (NSC). The secondary NSC constantly monitors the primary and takes over should the primary fail. Furthermore, the NSCs are geographically split in case of failure of a Site's integrity. This includes a redundant Regional VIDA Manager (included in base and described in Section 11.18.6.2 of the proposal) and a redundant Regional Site Manager (RSM). Each Fixed End location will come equipped with a color laser printer.

OpenSky Hot Standby Stations

The OpenSky system has an inherent level of redundancy built in with 95% coverage overlap as discussed above. A hot standby station automatically detects failure of another on-Site base station and comes up on the failed channel frequency.

Network Switching and Routing at Primary Dispatch Locations

All Harris radio dispatch workstations come with two Network Interface Cards (NICs). If there are at least two separate and diverse network paths at dispatch locations, additional redundancy would be achieved at these locations by making the two network connections.

First of Kind Vehicle Installation

Harris shall install Mobile Equipment on a sample of each type of Vehicle and based that pilot installation ("First of Kind" or "FOK") create a procedure and protocol that it will follow for all installation of Mobile Equipment in the remainder of the Vehicles. Harris shall provide the following on-Site support for the FOK) installation of each vehicle type:

- Perform check of fitting and mounting to meet the approval of the SFMTA
- Provide on-Site guidance for installations for each vehicle type
- Make the necessary changes to final design documents including the BOM and pre-installation trays.
- Provide training to the installers for each type of vehicle installation
- Create a customer review report with pictures, reports and a presentation for a customer review meeting to gain SFMTA acceptance.

SFMTA Replacement Radio System

The SFMTA will provide Harris access to an appropriate set of vehicles to support this effort. The FOK will be conducted on a subset of vehicles as determined during the design phase.

PHASE 4.3.2: TRAINING PLAN (FINAL)

Please reference the Proposal Volume II, Section 16, Training Plan. Training Plan to be finalized as part of a CDRL delivery during the Design Phase.

Harris and its subcontractors are to provide training to the SFMTA, which will be delivered by subject matter experts from the qualified Harris Team partner. The Harris technical training staff will conduct training on use and maintenance of the PSVRN. Fiber-Span will conduct training on tunnel communications equipment use and maintenance. Harris will also train SFMTA staff in System concepts and the maintenance techniques required to diagnose any potential System degradation. Harris will train SFMTA radio maintenance staff in System troubleshooting. Training on the Multimodal Transit Management System (MTMS) will be conducted by ACS. The comprehensive training program that will be delivered by ACS is described in the CAD/AVL section of our proposal.

The proposed training plan for the SFMTA includes classroom and hands-on instruction for dispatchers, designated radio operation trainers, system administrators and managers, and maintenance technicians. At the conclusion of each training course, a comprehensive training report is provided to the SFMTA that includes a student roster, course dates, and student class evaluations.

As outlined and described in our proposal the types of training consist of:

- Dispatcher Training
- Radio Communications Subscriber Unit Training
- Transitional Training
- Train-the-Trainer Training
- Cutover Support
- LMR Network Management System Training
- System Administration Training (Multiple Courses)
 - PSVRN System Administration Course
 - PSVRN Fleet Mapping Workshop
 - Implementation Support Workshop
 - Unified Administration System Course
 - Regional Network Manager Course
 - ISSI Configuration & Administration Course
- Radio System Maintenance Training (Multiple Courses)
 - P25IP System Maintenance Course
 - OpenSky Site Equipment Maintenance Course
 - Network Operation & Maintenance Course

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SFMTA Replacement Radio System

- Unified System Administration Course
- UAC-Based Interoperability Gateway Course
- MASTR V Station Maintenance Course
- P25IP Simulcast System Maintenance Course
- VIDA Broadband Network Administration & Maintenance Course
- Microwave Maintenance Course
- Fiber-Span Tunnel Solution Maintenance Course
 - 800 MHZ RF Coverage Extension System Customer Maintenance
- Vehicle Equipment Training

Final Training Plan (CDRL 12-8-1) will be reviewed during phase 4.1 and will formally be approved and delivered during Phase 4.3 of Project execution

PHASE 4.3.3: TRAINING SCHEDULE (DRAFT)

- The training schedule will be developed in consultation with the SFMTA after Contract award and included in the master Project schedule. Training sessions will be scheduled to accommodate shift Work and minimize disruption to normal operations. Harris will train SFMTA employees, contractors, or other SFMTA and CCSF designees at SFMTA facilities or other such locations approved by the SFMTA, unless otherwise specified.
- All training is conducted at facilities provided by the SFMTA with the exception of Radio System Maintenance training, which will be provided at Harris's training facilities in Las Vegas, Nevada. Harris will provide travel and lodging for fifteen (15) of participants for two (2) scheduled training sessions to be held in Harris' Las Vegas, Nevada Training Facilities. (The SFMTA will be responsible for any expenses other than travel and lodging.) Each session is for a maximum of seven (7) days. Additionally, tunnel solution training conducted by Fiber-Span will be conducted on Site due to requiring direct access to the installed Equipment.
- To optimize the learning experience, Harris' proposal also includes the ideal class size, as such the training schedule and number of days are planned accordingly. The following table lists training for the SFMTA personnel and the maximum number of participants:

- **Table 0-A: Class Size**

Training Course	Maximum No. of Participants
Dispatcher Training	40
Radio Communications Subscriber Unit Training	30
LMR Network Management System Training	12
System Administration Training	24

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SFMTA Replacement Radio System

Training Course	Maximum No. of Participants
Radio System Maintenance Training	15
Vehicle Equipment Maintenance Training	20
Training Trainers	12

- Preliminary Training Schedule (CDRL 12-8-2) will be reviewed during phase 4.1. Harris will provide the SFMTA with a list of course objectives and core competency skills for each training session at least 90 days in advance of the first scheduled session
- Harris and its subcontractors will Work with SFMTA to accommodate flexible shift Work training requirements. A mutually agreed on training schedule to be defined in the Design Phase, which meets SFMTA needs will be developed during Phase 4.3. Training classes and times will be developed on a per shift basis and per day basis.

PHASE 4.3.4: TRAINING MANUALS AND AGENDAS (DRAFT)

Harris will prepare training manuals and syllabi for each training course, and submit the training manuals and syllabi to the SFMTA for review 60 days prior to the start of classroom instruction. The training materials will reflect the SFMTA's specific Replacement Radio System and Equipment configuration. ACS provides extensive product user manuals to support each training course. When the training program is complete in Phase 4.5.1, the SFMTA personnel operate and maintain the System with confidence, and the SFMTA has a smoother and more efficient transit system. Each student attending instructor-led training receives a training manual that includes a copy of the instructor's presentation, lab exercises, and technical documentation, as appropriate. Harris will also provide six additional hard copies of the training manuals and six CD ROM copies in Adobe Acrobat PDF format, and editable Microsoft Office format (i.e., PowerPoint, Word).

The training materials will become the property of the SFMTA upon completion of each course. The SFMTA will be granted license unlimited permission to reuse, copy, modify and issue any of the training materials delivered by Harris for future training of its employees without copyright or licensing restrictions.

All training will be conducted utilizing the Public Service Voice Radio Network or Harris training systems in Las Vegas, Nevada. Training will include classroom discussion and hands-on exercises that include System orientation and familiarization, and Equipment demonstration

Preliminary Training Manuals and Agendas (CDRL 12-8-3) will be reviewed during phase 4.1 and and delivered during Phase 4.3 of Project execution.

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SFMTA Replacement Radio System

Phase 4.4 - Integrated System Testing

Scope - Includes the remainder of integrated System testing including but not limited to the Radio Coverage Acceptance Test, the Field Performance Test, and the Mini-Fleet Test as described in the Design Criteria for the Project. Phase 4.4 shall also include finalization of all training documentation as described in the Design Criteria.

Please reference Section 4.12.5.4 Project Schedule Narrative for Acceptance Test Narrative.

When the SFMTA issues an NTP for Phase 4.4, Harris will commence with Field Acceptance Testing. The

Harris, ACS and Fiber-Span system engineers will verify that System installation and optimization is completed and ready for acceptance testing. Installation and operation of the new P25, OpenSky, CAD/AVL, Microwave, and Tunnel BDA systems will be demonstrated through completion of the following Acceptance Test Procedures as defined by the Contract Documents:

- Staging Acceptance Test (Completed in Section 4.2)
- Site inspections and test.
- Functional Test Procedures designed to test all major features of the System after Sites have been installed and optimized
- Coverage Acceptance Test Procedure defines how the RF coverage tests will be conducted and the type of test to be performed
- Mini Fleet Test

Preliminary Acceptance Criteria were submitted as part of Harris' Proposal. The Acceptance Criteria as submitted in the Proposal will be in the substantial form of the final Acceptance Criteria. All advanced features will be tested and approved prior to the completion of the Phase 4.4 unless mutually agreed to be approved on to a punch-list.

PHASE 4.4.1: FIELD PERFORMANCE TEST REPORT (FATP) – (APPENDIX 12, 7.9.5)

Note: This was previously Phase 4.4.2. Harris recommends that a Field Performance Test Report (AKA Functional Acceptance Test Report) be re-sequenced so that it is prepared prior to performance of the Coverage Acceptance Test.

The Field Performance Tests will be designed to test all major features and subsystems of the provided System. The FATP contains a description of the test and the methodology to be followed. A record form for logging the results for each functionality test is provided.

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SFMTA Replacement Radio System

CDRL 12-7-3 Test Records

PHASE 4.4.2: RADIO COVERAGE ACCEPTANCE TEST REPORT (CATP)

Harris will provide one unified radio System supporting two VIDA air interface applications:

- P25 on 700 MHz
- OpenSky on 800 MHz

Harris' engineering team designed these systems in parallel to create cost synergies and optimal coverage for the SFMTA. The proposed Harris System will meet or exceed the SFMTA's coverage requirements as defined below and referenced in "Harris Proposal Volume II, Section 12, Coverage Predictions":

- Above Ground:
 - 95% coverage for both mobiles and Portables above ground and outdoors
 - 95% coverage for Portables in cable cars
 - 85% coverage for Portables in-vehicles above ground
- Below Ground:
 - 97% coverage for mobile data and voice coverage below ground being provided by BDA Systems
 - 95% coverage for Portables below ground also provided by BDA systems
 - For more information on underground coverage, please refer to Volume 1, Section 4: Approach and Schedule for the proposal narrative and the underground coverage maps included at the end of this section.

The provided Coverage Acceptance Test as submitted with the proposal (Vol. II, Section 15a) includes the following tests:

- Data IP Connectivity Test
- Cable Car Voice Quality Test
- P25 Simulcast (BER) Test
- OpenSky Block Error Rate (BLER) Test
- Critical Voice Quality Test

For the Critical locations (listed in the Design Criteria, Document 0900), RF coverage using this ATP is verified by evaluating the voice quality of Digital voice test calls to/from a Portable radio in each of the critical locations specified by the SFMTA (refer to

SFMTA Replacement Radio System

Table 15-7 – Critical Locations and Acceptance Requirements: At each location, test calls are placed from the Portable user to the dispatcher (an inbound call), as well as from the dispatcher to the Portable user (an outbound call). The inbound and outbound test calls at each location are graded using the DAQ definitions in Table 15-6. Scores that equal or exceed the SFMTA's specified CPC of DAQ 3.4 are considered acceptable (PASS), and those lower than DAQ 3.4 are not acceptable (FAIL). DAQ 3.4 will be compared with Harris provided industry audio samples for the purpose of defining DAQ 3.4. If the Cable Car Barn fails the voice quality test then additional tests will be made to determine if the loss characteristics of the Cable Car Barn building exceed 25 dB building loss.

Of all the critical locations listed, all testing is provided is outdoors with the exception of the Cable Car Barn. The overall chart of Critical Locations as reflected in the proposal can be found in the RFAP Proposal, Vol. II, Section 12. Harris has proposed BDA solutions only for the Tunnels. Harris has not provided a BDA solution for the Cable Car Barn (excluding the basement area) as long as the building loss does not exceed 25 dB. In the event that Harris cannot satisfy the in-building coverage requirement for this location, then Harris will be responsible to provide a BDA solution at no additional cost to the SFMTA.

CDRL 12-7-3 Test Records

PHASE 4.4.3: MINI-FLEET TEST REPORT – (APPENDIX 12, 7.9.6)

CDRL 12-7-3 Test Records

A Mini-Fleet testing will include the deployment of two or more of each type of revenue and non-revenue vehicles. This test commences once all of the fixed end Equipment is installed and operational. Harris expects a 30 day field test, with appropriate planning and remedial activities that could extend this testing to 90 days. All observed problems must be fully diagnosed and either resolved, worked-around or otherwise addressed to the SFMTA's acceptance before production revenue service and beneficial use. Harris will execute the mini-Fleet testing with on-Site engineering resources as necessary to monitoring fleet operations, conduct diagnostic analysis, and effect field repairs, replacement or rework as necessary.

PHASE 4.4.4: TRAINING SCHEDULE (FINAL)

CDRL 12-8-2 Final Training Schedule will be reviewed during phase 4.1 and will formally be approved and delivered during Phase 4.3 of Project execution. Reference Phase 4.3.3

PHASE 4.4.5: TRAINING MANUALS AND AGENDAS (FINAL)

CDRL 12-8-3 Final Training Manuals and Agendas will be reviewed during phase 4.1 and will formally be approved and delivered during Phase 4.3 of Project execution. Reference Phase 4.3.4 for the Draft preparation of the Training Manuals and Agendas.

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SFMTA Replacement Radio System

Harris will complete the drafting and correction of Operations and Maintenance manuals prior to the commencement of the actual training program.

PHASE 4.4.6: DATABASE DICTIONARY AND USER MANUALS

Item	Content	CDRL
Manuals		
Hardware Reference and Instruction Manuals	Harris/Subcontractor typical manuals.	CDRL 12-9-10
Maintenance Manuals	Harris/Subcontractor typical manuals.	CDRL 12-9-11
Diagnostic Program Manuals	Harris/Subcontractor typical manuals.	CDRL 12-9-12
Database Documentation	CAD/AVL – Typical manuals	CDRL 12-9-17
Database Dictionary	CAD/AVL – Typical manuals	CDRL 12-9-18
PSVRN User Manual	P7300 User Manual	CDRL 12-9-19
MTMS User Manual	M7300 User Manual	CDRL 12-9-20
Bus Operator Manual	OrbStar User Manual	CDRL 12-9-21
Field Supervisor Manual	M7300/P7300 User Manual	CDRL 12-9-22
Non-Revenue Vehicle Manual	M7300/P7300 User Manual	CDRL 12-9-23
PSVRN System Administration Documentation	UAS - User/Administrator Manual RNM – User/Administrator Manual	CDRL 12-9-24
MTMS System Administrator Documentation	UAS - User/Administrator Manual RNM – User/Administrator Manual	CDRL 12-9-25
PSVRN Radio Dispatcher Manual	C3 Maestro – User Manual	CDRL 12-9-26
MTMS Radio Dispatcher Manual	CAD/AVL – User Manual	CDRL 12-9-27

SFMTA Replacement Radio System

Phase 4.5 – Training, System Cutover, and Availability Demonstration

Scope - Includes but is not limited to training of SFMTA staff, installation of mobile Equipment on SFMTA's fleet of revenue and non-revenue vehicles, and distribution of Portable Equipment. Phase 4.5 shall also include delivery of all as-built versions of maintenance manuals and as-built System documentation. Phase 4.5 shall conclude with the System Availability Test and submittal of the test report.

SYSTEM CUTOVER

Please reference Section 4.12.5.4 ad 4.12.6 for the Proposal for the complete description of the proposed cutover. System Cutover plan will be finalized as part of the CDRL deliverables in the design phase.

Preparations for System Cutover

When the SFMTA issues an NTP for Phase 4.5 System Cutover, Harris will begin programming Portable radios and performing the old equipment removals from and installation of new Equipment to the Vehicles. To make cutover a successful, careful planning must take place to ensure everything is ready, scheduled and coordinated. Harris will Work with the SFMTA to ensure that the SFMTA employees are informed and prepared for each step. Many issues associated with cutover must be worked out, such as user training, mobile installation schedules, Portable radio distribution, and user availability for the cutovers to progress as rapidly as possible.

Harris will support the SFMTA with Cutover by:

- Providing training and assistance in Cutover, Talkgroup, System Database and Training planning.
- Assist the SFMTA to plan and schedule System Administrator, Dispatcher and User training.
- Work with the SFMTA to establish user radio programming guides, radio distribution and installation, schedules, and interoperability interfaces to be employed during cutover.

The SFMTA will assign a System Administrator responsible for:

- System setup and database management.
- Prepare radio user profiles and radio personalities.
- Schedule training and distribution of user radios.
- Work with Harris to ensure that all tasks are scheduled and completed per agreed upon schedule.

All of these efforts will lead to more effective and responsive SFMTA employees who will be better prepared to respond to operational issues with a much greater situational awareness.

SFMTA Replacement Radio System

Cutover Execution

Harris and the SFMTA will select the time and initial users for cutover. Harris will ensure the Portable radios and associated accessories are ready for distribution. SFMTA dispatchers will be notified to go live on the new System. As the System goes operational, Harris will have technical people on Site at the OCC to provide individual assistance in answering any questions the dispatchers and users may have and monitor operational efficiency.

During cutover, Harris will use the capabilities of the interoperability gateways to link the user frequencies to the new talkgroups. This way, users who have migrated to the new System can talk via their assigned talkgroup to their peers who are still on the old radio system. When the cutover process is complete, the gateways will be re-programmed for the various interoperability links as per the design.

During cutover, Harris will monitor the System activity and performance, and look for alarms by using the network monitoring capabilities of the System. As users are successfully migrated onto the new System, Harris and the SFMTA will inform the next user groups identified in the plan. The process will continue until all users are migrated onto the System according to the plan.

Site Cleanup

According Table 5.1.3 Site Cleanup Summary, Harris will remove and dispose of decommissioned equipment according to the cutover plan. Harris will coordinate with the SFMTA to ensure that users are no longer using the old radio equipment prior to any decommissioning.

PHASE 4.5.1: COMPLETION OF TRAINING PROGRAM

Item	Content	CDRL
Training Manuals and Agendas	Standard Harris/Vendor Training Manuals finalized in Phase 4.4.5	CDRL 12-8-3
Training Reports	Training Attendance Records	CDRL 12-8-4

Preliminary Training Plan has been submitted as part of Harris' Proposal. In reference to Section 8.1.13, 00820 Document, Harris has made some clarifications with regards Class Size.

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SFMTA Replacement Radio System

PHASE 4.5.2: INSTALLATION OF MOBILE EQUIPMENT IN ALL REVENUE AND NON-REVENUE VEHICLES

Vehicle Equipment List can be found in *Attachment #3 to this SOW*.

Harris shall draft and present for SFMTA review and acceptance an Installation Work Procedure (IWP) that includes sample drawings for each Pre-Installation KIT. Harris will update the IWP as necessary to address installation problems as they arise.

- Installation Testing Procedure and training for vehicle testing and diagnostics.
- Pre-Installation kits and/or enclosures that include the assembly and testing of all vehicle equipment are built and tested. All pre-assembled installation trays will be inspected for quality assurance and placed into inventory until they are installed.
- The on-site support the First of Kind (FOK) installation of each vehicle type will have been completed in Phase 4.3.1
- Harris will perform the vehicle installation services and management of those activities. The following table assumes that this vehicle installation will be assigned during the design phase to accomplish the vehicle installation Work during Phase 4.5. Harris requires that there are 10 vehicles per day as clarified in Addendum to RFQ/RFP. Cutover schedule will be defined in the Design Phase.

Vehicle Type	Vehicle Quantity	Vehicles Available Per Day	Installation Location
Fixed Route Buses	440	4	Customer Facility / Contractor Facility
60' Fixed Route Buses	160	4	Customer Facility / Contractor Facility
Light Rail Vehicles	160	4	Customer Facility
Electric Trolley Coaches	395	4	Customer Facility
Historic Street Cars	74	4	Customer Facility
Cable Cars	50	4	Customer Facility
Non Revenue Vehicles/Voice Only	100	4	Customer Facility / Contractor Facility
Non Revenue Vehicles/AVL & Voice Only	90	4	Customer Facility / Contractor Facility
Non Revenue Vehicles/Voice & Data Only	50	4	Customer Facility / Contractor Facility
Non Revenue Vehicles/Laptops*	30	4	Customer Facility / Contractor Facility

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SFMTA Replacement Radio System

*Note – These laptops will be provided by the SFMTA unless the Option for the Mobile Dispatch Computers is exercised.

In order to ensure success, sign-off personnel must be readily available to complete vehicle installation.

PHASE 4.5.3: CONFIGURATION AND DISTRIBUTION OF ALL PORTABLE EQUIPMENT

The configuration and distribution of all Portable Equipment shall be coordinated as described in the operational planning in Phase 4.1.

Over the Air Programming (OTAP) is included as part of the base bid on all P25 Portable Equipment.

SFMTA Replacement Radio System

PHASE 4.5.4: ALL AS-BUILT H/W DOCUMENTATION, S/W DOCUMENTATION, AND MAINTENANCE MANUALS

Item	Content	CDRL
Antenna Tower Loading	Survey Report - Tower Loading at Every existing tower	CDRL 12-2-3
System Functional Description Document		CDRL 12-9-2
Hardware		
Hardware Inventory		CDRL 12-9-4
Hardware Documentation Inventory	Standard Harris HW Revision (Excel)	CDRL 12-9-5
As-Built Drawing Package		
Vehicle Installation		CDRL 12-9-7
Fixed Site Installation	Interconnect and Cable Diagrams	CDRL 12-9-8
Site Floor Plans		CDRL 12-9-9

PHASE 4.5.5: DELIVERY OF ALL PROGRAM SOURCE CODE; EXECUTION OF THE S/W ESCROW AGREEMENT

All items referring to the Escrow Agreement are addressed the Terms and Conditions of the Contract.

SFMTA Replacement Radio System

PHASE 4.5.6: SYSTEM AVAILABILITY TEST REPORT (RFP APPENDIX 12, 7.9.7)

System Component	Criteria	Measurement
Unavailability Criteria		
Radio Site	Repeater Site unplanned outage of any entire station Site for more than 4 hours for any one event or 0.1% cumulative for one year.	Availability analysis is completed in CDRL 12-1-8 (System Reliability and Availability Calculation) to validate the design will meet this criteria.
Site Control	Site control or Site message switching sub-system unplanned outage for more than 2 hours event or 0.1% cumulative for one year.	Availability analysis is completed in CDRL 12-1-8 (System Reliability and Availability Calculation) to validate the design will meet this criteria
Network and Backhaul	Network and backhaul sub-system (contractor-provided Equipment only) – unplanned outage of network connectivity to one Site for more than 2 hours event or 0.1% cumulative for one year.	Availability analysis is completed in CDRL 12-1-8 (System Reliability and Availability Calculation) to validate the design will meet this criteria. In addition, the CDRL 12-1-7 (Failure Modes and Effects Analysis) is completed to validate the backhaul reliability criteria.
Vehicle On-board Equipment	Due to any simultaneous event, Failure of on-board Equipment, including radio, antenna, control head, microphone, speaker, ancillary Equipment and the CAD/AVL interface in 5% of the SFMTA's combined revenue and non-revenue fleets.	Availability analysis is completed in CDRL 12-1-8 (System Reliability and Availability Calculation) to validate the design will meet this criteria. In addition, the CDRL 12-1-7 (Failure Modes and Effects Analysis) is completed to validate the backhaul reliability criteria.
Loss of Power and/or HVAC	Loss of commercial or generator power or environmental controls (where the SFMTA has provided these facilities) or failure of SFMTA and/or CCSF provided equipment is not considered downtime.	Availability analysis is completed in CDRL 12-1-8 (System Reliability and Availability Calculation) to validate the impact of commercial and SFMTA dependence on the design. In addition, the CDRL 12-1-7 (Failure Modes and Effects Analysis) is completed to show the impact of commercial and SFMTA provided systems.

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SFMTA Replacement Radio System

System Component	Criteria	Measurement
Reliability Criteria		
Voice Communications	No single point of failure shall disable voice communications from the dispatch center to the vehicle fleet, other than failure of Equipment onboard a single vehicle. The MTMS and PSVRN radio systems shall include fallback modes such as Network Voice Fallback with fallback talkgroups.	The fallback modes of a single voice user will be tested. The impact of a single user failure will be tested to verify that fleet-wide communications are not disrupted.
Data Communications	No single point of failure shall disable data communications from the dispatch center to the vehicle fleet, other than failure of Equipment onboard a single vehicle.	The fallback modes of a single data user will be tested. The impact of a single user failure will be tested to verify that fleet-wide communications are not disrupted.
Consoles	Each console shall have all functions available at least 99.8% of the time, based on 24 hour a day operation, 365 days a year.	The availability of a console shall be verified by a reliability analysis.
Consoles	At least half of the consoles shall have all functions available at least 99.9% of the time based on 24 hour a day operation, 365 days a year.	The consoles shall be tested for proper operation during the availability test period. The availability of a console shall be verified by a reliability analysis.
Consoles	No single point of failure shall disable both radio and telephone communications at more than one console.	The failure of a single console will be tested. The impact of a single console failure will be tested to verify that other consoles and fleet-wide communications are not disrupted.
Telephone Access	Any system or interface implemented or installed by contractor shall not disable access to telephone lines for incoming and outgoing calls to more than one console.	The failure of a single telephone line interface console position will be tested. The impact of a single Telephone line interface failure will be tested to verify that other telephone lines, consoles and fleet-wide communications are not disrupted.

SFMTA Replacement Radio System

System Component	Criteria	Measurement
Onboard MTMS Equipment	The full specified functionality for the MTMS onboard Equipment for each vehicle shall be available at least 99.7% of the time, based on twenty-four hour a day operation, 365 days a year.	The on-board Equipment will be tested for proper operation during the entire availability test period. The extended availability expectation shall be verified by a reliability analysis.
Data Logging	The ability for MTMS to correctly log data from vehicles, without lost events, shall be available at least 99.9 % of the time, based on twenty-four hour a day operation, 365 days a year. Measurement of this parameter requires that the Vehicle is within MTMS radio coverage.	The MTMS data logging will be tested for proper operation during the entire availability test period. The extended availability expectation shall be verified by a reliability analysis.
MTMS System	MTMS availability is considered compromised if the MTMS Equipment is inoperable on more than 30% of the vehicles.	The MTMS system shall be tested for the impact of a single RF Site, NCC Site, or Maintenance Yard Site failure. The CDRL 12-1-7 (Failure Modes and Effects Analysis) will be used to incorporate this test data in the acceptance that not more than 30% of the fleet to become inoperable.

4 Spare Parts

Harris has recommended a 3% spares rate for the Equipment described below (3% was used only for mobiles, Portables, MDT, and VLU units) which would be sufficient to meet the required response time to replace any failed units under the warranty program. Any spares that are used prior to the completion of the warranty period will be replaced at no cost to the City. Additional spares can be purchased if necessary after the completion of the warranty period.

During the availability analysis of the design phase, Harris will Work with the SFMTA to determine if any additional spare parts are required to satisfy the availability design criteria as described in the Design Criteria Package, including Appendix 12 (Document 0900). Additional spares would be added via the change management process.

SFMTA Replacement Radio System

For Item #2 Mobile Data Radio, Harris has not recommended any quantities of this item to allow SFMTA to utilize a single batch of spare Harris radios which could either be feature encrypted for P25 or OpenSky services depending upon which type of spare is needed.

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot, MS = Milestone			
Item No.	Item Description	Estimated Quantity	Unit
1	Mobile Voice Radio	44	EA
2	Mobile Data Radio (if applicable)	---	---
3	Mobile Data Terminal	40	EA
4	Vehicle Logic Unit	36	EA
5	On-Board Electronic Sign	50	EA
6	On-Board Public Address Amplifier	36	EA
7	Complete set of revenue vehicle hardware including all Equipment, cables, connectors, and brackets (assume for Transit Bus, 40 ft.)	6	EA
8	Complete set of revenue vehicle hardware including all Equipment, cables, connectors, and brackets, Light Rail Vehicle	2	EA
9	Complete set of non-revenue vehicle hardware including all Equipment, cables, connectors, and brackets (assume for sedan)	3	EA
10	Dispatch Voice Radio Console, including all hardware, Software, and applicable Software licenses.	2	EA
11	Dispatch CAD/AVL Console, including all hardware, Software, and applicable Software licenses.	3	EA
12	CAD/AVL Software license, read-only	5	EA
13	Portable Radio, Tier I, P25 compliant, including antenna and battery	16	EA
14	Portable Radio, Tier II, P25 compliant, including antenna and battery	2	EA
15	Portable Radio, Tier III, P25 compliant, including antenna and battery	2	EA

SFMTA Replacement Radio System

5 Options

As options are identified and exercised, schedule will need to be resubmitted to include the implementation to the final schedule. Please reference Section 18 of the Proposal for additional details. Harris has provided recommended limits to the number of days following NTP.

Item No.	Applicability of price in days from NTP	Item Description	Details	Qty
1	365 ⁱ	Over the Air Programming for Portable radios (see Appendix 12 Section 2.17) (This scope is now included as part of the base option).	Please reference Section 18 of the Proposal.	700
2	365 ⁱ	Over the Air Re-keying for Portable radios (see Appendix 12 Section 2.17) + Key Management Facility (KMF) server	Please reference Section 18 of the Proposal.	50
3	365 ⁱ	Encryption – Subscriber to Subscriber (see Appendix 12 Section 2.17)	Please reference Section 18 of the Proposal.	50
4	365 ⁱ	Intrinsically safe Portable radio, Tier II (see Appendix 12 Section 2.17)	Please reference Section 18 of the Proposal.	25
5	180	Automatic Passenger Counting System Interface (see Appendix 12 Section 3.3)	Please reference Section 18 of the Proposal.	250
6	180	Track Layout and Turnaround Layer (see Appendix 12 Section 3.3)	Please reference Section 18 of the Proposal.	1
7	180	Headway Control (see Appendix 12 Section 3.3)	Please reference Section 18 of the Proposal.	1
8	180	“Crush-Load” Detection with Wheelchair Priority Pickup (see Appendix 12 Section 3.3)	Please reference Section 18 of the Proposal.	1
9	180	Capture Vehicle Load Using Real-Time Automatic Passenger Count Input (see Appendix 12 Section 3.3)	Please reference Section 18 of the Proposal.	250
10	180	Predictive Arrival and Departure Information System (see Appendix 12 Section 3.3)	This Predictive Arrival and Departure Info.	390 (LS)

SFMTA Replacement Radio System

Item No.	Applicability of price in days from NTP	Item Description	Details	Qty
11	180	Predictive Subsystem and Web Services API (see Appendix 12 Section 3.3)	Please reference Section 18 of the Proposal.	390 (LS)
12	365 ⁱ	Mobile Dispatch Computers (see Appendix 12 Section 3.3)	Please reference Section 18 of the Proposal.	30
13	180	MTMS Development Environment (see Appendix 12 Section 3.3)	Please reference Section 18 of the Proposal.	1
14	180	Yard Management System for 995 vehicles (see Appendix 12 Section 3.3) at the following vehicle maintenance facilities - Potrero, Muni Metro East, Presidio, Green, Woods, Flynn, and Islais Creek (planned)	Please reference Section 18 of the Proposal.	995
15	180	Backup OCC at Lenox Way Operations Control Center To include, design, construction, installation, and Equipment (must include console furniture)	Scope is described below.	1
16	365 ⁱ	Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with six (6) 800 MHz MTMS data/voice channels and nine (9) 700 MHz P-25 compliant PSVRN voice channels. – Year 1 (See Document 00835 Warranty and Maintenance).		1
17	365 ⁱ	Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with six (6) 800 MHz MTMS data/voice channels and nine (9) 700 MHz P-25 compliant PSVRN voice channels. – Year 2 (See Document 00835 Warranty and Maintenance).		1

SFMTA Replacement Radio System

Item No.	Applicability of price in days from NTP	Item Description	Details	Qty
18	365 ⁱ	Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with six (6) 800 MHz MTMS data/voice channels and nine (9) 700 MHz P-25 compliant PSVRN voice channels. – Year 3 (See Document 00835 Warranty and Maintenance).		1
19	365 ⁱ	Three (3) Year Extended Support Program for nine (9) additional P-25 compliant 700 MHz PSVRN voice channels. – Year 1 (See Document 00835 Warranty and Maintenance).		1
20	365 ⁱ	Three (3) Year Extended Support Program for nine (9) additional P-25 compliant 700 MHz PSVRN voice channels. – Year 2 (See Document 00835 Warranty and Maintenance).		1
21	365 ⁱ	Three (3) Year Extended Support Program for nine (9) additional P-25 compliant 700 MHz PSVRN voice channels. – Year 3 (See Document 00835 Warranty and Maintenance).		1
22	180	Logging Recorder: Additional "Hindsight-P25/OpenSky Recorder Assistant" licenses for Exacom logging recorder for remote viewing of the recorder only.	Reference the spec Appendix 12, Section 2.15 Described in the proposal Section 4.2.1.3 and Section 11.15	1
23	180	Logging Recorder: Upgrade from Exacom fault-tolerant to Exacom redundant logging recorder. Equipment only cost.	Described in the proposal Section 4.2.1.3 and Section 11.15	1
24	180	Logging Recorder: Enable Recording of encrypted calls on Exacom	Described in the proposal Section 4.2.1.3 and Section 11.15	1

SFMTA Replacement Radio System

Item No.	Applicability of price in days from NTP	Item Description	Details	Qty
25	180	Logging Recorder: A turnkey NICE logging recorder installation with third party storage and server hardware.	Encrypted Logging is included on the NICE quotation. Details described below.	1
26	180	Islais Creek Facility Console and Bulk Data Transfer	Please reference Section 18 of the Proposal.	1
27	180	Kirkland Facility Console and Bulk Data Transfer	Described as optional in the System Diagram (Attachment 3) and Maintenance Facility Equipment List (Attachment 1)	1
28	180	If required, complete price for Phases 4.1 - 4.5 for the Stockton Tunnel.	As described in 4.2.2.6 of the Proposal	1
29	180	If required, complete price for Phases 4.1 - 4.5 for the Yerba Buena Tunnel.	As described in 4.2.2.6 of the Proposal	1
30	180	If required, complete price for Phases 4.1 - 4.5 for the Broadway Tunnel.	As described in 4.2.2.6 of the Proposal	1
31	180	If required, complete price for Phases 4.1 - 4.5 for the MacArthur Tunnel.	As described in 4.2.2.6 of the Proposal	1
32	180	BDA for Cable Car Barn	As described in Phase 4.2.3	1
33a	45 ⁱ	Traffic Signal Priority System (re-design) Credit to Contractor for the inclusion of a Traffic Signal Priority Pilot for 6 Intersections, and a TSP management server design changes. This solution uses a 5.9 GHz, DSRC radio.		1
33b	45 ⁱ	TSP D4 protocol integration with the VLU.		1

SFMTA Replacement Radio System

Item No.	Applicability of price in days from NTP	Item Description	Details	Qty
33c	45 ⁱ	TSP Onboard Equipment - Pilot Onboard Equipment	See details below regarding the onboard Equipment.	20
34	90 ⁱ	South Hill Tower Replacement	From the Proposal this includes the replacement of a 60' tower. Please see scope below.	1
35	90 ⁱ	Option for installation of 312 strand fiber in the main tunnel is Additional Work.	All strands are to be tested and terminated at all station locations as well as fully tested and in water and dust tight splice cases. Pricing to include installation, fiber and all other parts necessary for operation. Price is additional cost compared to the 24 fiber stands pulled in the base offering.	1
36a,b	90 ⁱ	PERS - 8 Ch Stations + Install	Reference the Proposal. All items related to PERS are now optional.	1
36c,d	90 ⁱ	PERS - Tunnel Channelization	Reference the Proposal. All items related to PERS are now optional.	1
37	365 ⁱ	McLaren Park Clean Up	Removal of legacy equipment.	1
38	90 ⁱ	MTMS Next Bus Interface	Provide an optional interface to the Nextbus Standard Product Application Programming Interface.	1

SFMTA Replacement Radio System

Item No.	Applicability of price in days from NTP	Item Description	Details	Qty
39	90 ^{i i}	MTMS Option Transit Safe	TransitSafe interface to include development and testing of an interface with the existing TransitSafe system. No scope of services for the modification of the TransitSafe system is included. It is expected that SFMTA will provide the scope of services for the development and integration of the Transit Safe system changes.	1
40	90 ^{i i}	MTMS Option TransLink Interface	TransLink Interface as described in the SFMTA RFAP requirements. Currently, Harris has limited the scope to include the Harris side of the integration. No services were solicited to modify the TransLink side of the Interface.	1
	180	Lenox Way – Console relocation (zero cost option)	Relocate three (3) “variant 1” consoles as described in Appendix 14 and control stations from other locations (such as Cable Car Machinery, Command Coach and Potrero) without additional cost.	1

ⁱ Dates extended beyond 180 days are potentially subject to a CPI adjustment

^{i i} Dates less than 180 days are options (not in the original SFMTA Appendix 28) that will have design impact if not selected within the recommended time

Optional Deductions include:

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Page | 60



SFMTA Replacement Radio System

Item No.	Applicability of price in days from NTP	Item Description	Recommended Changes to the Requirements Document	Qty
1	90 ⁱ i	Credit to the City (as provided in Document 530 – Cost Schedule) for adjustment to requirements as specified in section 2.11 of the RFAP Appendix 12 Technical Specifications. Lump sum is based on the contractor's new proposal for removal of Head End equipment at West end of the Sunset Tunnel and feed the West end of the Marketplace/Twin Peaks tunnel instead.	For Section 2.11, add a bullet below Underground System general requirements include: stating: Contractor may also use SFMTA provided fiber between the Marketplace/Twin Peaks and Sunset tunnels. Fiber exists between: * The West portal of the Sunset tunnel to the West portal of the Marketplace/Twin Peaks Tunnel * The East portal of the Sunset tunnel to the Justin Herman vent shaft in the Marketplace/Twin Peaks Tunnel. * The Justin Herman vent and the radio transmitter rooms had One Market Plaza.	1
2	90 ⁱ i	Credit to the City (as provided in Document 530 – Cost Schedule) for adjustment to requirements as specified in section 2.11 of the RFAP Appendix 12 Technical Specifications. Lump sum is based on the contractor's new proposal for removal of Head End equipment at East end of the Sunset Tunnel and feed the East end of the Marketplace/Twin Peaks tunnel instead.	Please see the comments for item 20.	1
3	90 ⁱ i	Credit to the City City (as provided in Document 530 – Cost Schedule) for adjustment to working hours in the tunnels as defined in Appendix 3, Document 00830. Lump sum is based on the contractor's new proposal for five (5) hour Work times available during weekdays.	Section 1.11, B of Appendix 12, 0900 Document REPLACE "1:45a.m. to 3:45" am for Monday through Friday with "11:45am to 3:45am"	1

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SFMTA Replacement Radio System

Item No.	Applicability of price in days from NTP	Item Description	Recommended Changes to the Requirements Document	Qty
4	90 ⁱ	<p>Credit To City (as provided in Document 530 – Cost Schedule) for SFMTA provided logging recorder. Contractor to still support interface.</p> <p>Harris will keep the Exacom logging recorder in the base offering, but a price will be listed here for the purposes of SFMTA determining during the design phase whether or not reuse of the C3 Project's NICE is possible. This includes the Exacom Hindsight-G2 96 mixed-ch recorder; drive array, workstation, and P25&OS interface modules with 1 year on-Site warranty.</p>	Change Section 2.15 to Optionally.	1

Additional notes related to options:

- Predictive Arrival System: ACS SmartTraveler System (Option #10 and 11)
 - The Scope of the Predictive Arrival System priced option is to replace the components of the Nextbus “system” that are not installed on the Vehicles or used in passenger information displays (signs). The existing stop/stations signs would be reused. Harris will provide servers necessary to support the ACS SmartTraveler product (used to control the existing street signs) and ACS SmartTraveler Plus product (used to provide the Web interface and the Underground tunnel display). The priced solution is not redundant. This option reuses 390 existing street signs and the Underground tunnel displays. Since no additional power requirements are expected at these locations, SFMTA shall provide any power at these locations if required.
 - The Predictive Subsystem and Web Services API include the ACS SmartTraveler Plus as described in the System description.

- NICE Logging Recorder (Option #25)

The NICE Logging Recorder Option is included as an alternative to the Exacom system. The NICE Logging Recorder Option includes the following System features:

- 250 Channel Recorder
- Hot Swap Raid (not included in the Exacom system)

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SFMTA Replacement Radio System

- P25 Phase I or Phase II Integration
- OpenSky Integration
- Reconstruction Users (Qty 12)
- Recording of AES encrypted voice
- Redundant Logging Recorder (not included in the Exacom system)

- Traffic Signal Priority (Option #33)

Support for the optional Traffic Signal Priority Pilot for 6 Intersections, and a TSP management server. This solution uses a 5.9 GHz, DSRC radio. This pilot includes the installation and testing of 20 vehicles for the pilot evaluation. For these 20 vehicles, it is currently designed that the Wireless Bulk Data Transfer Radio is a separate unit from the TSP Radio. Please reference section 4.10 of the Proposal (with the modification using a 4.9 GHz radio to a 5.9 GHz DSRC radio.)

- PERS (Option #36) – No PERS equipment or services has been included in the base offering.

- Scope of Work for Back-up Control Center at Lenox Way (Option #15)

The following preliminary assessment is provided for Work at this Site, including:

- Review and confirm the Site description on the Cover Sheet for the Work Site.
- Prepare a detailed review of the Site and document existing conditions in detail.
- Perform a load study of the AC and DC power system at Lenox Way that includes the new consoles/radio equipment and that includes the equipment resident on the System at each phase in the renovation plan.
- Perform a HVAC study of the Lenox Way Site that includes all of the existing Equipment and people and the new consoles/radio Equipment and that includes the equipment resident at the Site at each phase in the renovation plan.
- During construction deactivate the gas based fire suppression system and provide alternative, non-water baser fire suppression equipment. Prepare an expert review of the existing gas fire suppression system. Perform as Incidental Work any necessary work to make the suppression system compatible with the new facility configuration.
- Remove the ceiling tiles and floor tiles.
- Re-outfit the room with new floor, ceiling, lighting, HVAC ducts, consoles, electronics and displays.
- Install new flat displays as required for coordinated operations.
- Reactivate the gas based fire suppression system.

SFMTA Replacement Radio System

- Start-Up all systems using vendor help as appropriate. Prepare a detailed test procedure for The SOMA review and potential approval. Conduct an acceptance test of all systems and Equipment in the presence of a representative of the SOMA. (The gas based fire suppression shall be tested without actual agent discharge.)

Harris will provide the following calculations and plans, to be developed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. [CDRL 12-5-1 Lenox Way Site Calculations and Reports].

Electrical:

- Detailed Electrical Load Study including the entire complex
- HVAC load Calculation including the entire complex

Provide a detailed plan for the renovation of the Control Room that includes consideration of:

- Protection of vital circuits, HVAC, lighting and power during construction.
- Protection of systems that will not be replaced such as the gas fire suppression system.
- Removal and replacement of control room infrastructure.
- Inspection of the FM200 gas fire suppression system and an assessment of its effectiveness.
- Completed Construction Drawings [CDRL 12-5-2 Lenox Way Completed Construction Drawings]
- Completed Materials Specifications [CDRL 12-5-3 Lenox Way Completed Materials Specifications]

5.4.3 Civil/Architectural

Console furniture shall be provided to accommodate the dispatch workstations and their use by dispatchers and train controllers. It shall be of modular, ergonomic design, and provide the following features:

- MTMS and PSVRN Workstation storage
- Convenient height-adjustable writing surface
- Drawers and storage space
- Power outlet strips
- Design for neat and safe cable runs and connections such as internal cable guides and covered knockouts
- Design for headset jacks
- Comply with ADA regulations
- Comply with state and local seismic bracing requirements.

SFMTA Replacement Radio System

Harris will be responsible for any Civil/Architectural improvements required to accommodate newly installed Equipment including Quantity five (5) back-up dispatch Work-stations.

Architectural drawings for Lenox Way Operations Control Center are contained in Appendix Nine (9).

- Scope of Work for South Hill Tower Replacement (Option #34)
 - For the replacement of the 40' tower with a new 60' tower at South Hill.
 - Remove current carriers from the existing 40' tower to temporary location.
 - Remove existing 40' tower.
 - Install new 60" tower back in location of removed tower.
 - Relocate current carriers back to the new 60' tower from the temporary location.

Exercised options will be managed and implemented by Change Order.

6 Attachment Documents

Attachment 1 – List of Equipment

Attachment 2 –Responsibility Matrix Attachment 3 – System Block Diagrams (*These diagram drawings supersede the drawings submitted in the original Harris proposal.*)

Attachment 4 – Sample Monthly Report (for reference only)

Attachment 6 – Microwave Feasibility Study (*To completely replace the Proposal submission Volume II, Section 11c*)

Radio Replacement Project

Attachment 1

RF Sites

Base Station Types and Quantities Including Cabinets per Site						
Radio Sites	700 MHz, P25 Simulcast, MASTR V				800 MHz OpenSky	
	SFMTA 9-Channels	SFMTA 9-Racks	*PERS 8-Channels	*PERS 8-Racks	SkyMASTR Cabinets Channels	SkyMASTR Cabinets Racks
One Market Plaza	9	3	8	1	**3	1
Central Radio Station	9	3	8	1	**3	1
Forest Hill	9	3	8	1		
Bernal Heights					1	1
South Hill	9	3	8	1	**2	1
Base Station Totals	36		32		1	
Rack Totals		12		4		4
*PERS is a priced option						
**Additional Hot Standby Channel is included						

Radio Replacement Project

Attachment 1

Antenna Sites

Air Interface	Purpose	SFMTA Antenna Quantities	Optional PERS Antenna Quantities	Antenna Type	Cable	Cable Length	Antenna Manufacturer/Model No.	Tower Height, Feet
One Market Plaza								
P25	TX	1	1	Directional	1-5/8"	150	Ampheno/Antel; BCR-75013-EDIN-3-25	Building Parapet
OpenSky	TX	1		Omni-Directional	1-5/8"	150	Sinclair; SC479-HF1LDF, 4° electrical downtilt	Building Parapet
P25 and OpenSky	RX w/TTA	1		Omni-Directional	7/8" and 1/2"	150	Sinclair; SC479-HF1LDF, 4° electrical downtilt	Building Parapet
OpenSky Hot Standby	TX and RX	1		Omni-Directional	7/8"	150	Sinclair; SC479-HF1LDF, 4° electrical downtilt	Building Parapet
Bernal Heights								
OpenSky	TX and RX	1		Directional	7/8"	200	Andrew; DB844G65ZAXY	50
Forest Hill								
P25	TX	1	1	Omni-Directional	1-5/8"	150	Sinclair; SC479-HF-1LDF, 6° electrical downtilt	40

Radio Replacement Project

Attachment 1

Air Interface	Purpose	SFMTA Antenna Quantities	Optional PERS Antenna Quantities	Antenna Type	Cable	Cable Length	Antenna Manufacturer/Model No.	Tower Height, Feet
P25	RX w/TTA	1		Omni-Directional	7/8" and 1/2"	150	Sinclair; SC479-HF-1LDF, 6° electrical downtilt	60
Optional: OpenSky Station	TX and RX	1		Directional	7/8"	150	Andrew/ DB844G65ZAXY	40
Central Radio Station								
P25 and OpenSky	TX	1	1	Omni-Directional	1-5/8"	250	Sinclair; SC479-HF1LDF, 4° electrical downtilt	160
P25 and OpenSky	RX w/TTA	1		Omni-Directional	7/8" and 1/2"	250	Sinclair; SC479-HF1LDF, 4° electrical downtilt	180
OpenSky Hot Standby	TX and RX	1		Directional	7/8"	250	Sinclair; SC479-HF1LDF, 4° electrical downtilt	140
South Hill								
P25 and OpenSky	TX	1	1	Directional	1-5/8"	100	Sinclair; SE414-SF3PALDF	40
P25 and OpenSky	RX w/TTA	1		Directional	7/8" and 1/2"	100	Sinclair; SE414-SF3PALDF	60
OpenSky Hot Standby	TX and rX	1		Directional	7/8"	100	Sinclair; SE414-SF3PALDF	40

Radio Replacement Project

Attachment 1

Items	Qty	Notes
1455 Market Street - Network Switching Center		
Network Switching Center		
Server,Network Switch(NSS),Primary	1	Service,SyBase Software License,NSS
Server,Regional VIDA Manager (RVM)	1	Service,SyBase Sftwr License,RNM/CNM
Printer,Laser,Black/White,NSC	1	
Server,Regional Site Mgr Professional	1	License,Sql 2008 Enterprise Edition
Printer,Color Laser,110V	1	
Server,Transcoder	1	
P25 IP Simulcast Control Point System	1	
Server,ISSI Gateway	1	
Router,Cisco,2911,AC,Sec,w/EtherSwitch	1	
EthrSwth,L2,SM,23FE,1 GE,Cisco,SM-ES2-24	1	
Router,Cisco ASR1001,AC Pwr,IP Bs,Adv IP	1	

Radio Replacement Project

Attachment 1

Items	Qty	Notes
Switch,Cisco 3560X-48T-S,48 Port	1	
Server,Dell R610,SUMS Automation server	1	
Cisco ASA5510	1	
Unitrends DPU 720	1	
Server,Dell R610,Active Directory Server	1	
HIDS	217	
LogLogic ST, for 3 year retention	1	
LogLogic SEM	1	
Quest 2-Factor VPN	1	
IDS,SourceFire DC1000	1	
IDS,SourceFire 3D2500	1	
CiscoWorks	1	
ORBCAD Application Cluster - 2 Servers		
windows large san dl380g7 x 1	2	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk

Radio Replacement Project

Attachment 1

Items	Qty	Notes
HP DL380G7 SFF CTO Chassis	2	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	2	
HP E5640 DL380G7 Kit	2	
HP 4GB 2Rx8 PC3-10600E-9 Kit	12	
HP 146GB 10K 6G 2.5 SAS DP HDD	4	
HP Slim 12.7mm SATA DVDRW Optical Kit	2	
HP DL380G6 3 Slot PCI-E Riser Kit	2	
HP 512MB Flash Backed Write Cache	2	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	4	
HP NC360T PCIe DP Gig Adptr	2	
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	4	
HP 460W HE 12V Hotplg AC Pwr Supply Kit	4	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	2	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	2	

Radio Replacement Project

Attachment 1

Items	Qty	Notes
Active SQL Cluster - 2 Servers		
windows large san dl380g7 x 1	2	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk
HP DL380G7 SFF CTO Chassis	2	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	2	
HP E5640 DL380G7 Kit	2	
HP 4GB 2Rx8 PC3-10600E-9 Kit	12	
HP 146GB 10K 6G 2.5 SAS DP HDD	4	
HP Slim 12.7mm SATA DVDRW Optical Kit	2	
HP DL380G6 3 Slot PCI-E Riser Kit	2	
HP 512MB Flash Backed Write Cache	2	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	4	
HP NC360T PCIe DP Gig Adptr	2	
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	4	

Radio Replacement Project

Attachment 1

Items	Qty	Notes
HP 460W HE 12V Hotplg AC Pwr Supply Kit	4	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	2	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	2	
LTDB SQL Cluster - 2 Servers		
windows large san dl380g7 x 1	2	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk
HP DL380G7 SFF CTO Chassis	2	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	2	
HP E5640 DL380G7 Kit	2	
HP 4GB 2Rx8 PC3-10600E-9 Kit	12	
HP 146GB 10K 6G 2.5 SAS DP HDD	4	
HP Slim 12.7mm SATA DVDRW Optical Kit	2	
HP DL380G6 3 Slot PCI-E Riser Kit	2	
HP 512MB Flash Backed Write Cache	2	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	4	

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Radio Replacement Project

Attachment 1

Items	Qty	Notes
HP NC360T PCIe DP Gig Adptr	2	
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	4	
HP 460W HE 12V Hotplg AC Pwr Supply Kit	4	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	2	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	2	
Shared SAN		
HP P2000 G3 MSA FC Dual Cntrl SFF Array	1	HP P2000 G3 8GB dual controller SAN array
HP 146GB 6G SAS 10K 2.5in DP ENT HDD	20	2.8TB Raw Space
Factory integrated	20	
HP Installation and Startup Service	1	
HP MSA Install SVC	1	
HP 5m Multi-mode OM2 LC/LC FC Cable	2	
HP P2000 Snapshot 512 Software E-LTU	1	
HP P2000 Remote Snap Software E-LTU	1	

Radio Replacement Project

Attachment 1

Items	Qty	Notes
HP 16A High Voltage Modular PDU	2	
HP 8/24 Base 16-ports Enabled SAN Switch	2	Redundant 8GB switch, 16 ports activated
U.S. - English localization	1	
HP 3y Support Plus 24 SVC	1	
MSA2000 G3 support	1	
P2000 Snapshot 512 SW LTU SW Support	1	
P2000 Remote Snap SW LTU SW Support	1	
HP B-Series 8/8 and 8/24 Switch Support	1	
HP 3.6m C19 Nema L6-20P NA/JP Pwr Crd	2	
HP Installation Service	1	
ProLiant Add On Options Installation SVC	4	
LowEnd SAN/Edge Switch/HAFM Installation	1	
HP MSA2000 SW Installation	2	
HP 15m Multi-mode OM3 LC/LC FC Cable	16	

Radio Replacement Project

Attachment 1

Items	Qty	Notes
HP 8Gb Shortwave B-series FC SFP+ 1 Pack	16	
Reports Server		
windows large san dl380g7 x 1	1	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk
HP DL380G7 SFF CTO Chassis	1	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	1	
HP E5640 DL380G7 Kit	1	
HP 4GB 2Rx8 PC3-10600E-9 Kit	6	
HP 146GB 10K 6G 2.5 SAS DP HDD	2	
HP Slim 12.7mm SATA DVDRW Optical Kit	1	
HP DL380G6 3 Slot PCI-E Riser Kit	1	
HP 512MB Flash Backed Write Cache	1	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	2	
HP NC360T PCIe DP Gig Adptr	1	

Radio Replacement Project

Attachment 1

Items	Qty	Notes
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	2	
HP 460W HE 12V Hotplg AC Pwr Supply Kit	2	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	1	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	1	
MDC (Citrix) Server Farm - 4 Servers		
windows large san dl380g7 x 1	4	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk
HP DL380G7 SFF CTO Chassis	4	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	4	
HP E5640 DL380G7 Kit	4	
HP 4GB 2Rx8 PC3-10600E-9 Kit	24	
HP 146GB 10K 6G 2.5 SAS DP HDD	8	
HP Slim 12.7mm SATA DVDRW Optical Kit	4	
HP DL380G6 3 Slot PCI-E Riser Kit	4	

Radio Replacement Project

Attachment 1

Items	Qty	Notes
HP 512MB Flash Backed Write Cache	4	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	8	
HP NC360T PCIe DP Gig Adptr	4	
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	8	
HP 460W HE 12V Hotplg AC Pwr Supply Kit	8	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	4	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	4	
DCC Server - 2 Servers		
HP DL360G7 E5640 1P Performance US Svr	2	4 Core Xeon E5640 2.66Ghz Processor, 12MB Cache per processor, 6GB DDR3 RAM std Includes SmartArray P410i/256MB RAID controller, (2) 1GbE dual port NICS
HP E5640 DL360 G7 Processor	2	2nd Processor
HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	6	RAID1 + online spare
HP DL360 12.7mm SATA DVD-RW Kit	2	SATA DVD-RW Kit

Radio Replacement Project

Attachment 1

Items	Qty	Notes
Proliant Server DL36x HW Supp	2	
GTRMD Server - 2 Servers		
HP DL360G7 E5640 1P Performance US Svr	2	4 Core Xeon E5640 2.66Ghz Processor, 12MB Cache per processor, 6GB DDR3 RAM std Includes SmartArray P410i/256MB RADI controller, (2) 1GbE dual port NICS
HP E5640 DL360 G7 Processor	2	2nd Processor
HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	6	RAID1 + online spare
HP DL360 12.7mm SATA DVD-RW Kit	2	SATA DVD-RW Kit
Proliant Server DL36x HW Supp	2	
Domain Controller Servers - 2 Servers		
HP DL360G7 E5640 1P Performance US Svr	2	4 Core Xeon E5640 2.66Ghz Processor, 12MB Cache per processor, 6GB DDR3 RAM std Includes SmartArray P410i/256MB RADI controller, (2) 1GbE dual port NICS
HP E5640 DL360 G7 Processor	2	2nd Processor
HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	6	RAID1 + online spare

Radio Replacement Project

Attachment 1

Items	Qty	Notes
HP DL360 12.7mm SATA DVD-RW Kit	2	SATA DVD-RW Kit
Proliant Server DL36x HW Supp	2	
SNMP Server - 1 Server		
HP DL360G7 E5640 1P Performance US Svr	1	4 Core Xeon E5640 2.66Ghz Processor, 12MB Cache per processor, 6GB DDR3 RAM stdIncludes SmartArray P410i/256MB RADI controller, (2) 1GbE dual port NICS
HP E5640 DL360 G7 Processor	1	2nd Processor
HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	3	RAID1 + online spare
HP DL360 12.7mm SATA DVD-RW Kit	1	SATA DVD-RW Kit
Proliant Server DL36x HW Supp	1	
DIS Servers		

Radio Replacement Project

Attachment 1

Items	Qty	Notes
HP ML350 g6 SFF Tower Server	9	2 quad Core Xeon E5530 2.40Ghz Processor, 8MB Cache per processor, 4GB DDR3 1066 RAM std Includes SmartArray P410i/256MB RAID controller, (2) 1GbE dual port NICs, 4 x 146GB HotPlug 2.5 SAS Dual Port Hard Drives (RAID 5 + online spare) - Dual 750W hot plug redundant power supplies
HPiLO advanced server license with 24x7 technical support and updates	9	2nd Processor
Proliant Server DL36x HW Supp	9	
CAD Network Equipment		
Cisco 24 Port Gigabit switch with IP base functionality	2	Stackable layer 2 switch, IP base sw, can utilize redundant power , IP base sw enables many layer 3 functionality
Cisco Redundant power supply for 24 port Lan base	2	Redundant power supply, can be shared between stacked switches or completely redundant
Cisco Redundant power supply cable	2	Sharing power cable
Cisco SmartNet warranty for 3750X switches, 1 yr	6	
Cisco 4 port 1GB interface for 3750x	2	

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Radio Replacement Project

Attachment 1

Items	Qty	Notes
Server Racks - HP 10642 42U		
HP 10642 42U Shock Rack Pallet	2	
HP 1U 10pk Universal Filler Panel	2	
HP Rack 9000/ Rack 10000 Grounding Kit	2	
HP 24A Low Voltage US/JP Modular PDU	4	
HP 10K Graphite Metallic 42U Side Panel	2	
Avocent Autoview 3200 digital KVM over IP	2	2 local users per unit, 1 per rack, 3 total
HP IP KVM Interface adapter	24	
Avocent Console, 17"	2	1 per rack
14' CAT5e cable, patch	60	
CAD/AVL Dispatch Workstation		
Intel® Xeon® W3530 2.80 8MB/1066 QC CPU	58	Total System Consoles. See Equipment List in Attachment #3
Intel® Core™ 2 Duo E8400 3.00 GHz, 6MB Cache, 1333 MHz FSB		Quad Core - 2.80 MHz, 8MB cache, 1066MHz FSB

Radio Replacement Project

Attachment 1

Items	Qty	Notes
Integrated 4-channel SAS 3Gb/s controller with RAID 0, 1, 0+1 capability		
160GB SAS 3Gb/s NCQ (7200 RPM)		
4GB (4x1GB) DDR3-1333 ECC RAM		4GB Total
16X DVD+/-RM SuperMulti Drive		
USB Standard Keyboard		
HP USB optical scroll mouse		
Integrated Intel Audio		
Integrated 10/100/1000 Gigabit PCIe		
nVidia NVS295 256MB PCIe Video Card		
HP 19' LCD Widescreen LCD	116	
Radio Consoles		
Computer, MaestroIP, UNA Dispatch	33	Total System Consoles. See Equipment List in Attachment #3
Monitor, 19in Touch Capable	33	

Radio Replacement Project

Attachment 1

Items	Qty	Notes
Speaker,Semi Rugged	66	
Footswitch,Dual	33	
Microphone,Gooseneck	33	
License,Vocoder	33	
Adapter,6 Wire Jackbox to Headset	33	
Feature,C3 Gateway	33	
Headset,Ear Bud Style	25	
Headset,Over-the-Head Style	25	
Logging Recorder		
Hindsight-Net XPlus/G2" Archival Digital Logging Recorder System with P25 and OpenSky-VNIC Integration	1	
120 Mixed-Ch Recorder w/DVD	1	
Raid 5 Array Hard Drive	1	
P25 Phase II Interface Module	1	
OpenSky-VNIC Interface Module	1	

Radio Replacement Project

Attachment 1

Items	Qty	Notes
Recorder Assistant Playback License (optional)	12	
Recording of AES encrypted voice (optional)	1	
Redundant Logging Recorder (optional)	1	

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
Central Radio Station - Network Switching Center (Backup)		
Server,Network Switch(NSS),Secondary	1	Service,SyBase Software License,NSS
Server,Regional VIDA Manager (RVM)	1	Service,SyBase Sftwr License,RNM/CNM
Printer,Laser,Black/White,NSC	1	
Server,Regional Site Mgr Professional	1	License,Sql 2008 Enterprise Edition
Printer,Color Laser,110V	1	
Server,Transcoder	1	
Router,Cisco,2911,AC,Sec,w/EtherSwitch	1	
EthrSwth,L2,SM,23FE,1 GE,Cisco,SM-ES2-24	1	
Router,Cisco ASR1001,AC Pwr,IP Bs,Adv IP	1	
Switch,Cisco 3560X-48T-S,48 Port	1	
Cisco ASA5510	1	
Unitrends DPU 720	1	

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
Server,Dell R610,Active Directory Server	1	
IDS,SourceFire 3D2500	1	
CiscoWorks	1	
Backup ORBCAD Application Cluster - 2 Servers		
windows large san dl380g7 x 1	2	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk
HP DL380G7 SFF CTO Chassis	2	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	2	
HP E5640 DL380G7 Kit	2	
HP 4GB 2Rx8 PC3-10600E-9 Kit	12	
HP 146GB 10K 6G 2.5 SAS DP HDD	4	
HP Slim 12.7mm SATA DVDRW Optical Kit	2	
HP DL380G6 3 Slot PCI-E Riser Kit	2	
HP 512MB Flash Backed Write Cache	2	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	4	

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Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
HP NC360T PCIe DP Gig Adptr	2	
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	4	
HP 460W HE 12V Hotplg AC Pwr Supply Kit	4	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	2	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	2	
Backup Active SQL Cluster - 2 Servers		
windows large san dl380g7 x 1	2	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk
HP DL380G7 SFF CTO Chassis	2	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	2	
HP E5640 DL380G7 Kit	2	
HP 4GB 2Rx8 PC3-10600E-9 Kit	12	
HP 146GB 10K 6G 2.5 SAS DP HDD	4	
HP Slim 12.7mm SATA DVDRW Optical Kit	2	

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
HP DL380G6 3 Slot PCI-E Riser Kit	2	
HP 512MB Flash Backed Write Cache	2	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	4	
HP NC360T PCIe DP Gig Adptr	2	
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	4	
HP 460W HE 12V Hotplg AC Pwr Supply Kit	4	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	2	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	2	
Backup LTDB SQL Cluster - 2 Servers		
windows large san dl380g7 x 1	2	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk
HP DL380G7 SFF CTO Chassis	2	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	2	
HP E5640 DL380G7 Kit	2	

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
HP 4GB 2Rx8 PC3-10600E-9 Kit	12	
HP 146GB 10K 6G 2.5 SAS DP HDD	4	
HP Slim 12.7mm SATA DVDRW Optical Kit	2	
HP DL380G6 3 Slot PCI-E Riser Kit	2	
HP 512MB Flash Backed Write Cache	2	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	4	
HP NC360T PCIe DP Gig Adptr	2	
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	4	
HP 460W HE 12V Hotplg AC Pwr Supply Kit	4	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	2	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	2	
Backup SAN		
HP P2000 G3 MSA FC Dual Cntrl SFF Array	1	HP P2000 G3 8GB dual controller SAN array
HP 146GB 6G SAS 10K 2.5in DP ENT HDD	20	2.8TB Raw Space

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
Factory integrated	20	
HP Installation and Startup Service	1	
HP MSA Install SVC	1	
HP 5m Multi-mode OM2 LC/LC FC Cable	2	
HP P2000 Snapshot 512 Software E-LTU	1	
HP P2000 Remote Snap Software E-LTU	1	
HP 16A High Voltage Modular PDU	2	
HP 8/24 Base 16-ports Enabled SAN Switch	2	Redundant 8GB switch, 16 ports activated
U.S. - English localization	1	
HP 3y Support Plus 24 SVC	1	
MSA2000 G3 support	1	
P2000 Snapshot 512 SW LTU SW Support	1	
P2000 Remote Snap SW LTU SW Support	1	
HP B-Series 8/8 and 8/24 Switch Support	1	

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
HP 3.6m C19 Nema L6-20P NA/JP Pwr Crd	2	
HP Installation Service	1	
ProLiant Add On Options Installation SVC	4	
LowEnd SAN/Edge Switch/HAFM Installation	1	
HP MSA2000 SW Installation	2	
HP 15m Multi-mode OM3 LC/LC FC Cable	16	
HP 8Gb Shortwave B-series FC SFP+ 1 Pack	16	
Backup Reports Server		
windows large san dl380g7 x 1	1	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk
HP DL380G7 SFF CTO Chassis	1	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	1	
HP E5640 DL380G7 Kit	1	
HP 4GB 2Rx8 PC3-10600E-9 Kit	6	
HP 146GB 10K 6G 2.5 SAS DP HDD	2	

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
HP Slim 12.7mm SATA DVDRW Optical Kit	1	
HP DL380G6 3 Slot PCI-E Riser Kit	1	
HP 512MB Flash Backed Write Cache	1	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	2	
HP NC360T PCIe DP Gig Adptr	1	
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	2	
HP 460W HE 12V Hotplg AC Pwr Supply Kit	2	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	1	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	1	
Backup DCC Server - 2 Servers		
HP DL360G7 E5640 1P Performance US Svr	2	4 Core Xeon E5640 2.66Ghz Processor, 12MB Cache per processor, 6GB DDR3 RAM std Includes SmartArray P410i/256MB RADI controller, (2) 1GbE dual port NICS
HP E5640 DL360 G7 Processor	2	2nd Processor

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	6	RAID1 + online spare
HP DL360 12.7mm SATA DVD-RW Kit	2	SATA DVD-RW Kit
Proliant Server DL36x HW Supp	2	
Backup GTRMD Server - 2 Servers		
HP DL360G7 E5640 1P Performance US Svr	2	4 Core Xeon E5640 2.66Ghz Processor, 12MB Cache per processor, 6GB DDR3 RAM std Includes SmartArray P410i/256MB RADI controller, (2) 1GbE dual port NICS
HP E5640 DL360 G7 Processor	2	2nd Processor
HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	6	RAID1 + online spare
HP DL360 12.7mm SATA DVD-RW Kit	2	SATA DVD-RW Kit
Proliant Server DL36x HW Supp	2	
Backup Domain Controller Servers - 2 Servers		
HP DL360G7 E5640 1P Performance US Svr	2	4 Core Xeon E5640 2.66Ghz Processor, 12MB Cache per processor, 6GB DDR3 RAM stdIncludes SmartArray P410i/256MB RADI controller, (2) 1GbE dual port NICS

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
HP E5640 DL360 G7 Processor	2	2nd Processor
HP 72GB 15K 6G SAS 2.5 Hot Plug Hard Drive	6	RAID1 + online spare
HP DL360 12.7mm SATA DVD-RW Kit	2	SATA DVD-RW Kit
Proliant Server DL36x HW Supp	2	
Backup MDC (Citrix) Server Farm - 4 Servers		
HP DL380 G7 X5670 Perf US Svr	4	2 way 6 core X5670 Xeon 2.93GHZ, 12MB L3 Cache per processor, 12GB DDR3 RAM std Includes SmartArray P410i/1GB FBWC RAID controller, (2) 1GbE dual port NICS
HP 2GB 2Rx8 PC3-10600R-9 Kit	12	Add'l 6GB for 18GB total
HP 146GB 6G SAS 15K 2.5in DP ENT HDD	16	RAID 5
HP 82E 8Gb Dual-port PCI-e FC HBA	4	Dual port 8GB Fiber HBA
HP NC360T PCIe Dp Gigabit Server Adapter	4	Add'l Cluster NIC - dual port
HP iLO Adv 1-Svr incl 1yr TS&U SW	4	ILO standard
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	4	

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
HP 3y 24x7 SW Support	4	
HP iLO AdvPack NonBL SW Support	4	
Backup SmartTraveler Server - Signs (Option)		
windows large san dl380g7 x 1	1	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk
HP DL380G7 SFF CTO Chassis	1	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	1	
HP E5640 DL380G7 Kit	1	
HP 4GB 2Rx8 PC3-10600E-9 Kit	6	
HP 146GB 10K 6G 2.5 SAS DP HDD	2	
HP Slim 12.7mm SATA DVDRW Optical Kit	1	
HP DL380G6 3 Slot PCI-E Riser Kit	1	
HP 512MB Flash Backed Write Cache	1	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	2	
HP NC360T PCIe DP Gig Adptr	1	

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	2	
HP 460W HE 12V Hotplg AC Pwr Supply Kit	2	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	1	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	1	
Backup SmartTraveler Server - Web (Option)		
windows large san dl380g7 x 1	1	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk
HP DL380G7 SFF CTO Chassis	1	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	1	
HP E5640 DL380G7 Kit	1	
HP 4GB 2Rx8 PC3-10600E-9 Kit	6	
HP 146GB 10K 6G 2.5 SAS DP HDD	2	
HP Slim 12.7mm SATA DVDRW Optical Kit	1	
HP DL380G6 3 Slot PCI-E Riser Kit	1	

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
HP 512MB Flash Backed Write Cache	1	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	2	
HP NC360T PCIe DP Gig Adptr	1	
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	2	
HP 460W HE 12V Hotplg AC Pwr Supply Kit	2	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	1	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	1	
Backup SmartTraveler Server - SMS (Option)		
windows large san dl380g7 x 1	1	HP DL380 - 2 x Quad core procs, 24 GB memory, 2 x 146GB disk
HP DL380G7 SFF CTO Chassis	1	2 x OS disk mirrored.
HP E5640 DL380G7 FIO Kit	1	
HP E5640 DL380G7 Kit	1	
HP 4GB 2Rx8 PC3-10600E-9 Kit	6	

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
HP 146GB 10K 6G 2.5 SAS DP HDD	2	
HP Slim 12.7mm SATA DVDRW Optical Kit	1	
HP DL380G6 3 Slot PCI-E Riser Kit	1	
HP 512MB Flash Backed Write Cache	1	
HP - Power cable - IEC 320 EN 60320 C13 - NEMA 5-15	2	
HP NC360T PCIe DP Gig Adptr	1	
HP StorageWorks FC2142SR - Network adapter - PCI Express - 4Gb Fibre Channel	2	
HP 460W HE 12V Hotplg AC Pwr Supply Kit	2	
HP Insight Ctl ML/DL Bdl E-LTU 24x7 SW	1	
Proliant ServerDL38x HWSupport, 3Y 24x7, 4 hr onsite	1	
Backup CAD Network Equipment		
Cisco 24 Port Gigabit switch with IP base functionality	2	Stackable layer 2 switch, IP base sw, can utilize redundant power , IP base sw enables many layer 3 functionality

Radio Replacement Project

Attachment 1

Network Switching Center (Backup)	Qty	Notes
Cisco Redundant power supply for 24 port Lan base	2	Redundant power supply, can be shared between stacked switches or completely redundant
Cisco Redundant power supply cable	2	Sharing power cable
Cisco SmartNet warranty for 3750X switches, 1 yr	6	
Cisco 4 port 1GB interface for 3750x	2	
Server Racks - HP 10642 42U		
HP 10642 42U Shock Rack Pallet	2	
HP 1U 10pk Universal Filler Panel	2	
HP Rack 9000/ Rack 10000 Grounding Kit	2	
HP 24A Low Voltage US/JP Modular PDU	4	
HP 10K Graphite Metallic 42U Side Panel	2	
Avocent Autoview 3200 digital KVM over IP	2	
HP IP KVM Interface adapter	24	
Avocent Console, 17"	2	1 per rack
14' CAT5e cable, patch	60	

Radio Replacement Project

Attachment 1

<u>Part # (Alcatel)</u>	<u>Racks and Accessories</u>	<u>Qty</u>	<u>Notes</u>
Microwave Equipment List (CRS to 1455 Market Street)			
Microwave Equipment List			
694-9000-006	Standard Rack, 7' tall, 19" wide	2	
3EM13317AA	Power Distribution Panel	2	
3EM22715AC	9500 MPR Shelf Kit w/Alarm FAN	2	
3DB18163AB	MSS Slot Cover - Blank Plate 1/2H	8	
3EM24105AA	Fan Alarm Cable - 25 foot	2	
3DB18326AC	Core Enhanced Module w 6 GbE ports (CORE-E) - TH/Clei	4	
3DB18634AB	MPT-Access with PoE	4	
3DB20371BA	MPT-HC 11GHz 10695-10955	2	
3DB20547BA	MPT-HC 11GHz 11205-11485	2	
3DB20117BA	MPT-HC RPS Module	2	
3CC14140AB	11GHz 10dB coupler	2	

Radio Replacement Project

Attachment 1

Part # (Alcatel)	Racks and Accessories	Qty	Notes
3CC52191AA	Light Service alignment kit with LEMO connector	2	
1AC016760006	Cat5e cable - GLP is per foot	1200	Items for SFMTA to purchase as part of the C3
1AD040130004	Ground kit – (qty 3 per run, based on length)	6	
1AB074610027	RJ-45 connector for indoor and outdoor ends of cat5e	20	Items for SFMTA to purchase as part of the C3
1AB150990002	R2CT connector protection for RJ45 outdoor	4	Items for SFMTA to purchase as part of the C3
1AD160490001	Tool HIROSE RJ45 IDU-ODU cable assembling	1	Items for SFMTA to purchase as part of the C3
3CC52169AA	RPS LC-LC optical jumper preassembled L=1m	2	
3EM23085AHAA	9500 MPR R3.01.00 SW License/CD	2	
3EM23086AHAA	9500 MPR R3.01.00 Flash Card (1 per CORE)	4	
3EM23067AAAA	9500 MPR CT License (Per PC Installed)	2	
3EM24226AA	Microwave Factory Test Certificate	2	
3EM23068ADAA	RTU 160Mbps TRX Capacity	4	
3EM23951AFAA	9500 MPR 3.01 O&M Manual CD-ROM	2	
1AB383760001	Optical SFP (Finisar, 850 MM) for use in ODU - MPT-HC	4	

Radio Replacement Project

Attachment 1

Part # (Alcatel)	<u>Racks and Accessories</u>	Qty	Notes
	ODU Cable Supplies	1	
1AB123320022	MM Optical Splitter/Combiner	2	
3EM07641AE	Fiber Optic Jumper Cable, LC to LC, 10 meter, multi mode	6	
3EM20277AA	Optics SFP GigE 850 NM Multimode 50 Meter	4	
3HE00027AA	SFP - GIGE SX SFP OPT MOD - LC	2	
1AF14495AB	4FT full integrated antenna 11GHz (SB4-107BAWY)	2	
-	<u>DC Power</u>		
1AF19622ABAA	uSageon, 25A, 70AH, 19in RR, 10 Year Front Access	2	

Radio Replacement Project

Attachment 1

Item Description	Qty	Notes
System Software Licenses		
Primary System Software		
Microsoft Windows Server 2008 Enterprise R2, 64 bit	6	Each Node of clusters (OrbCAD, SQL, LTDB SQL),
Microsoft Windows Server 2008 Client Access License	20	Total CALs for entire system
Microsoft Windows Server 2008 Standard R2	19	Citrix Servers(4), REPORTS,(2), DCC(2), Domain Controller (2), DIS,(9)
Microsoft SQL STD 2008 Processor license	4	One for each processor, shared per SQL cluster, unlimited clients
Crystal Reports Server 2008, 10 CALs	4	??? Users
Crystal Reports Server Developer Advantage	4	Developer engine
Citrix Presentation server w Subscription Advantage	32	For up to 32 Concurrent users
Microsoft Terminal Server Cals	32	For up to 32 Concurrent users
ArcView	102	58 OrbCAD local + 44 variant 4 (reduced function CAD only)
Service,SyBase Software License,NSS	1	

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Radio Replacement Project

Attachment 1

Item Description	Qty	Notes
Service,SyBase Sftwr License,RNM/CNM	1	
License,Sql 2008 Enterprise Edition	1	
Backup System Software		
Microsoft Windows Server 2008 Enterprise R2, 64 bit	6	Each Node of clusters (OrbCAD, SQL, LTDB SQL),
Microsoft Windows Server 2008 Client Access License	20	Total CALs for entire system
Microsoft Windows Server 2008 Standard R2	14	DCC(2), Domain Controller (2),SmartTraveler(2) Citrix Servers(4), REPORTS,(2),SmartTraveler Web (2),
Microsoft SQL 2008 Processor license	5	One for each processor, shared per SQL cluster, SmartTraveler DB, unlimited clients
Crystal Reports Server 2008, 10 CALs	3	
Crystal Reports Server Developer Advantage	3	Developer engine
Citrix Presentation server w Subscription Advantage	32	For up to 32 Concurrent data only users
Microsoft Terminal Server Cals	32	For up to 32 Concurrent data only users

Radio Replacement Project

Attachment 1

Item Description	Qty	Notes
EMC Recover Point/CE	6	EMC Remote Cluster enable appliances and software for 3 clusters
Service,SyBase Software License,NSS	1	
Service,SyBase Sftwr License,RNM/CNM	1	
License,Sql 2008 Enterprise Edition	1	
Miscellaneous SW		
Primavera Web Access software	2	Licenses are available for SFMTA's exclusive possession and use and are provided for the duration of the program.

Radio Replacement Project

Attachment 1

Frequency Plan

Channel	OWNER	TX FREQ	RX FREQ	One Market Plaza	Forest Hill	Central Radio Station	South Hill	Bernal Heights
700 MHz P25 System								
1	PERS	769.3563	799.3563	ü	ü	ü	ü	ü
2	SFMTA	769.6063	799.6063	ü	ü	ü	ü	ü
3	SFMTA	771.3688	801.3688	ü	ü	ü	ü	ü
4	PERS	771.5313	801.5313	ü	ü	ü	ü	ü
5	SFMTA	771.6688	801.6688	ü	ü	ü	ü	ü
6	PERS	771.8313	801.8313	ü	ü	ü	ü	ü
7	PERS	771.9688	801.9688	ü	ü	ü	ü	ü
8	SFMTA	772.1313	802.1313	ü	ü	ü	ü	ü
9	PERS	772.2688	802.2688	ü	ü	ü	ü	ü
10	SFMTA	772.4313	802.4313	ü	ü	ü	ü	ü
11	PERS	772.5688	802.5688	ü	ü	ü	ü	ü

Radio Replacement Project

Attachment 1

Channel	OWNER	TX FREQ	RX FREQ	One Market Plaza	Forest Hill	Central Radio Station	South Hill	Bernal Heights
12	SFMTA	772.7313	802.7313	ü	ü	ü	ü	ü
13	PERS	772.8688	802.8688	ü	ü	ü	ü	ü
14	SFMTA	773.1313	803.1313	ü	ü	ü	ü	ü
15	SFMTA	773.4188	803.4188	ü	ü	ü	ü	ü
16	PERS	773.9563	803.9563	ü	ü	ü	ü	ü
17	SFMTA	774.6438	804.6438	ü	ü	ü	ü	ü
800 MHz OpenSky System								
18	SFMTA	854.1125	809.1125			ü		
19	SFMTA	854.2375	809.2375	ü				
20	SFMTA	854.3125	809.3125				ü	
21	SFMTA	854.3875	809.3875	ü				
22	SFMTA	854.4625	809.4625			ü		
23	SFMTA	855.2375	810.2375					ü

Radio Replacement Project

Attachment 1

Building	Room	IE-3000 Router	IE-3000	Clock	CAD/AVL Data Interface Station	4.9 GHz Base	4.9 GHz Power	4.9 GHz Client
Maintenance Yard Equipment								
Woods								
Vehicle Maintenance Building	Entry Facility (2nd Level)	1						
Vehicle Maintenance Building	Rooftop							
Operation and Tire Repair	Operators Area			1				
Operation and Tire Repair	Dispatch Office				1			
Operation and Tire Repair	Telco Room		1				2	
Operation and Tire Repair	Rooftop					2		
Meet and Greet	Pole Mount		1				1	1
Presidio								
Presidio Facility	Telco Entry Facility (Room 203)	1						

Radio Replacement Project

Attachment 1

Building	Room	IE-3000 Router	IE-3000	Clock	CAD/AVL Data Interface Station	4.9 GHz Base	4.9 GHz Power	4.9 GHz Client
Presidio Facility	Meet and Greet		1					
Presidio Facility	Operators Area			1				
Presidio Facility	Dispatch Office				1			
Presidio Facility	Rooftop					1	1	
MME								
MME Facility	Entry Facility (Room 226)	1					2	
MME Facility	Telco Room 265		1					
MME Facility	Operators Area			1				
MME Facility	Dispatch Area (Room 281)				1			
MME Facility	Telco Room 182							
MME Facility	Telco Room 108							
MME Facility	Telco Room 138							

Confidential Unless Contract Awarded

Radio Replacement Project

Attachment 1

Building	Room	IE-3000 Router	IE-3000	Clock	CAD/AVL Data Interface Station	4.9 GHz Base	4.9 GHz Power	4.9 GHz Client
MME Facility	Meet and Greet		1					
MME Facility	Rooftop & Mezzanine					3	1	
Green								
Green Repair Shop	Telco Entry Facility							
Green Repair Shop	Rooftop							
Green Annex Building	Telco Entry Facility	1					1	
Green Annex Building	Operators Area			1				
Green Annex Building	Dispatch Office				1			
Green Annex Building	Meet and Greet		1					
Green Annex Building	Rooftop					1		
Geneva								
Geneva Car House	Telco Entry Facility	1					1	

Confidential Unless Contract Awarded

Radio Replacement Project

Attachment 1

Building	Room	IE-3000 Router	IE-3000	Clock	CAD/AVL Data Interface Station	4.9 GHz Base	4.9 GHz Power	4.9 GHz Client
Geneva Car House	Dispatch Office							
Geneva Car House	Meet and Greet		1					
Geneva Car House	Rooftop					1		
Potrero								
Potrero Facility	Telco Entry Facility	1					1	
Potrero Facility	Operators Area			1				
Potrero Facility	Dispatch Office				1			
Potrero Facility	Meet and Greet		1					
Potrero Facility	Yard Lighting and Panel Room							
Potrero Facility	Rooftop					1		
Scott								
Scotts Facility	Telco Entry Facility	1					1	

Confidential Unless Contract Awarded

Radio Replacement Project

Attachment 1

Building	Room	IE-3000 Router	IE-3000	Clock	CAD/AVL Data Interface Station	4.9 GHz Base	4.9 GHz Power	4.9 GHz Client
Scotts Facility	Rooftop					1		
Cable Car Facility	Telco Entry Facility	1						
Cable Car Facility	Operators Area			1				
Cable Car Facility	Dispatch Office				1			
Flynn								
Flynn Facility	Telco Entry Facility							
Flynn Facility	Equipment Room 138	1					2	
Flynn Facility	Dispatch Office Room 101				1			
Flynn Facility	Operators Area			1				
Flynn Facility	Rooftop					2		
Islais								
Islais	Telco Entry Facility	1	1				1	

Confidential Unless Contract Awarded

Radio Replacement Project

Attachment 1

Building	Room	IE-3000 Router	IE-3000	Clock	CAD/AVL Data Interface Station	4.9 GHz Base	4.9 GHz Power	4.9 GHz Client
Islais	Operators Area			1				
Islais	Meet and Greet				1			
Islais	Rooftop					1		
Kirkland								
Kirkland Facility	Telco Entry Facility	1	1				1	
Kirkland Facility	Operators Area			1				
Kirkland Facility	Meet and Greet				1			
Kirkland Facility	Rooftop					1		

Radio Replacement Project

Attachment 1

Location	Radio Consoles	CAD/AVL Consoles	CAD/AVL Web	Telephone Recording	Networked Clock	Control Stations	Antennas	Harris ^{1,2}	Harris /SFMTA ^{3,5}
LMR and CAD/AVL Dispatch Consoles⁴						Control Stations	Equipment Installation by:		
1455 Market Street									
Rubber Tire Dispatch and Train Control	11	11		11		5	2	ü	
Theater Supervisor	1	1		1				ü	
Superintendent	1	1		1				ü	
Senior Ops. Manager		1						ü	
Cable Car									
Machinery	1	1		1				ü	
Operations	1	1		1	1	1	1	ü	
Stations and Wayside Booths									
Station Agents			15						ü

Radio Replacement Project

Attachment 1

Location	Radio Consoles	CAD/AVL Consoles	CAD/AVL Web	Telephone Recording	Networked Clock	Control Stations	Antennas	Harris ^{1,2}	Harris /SFMTA ^{3,5}
Station Ops and Wayside Booths			5						ü
Divisions									
Woods	2	4		2	1	1	1	ü	
Presidio	2	4		2	1	1	1	ü	
MME	2	4		2	1	1	1	ü	
Green and Carhouse	3	6		3	1	1	1	ü	
Potrero	2	4		2	1	1	1	ü	
Flynn	1	2		1	1	1	1	ü	
Priced Option: Kirkland	1	2		1	1	1	1	ü	
Priced Option: Islais Creek	1	2		1	1	1	1	ü	
Other Agencies and Locations									
Priced Option: Lenox Way Backup Dispatch	8	8		8				ü	

Radio Replacement Project

Attachment 1

Location	Radio Consoles	CAD/AVL Consoles	CAD/AVL Web	Telephone Recording	Networked Clock	Control Stations	Antennas	Harris ^{1,2}	Harris /SFMTA ^{3,5}
Outside Agency (Emerg. Resp.)			1						ü
SFMTA Mgmt. & Others			10						ü
Customer Service (311)			10						ü
DPT Dispatch			2						ü
Security/PoP Dispatch	2	2		2				ü	
Motive Power			1			1	1		ü
Command Coach 9030	1	1						ü	
SFMTA Radio Shop	1	1				1	1	ü	
Supervisor Notebooks			20						ü
Training	1	2	1	1		1	1	ü	ü
Development Environment	1	1	1					ü	ü
<i>Base Proposal Totals (Does not include priced options)</i>	33	47	66	30	7	15	12		

Radio Replacement Project

Attachment 1

Location	Radio Consoles	CAD/AVL Consoles	CAD/AVL Web	Telephone Recording	Networked Clock	Control Stations	Antennas	Harris ^{1,2}	Harris /SFMTA ^{3,5}
<p>Notes:</p> <p>1. Harris is providing routers and switches for all locations listed as having equipment installation by Harris.</p> <p>2. Harris assumes network connectivity is available at all locations listed above.</p> <p>3. Harris is providing and installing CAD/AVL Citrix Server(s) to support the CAD/AVL Web clients. Harris is also providing the Citrix clients and SFMTA is installing them on the client PCs.</p> <p>4. Quantities are from Appendix 14 from Addendum 14 and drawings in Appendix 9.</p>									
<p>1. Harris is providing routers and switches for all locations listed as having equipment installation by Harris.</p>									
<p>2. Harris assumes network connectivity is available at all locations listed above.</p>									
<p>3. Harris is providing and installation CAD/AVL Citrix Server(s) to support the CAD/AVL Web Clients. Harris is also providing the Citrix clients and SFMTA is installing them on the client PC's.</p>									
<p>4. Quantities are from Appendix 14 from Addendum 14 and drawings in Appendix 9.</p>									
<p>5. Supervisors Notebooks - SFMTA will provide the notebooks unless SFMTA exercises the MDT laptop option.</p>									

Radio Replacement Project

Attachment 1

Radios Types	PSVRN 700 MHz Portables	PSVRN 700 MHz Mobiles	MTMS 800 MHz Mobiles	Portable Chargers
SFMTA Radios per Frequency Band				
<i>Non-Revenue Portables</i>				
Tier 1	525			
Tier 2	30			
Tier 3	20			
<i>Sub-Total</i>	<i>575</i>			
Non-Revenue Vehicles with Portable Chargers				
Configuration A		100		100
Configuration B ¹			90	90
Configuration C ²			50	50
<i>Sub-Total</i>		<i>100</i>	<i>140</i>	<i>240</i>
Revenue Vehicles with Portable Chargers				

Radio Replacement Project

Attachment 1

Radios Types	PSVRN 700 MHz Portables	PSVRN 700 MHz Mobiles	MTMS 800 MHz Mobiles	Portable Chargers
Double-Ended Historics ³			10	20
Single-Ended Historics ⁴			64	64
Breda Light Rail ³			160	320
<i>Sub-Total</i>			<i>234</i>	<i>404</i>
Revenue Vehicles without Portable Chargers				
Rubber-tired vehicles ⁵			995	
<i>Sub-Total</i>			<i>995</i>	
<i>Totals</i>	<i>575</i>	<i>100</i>	<i>1369</i>	<i>644</i>
<p>¹ Configuration B has a portable charger and a 800 MHz mobile radio with GPS for AVL traffic and closed channel voice on the MTMS system.</p> <p>² Configuration C has a portable radio charger 800 MHz mobile radio for all MDT data and closed voice traffic including AVL updates on the MTMS system.</p> <p>³ Double-ended vehicle quantities from Addendum 11, Appendix 28, Revenue Vehicles, Items 19, Breda double-ended LRVs, and 22, double-ended PCC style.</p>				

Radio Replacement Project

Attachment 1

Radios Types	PSVRN 700 MHz Portables	PSVRN 700 MHz Mobiles	<i>MTMS 800 MHz</i> Mobiles	Portable Chargers
<p>⁴ Single-ended historic quantities from Addendum 11, Appendix 28, Revenue Vehicles, Items 21 and 23-26.</p> <p>⁵ Revenue vehicles quantities without portable chargers come from Addendum 11, Appendix 28, Revenue Vehicles items 9-18.</p>				

Radio Replacement Project

Attachment 1

Vehicle Components - Qty per Vehicle	Std Fixed Route bus	Fixed route bus - 60'	Light Rail Vehicle - dual end	Electric Trolley	Electric Trolley - 60'	Historic street car	Cable Car	Non-Rev - voice only-A	Non-Rev - AVL & Voice-B	Non-Rev - Voice and Data -C	Mobile Dispatch Computers (Option)
Vehicle Equipment											
Quantity-->	440	160	160	275	120	74	50	100	90	50	30
Components to Install						(some dual end)					
portable radio mounting/charger, w/ antenna			2					1	1	1	
mobile radio, w/ antenna	1	1	1	1	1	1		1 (P25)	1	1	
mobile radio control head						2*			1		
Wireless Bulk Data Transfer Radio, with antenna	1	1	1	1	1					1	
Vehicular Access Network/Mobile Router	1	1	1	1	1						

Radio Replacement Project

Attachment 1

Vehicle Components - Qty per Vehicle	Std Fixed Route bus	Fixed route bus - 60'	Light Rail Vehicle - dual end	Electric Trolley	Electric Trolley - 60'	Historic street car	Cable Car	Non-Rev - voice only-A	Non-Rev - AVL & Voice-B	Non-Rev - Voice and Data -C	Mobile Dispatch Computers (Option)
Vehicle Logic Unit - IVU3100/2100	1	1	1	1	1					1(2100)	
Mobile Data Terminal - driver display - OrbStar	1	1	2	1	1					1	
GPS antenna	1	1	1	1	1	1			1	1	
Radio Handset - phone handset	1	1	2	1	1						
Emergency Activation switch	1	1	2	1	1						
AVA system - PA amp, AVA Card, Microphone, cabling to existing AVA signs	1	1		1	1						
Cell modem with GPS with Antenna(s)							1				1
Radio Tray	1	1	1	1	1					1	
Wiring/Cabling	1	1	1	1	1	1	1	1	1	1	

Radio Replacement Project

Attachment 1

Vehicle Components - Qty per Vehicle	Std Fixed Route bus	Fixed route bus - 60'	Light Rail Vehicle - dual end	Electric Trolley	Electric Trolley - 60'	Historic street car	Cable Car	Non-Rev - voice only-A	Non-Rev - AVL & Voice-B	Non-Rev - Voice and Data -C	Mobile Dispatch Computers (Option)
Power Filter	1	1	1	1	1	1			1	1	
Power Converter							1				
Conduit for Articulated section		1	1		1						
DVAS replacement - Replacement CCP, AVA Card, PA Amp, Audio Switch, 2 Phones, Cabling, and 640 signs/brackets.			1								
Interface Cabling to existing Equipment:											
Headsign, run signs	1	1	1	1	1						
Vehicle discrete, Odometer, Chair lift	1	1		1	1						
Cubic farebox	1	1	1	1	1						
Options											
APC interface - J1708 cable	1	1	1	1	1						

Radio Replacement Project

Attachment 1

Vehicle Components - Qty per Vehicle	Std Fixed Route bus	Fixed route bus - 60'	Light Rail Vehicle - dual end	Electric Trolley	Electric Trolley - 60'	Historic street car	Cable Car	Non-Rev - voice only-A	Non-Rev - AVL & Voice-B	Non-Rev - Voice and Data -C	Mobile Dispatch Computers (Option)
Vehicle Health Monitoring intf - J1708 install	1	1		1	1						
Laptop Computer											1
Traffic Signal Emitter Installed, w/ cable (Total Qty 20)	1	1		1	1						

Radio Replacement Project

Attachment 1

Tunnel Equipment

Site	Site Type	Equipment Type	Equipment Details	Location
MARKET STREET TUNNEL:				
Embarcadero	Rail Station, Portal	Headend, Antennas	Headend consisting of: 700MHz Directional Donor Antenna and Mounting Kit (Qty 1) 800MHz Directional Donor Antenna and Mounting Kit (Qty 1) Antenna Grounding Kits (Qty 2) Feeder Cables (Qty 2) 700MHz Channelized 10-Channel BDA (Qty 1) 700MHz Channelized 20-Channel BDA (Qty 1) 800MHz Channelized 10-Channel BDA (Qty 1) 700/800MHz Cross-band Coupler (Qty 1) 700 MHz Combiner / Coupler (Qty 1)	HE - Station Telecom Room
Embarcadero	Rail Station	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room
Embarcadero	Rail Station	Distributed Antenna System	Distributed Antenna System consisting of Omni-directional Antennas, Coaxial Cable, Splitters, Connectors, etc.	Station / Mezzanine Area
Montgomery	Rail Station	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room

Radio Replacement Project

Attachment 1

Site	Site Type	Equipment Type	Equipment Details	Location
Montgomery	Rail Station	Distributed Antenna System	Distributed Antenna System consisting of Omni-directional Antennas, Coaxial Cable, Splitters, Connectors, etc.	Station / Mezzanine Area
Powell	Rail Station	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room
Powell	Rail Station	Distributed Antenna System	Distributed Antenna System consisting of Omni-directional Antennas, Coaxial Cable, Splitters, Connectors, etc.	Station / Mezzanine Area
Civic Center	Rail Station	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room
Civic Center	Rail Station	Distributed Antenna System	Distributed Antenna System consisting of Omni-directional Antennas, Coaxial Cable, Splitters, Connectors, etc.	Station / Mezzanine Area
Van Ness	Rail Station	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room
Van Ness	Rail Station	Distributed Antenna System	Distributed Antenna System consisting of Omni-directional Antennas, Coaxial Cable, Splitters, Connectors, etc.	Station / Mezzanine Area
In Tunnel location between Van Ness and Church Stations	Rail Station	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room

Radio Replacement Project

Attachment 1

Site	Site Type	Equipment Type	Equipment Details	Location
Church	Rail Station	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room
Church	Rail Station	Distributed Antenna System	Distributed Antenna System consisting of Omni-directional Antennas, Coaxial Cable, Splitters, Connectors, etc.	Station / Mezzanine Area
Castro	Rail Station	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room
Castro	Rail Station	Distributed Antenna System	Distributed Antenna System consisting of Omni-directional Antennas, Coaxial Cable, Splitters, Connectors, etc.	Station / Mezzanine Area
Eureka	Rail Station	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room
Eureka	Rail Station	Distributed Antenna System	Distributed Antenna System consisting of Omni-directional Antennas, Coaxial Cable, Splitters, Connectors, etc.	Station / Mezzanine Area
In Tunnel location between Eureka and Forest Hill Stations	Rail Station	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room
Forest Hill	Rail Station	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room

Radio Replacement Project

Attachment 1

Site	Site Type	Equipment Type	Equipment Details	Location
Forest Hill	Rail Station	Distributed Antenna System	Distributed Antenna System consisting of Omni-directional Antennas, Coaxial Cable, Splitters, Connectors, etc.	Station / Mezzanine Area
West Portal	Rail Station, Portal	Headend	Headend consisting of: 700MHz Directional Donor Antenna and Mounting Kit (Qty 1) 800MHz Directional Donor Antenna and Mounting Kit (Qty 1) Antenna Grounding Kits (Qty 2) Feeder Cables (Qty 2) 700MHz Channelized 10-Channel BDA (Qty 1) 700MHz Channelized 20-Channel BDA (Qty 1) 800MHz Channelized 10-Channel BDA (Qty 1) 700/800MHz Cross-band Coupler (Qty 1) 700 MHz Combiner / Coupler (Qty 1)	HE - Station Telecom Room
West Portal	Rail Portal	Remote Node	Qty 2 Dual-Band 700/800MHz WDM Remote Repeater Units (RRU) for complete redundancy	Station Telecom Room
West Portal	Rail Station	Distributed Antenna System	Distributed Antenna System consisting of Omni-directional Antennas, Coaxial Cable, Splitters, Connectors, etc.	Station / Mezzanine Area

Radio Replacement Project

Attachment 1

Site	Site Type	Equipment Type	Equipment Details	Location
SUNSET TUNNEL:				
East Portal	Rail Portal	Headend, Antennas	Headend consisting of: 700MHz Directional Donor Antenna and Mounting Kit (Qty 1) 800MHz Directional Donor Antenna and Mounting Kit (Qty 1) Antenna Grounding Kits (Qty 2) Feeder Cables (Qty 2) 700MHz Channelized 10-Channel BDA (Qty 1) 700MHz Channelized 20-Channel BDA (Qty 1) 800MHz Channelized 10-Channel BDA (Qty 1) 700/800MHz Cross-band Coupler (Qty 1) 700 MHz Combiner / Coupler (Qty 1)	HE - Station Telecom Room

Radio Replacement Project

Attachment 1

Site	Site Type	Equipment Type	Equipment Details	Location
Carl Street Substation	Rail Portal	Headend, Antennas	Headend consisting of: 700MHz Directional Donor Antenna and Mounting Kit (Qty 1) 800MHz Directional Donor Antenna and Mounting Kit (Qty 1) Antenna Grounding Kits (Qty 2) Feeder Cables (Qty 2) 700MHz Channelized 10-Channel BDA (Qty 1) 700MHz Channelized 20-Channel BDA (Qty 1) 800MHz Channelized 10-Channel BDA (Qty 1) 700/800MHz Cross-band Coupler (Qty 1) 700 MHz Combiner / Coupler (Qty 1)	HE - Station Telecom Room
CAR TUNNELS (OPTIONAL):				

Radio Replacement Project

Attachment 1

Site	Site Type	Equipment Type	Equipment Details	Location
Yerba Buena (Option)	Car Portal	2 Headends, Dual Antennas	Dual Headends at each end of tunnel, consisting of: 700MHz Directional Donor Antenna and Mounting Kit (Qty 2) 800MHz Directional Donor Antenna and Mounting Kit (Qty 2) Antenna Grounding Kits (Qty 4) Feeder Cables (Qty 4) 700MHz Channelized 10-Channel BDA (Qty 2) 700MHz Channelized 20-Channel BDA (Qty 2) 800MHz Channelized 10-Channel BDA (Qty 2) 700/800MHz Cross-band Coupler (Qty 2) 700 MHz Combiner / Coupler (Qty 2) In-tunnel Directional Re-broadcast Antennas	HE - Wall in each portal area

Radio Replacement Project

Attachment 1

Site	Site Type	Equipment Type	Equipment Details	Location
Broadway (Option)	Car Portal	2 Headends, Dual Antennas	Dual Headends at each end of tunnel, consisting of: 700MHz Directional Donor Antenna and Mounting Kit (Qty 2) 800MHz Directional Donor Antenna and Mounting Kit (Qty 2) Antenna Grounding Kits (Qty 4) Feeder Cables (Qty 4) 700MHz Channelized 10-Channel BDA (Qty 2) 700MHz Channelized 20-Channel BDA (Qty 2) 800MHz Channelized 10-Channel BDA (Qty 2) 700/800MHz Cross-band Coupler (Qty 2) 700 MHz Combiner / Coupler (Qty 2) In-tunnel Directional Re-broadcast Antennas	HE - Wall in each portal area

Radio Replacement Project

Attachment 1

Site	Site Type	Equipment Type	Equipment Details	Location
Stockton (Option)	Car Portal	2 Headends, Dual Antennas	Dual Headends at each end of tunnel, consisting of: 700MHz Directional Donor Antenna and Mounting Kit (Qty 2) 800MHz Directional Donor Antenna and Mounting Kit (Qty 2) Antenna Grounding Kits (Qty 4) Feeder Cables (Qty 4) 700MHz Channelized 10-Channel BDA (Qty 2) 700MHz Channelized 20-Channel BDA (Qty 2) 800MHz Channelized 10-Channel BDA (Qty 2) 700/800MHz Cross-band Coupler (Qty 2) 700 MHz Combiner / Coupler (Qty 2) In-tunnel Directional Re-broadcast Antennas	HE - Wall in each portal area

Radio Replacement Project

Attachment 1

Site	Site Type	Equipment Type	Equipment Details	Location
MacArthur (Option)	Car Portal	2 Headends, Dual Antennas	Dual Headends at each end of tunnel, consisting of: 700MHz Directional Donor Antenna and Mounting Kit (Qty 2) 800MHz Directional Donor Antenna and Mounting Kit (Qty 2) Antenna Grounding Kits (Qty 4) Feeder Cables (Qty 4) 700MHz Channelized 10-Channel BDA (Qty 2) 700MHz Channelized 20-Channel BDA (Qty 2) 800MHz Channelized 10-Channel BDA (Qty 2) 700/800MHz Cross-band Coupler (Qty 2) 700 MHz Combiner / Coupler (Qty 2) In-tunnel Directional Re-broadcast Antennas	HE - Wall in each portal area

Radio Replacement Project

Attachment 1

Site	Site Type	Equipment Type	Equipment Details	Location
Cable Barn (Option)	Facility	Head End, Antennas, Distributed Antenna System	Headend, and Distributed Antenna System consisting of: 700MHz Directional Donor Antenna and Mounting Kit (Qty 1) 800MHz Directional Donor Antenna and Mounting Kit (Qty 1) Antenna Grounding Kits (Qty 2) Feeder Cables (Qty 2) 700MHz Channelized 10-Channel BDA (Qty 1) 700MHz Channelized 20-Channel BDA (Qty 1) 800MHz Channelized 10-Channel BDA (Qty 1) 700/800MHz Cross-band Coupler (Qty 1) 700 MHz Combiner / Coupler (Qty 1) Distributed Antenna System consisting of Omni-directional Antennas, Coaxial Cable, Splitters, Connectors, etc.	HE - First Floor Facility Telecom Room
NOTE: Fiber-optic cabling, radiating coaxial cable, AC Power, DC Back-up Power / UPS etc. are <u>not</u> included.				

SFMTA Radio Replacement Project
Attachment #2 – Responsibility Matrix

March 22, 2012

This document generally describes each party's responsibility to perform tasks and provide documents and information to the other party. The description of tasks and Work herein is necessarily general and does not modify or otherwise change obligations and duties of any party as those are set in the Contract Documents.

Definitions within this section include:

R = Responsible - The entity responsible for the performance of the activity or function, to be completed by the dates set forth in the schedule line items detailed below. There should be one entity with this assignment for each task or function.

A = Assistance - An entity that will provide the amount and type of assistance as provided in this Contract. Assistance does not transfer responsibility from one party to the other party in any manner. (See General Conditions, Section 2.2.4).

X = Approve - Those who are ultimately accountable for the correct and thorough completion of the activity or function.

C = Consulted - Those whose opinions are sought in two-way communication.

I = Information - Those who are kept up-to-date on progress in one-way communication.

NOTE: “tbd” in the Schedule Line column is a place holder for the corresponding/related line item once the schedule is produced in Primavera Project Schedule Software which will be provided as part of deliverables after NTP on Phase 4.1.

Phase 4.1 Design Engineering Services Activity or Function	Sched Line	Harris	SFMTA
Submit Integrated System Test Plan, all Test Procedures and Grid Maps	tbd	R	X
Establish PMO	tbd	R	X
Submit PMP, Schedule	tbd	R	X
PrimaVera Schedule Training	tbd	R	A
Submit Project Quality Plan	tbd	R	X
Submit Requirements Traceability Matrix	tbd	R	A,X
Submit Inspection Plan	tbd	R	X
Perform detailed Site Surveys	tbd	R	A
Perform detailed Vehicle Surveys	tbd	R	A
Perform detailed MW Path/Site Surveys	tbd	R	A
Provide Track Safety Training and Track Safety Requirements	tbd	A	R



SFMTA Radio Replacement Project
Attachment #2 – Responsibility Matrix

March 22, 2012

Phase 4.1 Design Engineering Services Activity or Function	Sched Line	Harris	SFMTA
Prepare Track Safety Training and Track Safety Supervision Plan	tbd	R	A,X
Perform detailed Tunnel BDA Surveys	tbd	R	A
Stakeholder Workshops – SFMTA to arrange meetings and to support during meetings. Harris to present preliminary material.	tbd	R	A
Recommend alternate site locations if necessary to performance criteria	tbd	R	A,X
Provide ERP, antenna model and pattern at each site	tbd	R	
Provide interface to third party frequency coordinator	tbd	R	A
Channel planning for the system	tbd	R	A,X
Determine available channel(s) for SFMTA	tbd	A	R
Provide help in filling out the LMR FCC applications	tbd	A	R
Work with third party coordinator and Harris to fill out the LMR FCC application	tbd	A	R
Send in the LMR FCC application and track it	tbd		R
MW FCC application preparation, submission, and tracking	tbd	R	
Create Software Requirements Document	tbd	R	
Create Vehicle Installation Drawings	tbd	R	X
SFMTA approves coach electrical supply is suitable and adequate for proposed equipment requirements.	tbd	A	R,X
Prepare Site Drawings, Floor Plans, and Rack Drawings	tbd	R	X
Provide Detailed Survey Analyses to Harris	tbd	R	A,X
Generate Zoning Drawings	tbd	R	A,X
Intermediate (65%) Design Review	tbd	R	C,X
Review and Adjust inputs to existing FCC applications (if needed)	tbd	R	A
Complete and Submit existing FCC applications	tbd	A	R



SFMTA Radio Replacement Project
Attachment #2 – Responsibility Matrix

March 22, 2012

Phase 4.1 Design Engineering Services Activity or Function	Sched Line	Harris	SFMTA
Generate Construction Drawings	tbd	R	X
ISSI Interface support with related Vendors	tbd	A	R
Interoperability Gateway Interface – SFMTA to provide documentation and technical support for interface design	tbd	A	R
Create Final Design Package (includes MW)	tbd	R	X
Prepare Tunnel/Track Access and Work Plan	tbd	R	A,X
Final (95%) Design Review	tbd	R	C,X
SFMTA provides Written Conditional Acceptance of Phases 4.1	tbd		X

Phase 4.2 System Development, Factory Testing, and Site Construction Phase 4.3 Equipment Installation Activity or Function	Sched Line	Harris	SFMTA
SFMTA clears the CEQA Review Process	tbd		R
SFMTA Issues Notice-to-Proceed for Phases 4.2 and 4.3	tbd		R,X
Site Construction Equipment Procurement and Permitting	tbd	R	A
Submit Environmental Mitigation Measures & Temporary Control Plans	tbd	R	X
BDA Tunnel Equipment Procurement	tbd	R	
Harris LMR Staging	tbd	R	C
MTMS CAD/AVL Staging (SFMTA)	tbd	R	A,C
Harris LMR/CAD/AVL Test with SFMTA	tbd	R	A,X
Wireless Bulk Data Staging (in SF)	tbd	R	A
MW Staging	tbd	R	
BDA Staging	tbd	R	X
Develop and submit System Cutover Plan and Schedule for vehicle cutovers to new system	tbd	R	X



SFMTA Radio Replacement Project
Attachment #2 – Responsibility Matrix

March 22, 2012

Phase 4.2 System Development, Factory Testing, and Site Construction Phase 4.3 Equipment Installation Activity or Function	Sched Line	Harris	SFMTA
Notify affected owners, tenants, contractors, utilities and required agencies of impending construction activities."	tbd	R	
Provide Commencement of Work notice to property owners within 300' feet radius of work.	tbd	R	
Bernal Heights (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
1455 Market Street (Site Construction, including all coax and Ethernet runs to the roof) Ref. SOW Phase 4.2.2, OCC Sites	tbd	A	R
Forest Hill (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
One Market Plaza (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
South Hill (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Central Radio Station (CRS) Twin Peaks (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Potrero Division (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Flynn Division (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Scott Division (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Cable Car Barn (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Green Annex Facility (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Green Geneva Historic Car House (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Metro Muni East Division (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Presidio Division (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Woods Division (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Islais Facility - Optional (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Kirkland Division – Optional (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X



SFMTA Radio Replacement Project
Attachment #2 – Responsibility Matrix

March 22, 2012

Phase 4.2 System Development, Factory Testing, and Site Construction Phase 4.3 Equipment Installation Activity or Function	Sched Line	Harris	SFMTA
Tunnel Site Construction – Radiating Coax, Fiber, AC/DC Power Upgrades, Distribute Antenna systems at each station	tbd	R	A,X
Tunnel BDA (Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Traffic Signal Priority (Site Construction, Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
1455 Market Street (Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Installation of the ISSI gateway – SFMTA will be responsible for providing liaison or external consultant support in connecting to any non-Harris P25 system.	tbd	R	A
Lenox Way Computer Room and Control Room (Install/Connect Equipment, Configure/Optimize, Functional Test, SFMTA Inspection/Punch list)	tbd	R	A,X
Harris to provide interconnectivity to any existing legacy audio path to the interoperability gateway. SFMTA to provide technical assistance in supporting	tbd	R	A
System Optimization	tbd	R	A
Submit Training Plan, Schedule, and Preliminary Manuals	tbd	R	A,X
LMR Network Management System Training	tbd	R	A
System Administration Training	tbd	R	A
Deliver all drawings and submittals (CDRL's) signifying completion of Phases 4.2 and 4.3	tbd	R	C,X
SFMTA provides Written Conditional Acceptance of Phases 4.2 and 4.3	tbd		X

Phase 4.4 Integrated System Testing Activity or Function	Sched Line	Harris	SFMTA
SFMTA issues Notice-to-Proceed for Phase 4.4	tbd		R,X
Conduct Pre-ATP Functional Test at each RF site.	tbd	R	I
Conduct Functional ATP for SFMTA at each RF site.	tbd	R	A,X
Conduct Pre ATP Functional Test at Dispatch Center.	tbd	R	I
Conduct ATP Functional Test for SFMTA at Dispatch Center.	tbd	R	A,X
Conduct Pre-TP Functional Test at Simulcast Control Point	tbd	R	I
Conduct ATP Functional Test for SFMTA at Simulcast Control Point	tbd	R	A,X
Submit Functional test documentation.	tbd	R	A,X
SFMTA review and approve Functional test documentation.	tbd		R,X
P25 Simulcast Bit Error Rate (BER) Test	tbd	R	A,X
OpenSky Block Error Rate (BLER) Test	tbd	R	A,X
Data IP Connectivity Test	tbd	R	A,X
Cable Car Voice Quality Test	tbd	R	A,X
Critical Location Voice Quality Test	tbd	R	A,X
Conduct MW Acceptance Testing with SFMTA. Correct punch list items.	tbd	R	A,X
Develop and provide MW as-built documentation	tbd	R	C,X
Conduct Field Performance Test	tbd	R	A,X
Conduct Mini-Fleet normal operations test	tbd	R	A,X
Conduct TSP Operations/Performance Test	tbd	R	A,X
Mini-Fleet Test Approval	tbd		X
BDA Systems Acceptance Testing	tbd	R	A,X

SFMTA Radio Replacement Project
Attachment #2 – Responsibility Matrix

March 22, 2012

Phase 4.4 Integrated System Testing Activity or Function	Sched Line	Harris	SFMTA
Deliver CDRLs signifying completion of Phase 4.4	tbd	R	C,X
SFMTA provides Written Conditional Acceptance of Phase 4.4	tbd		X

Phase 4.5 Training & System Cutover Activity or Function	Sched Line	Harris	SFMTA
SFMTA issues NTP to proceed with Phase 4.5	tbd		R,X
Dispatcher Training	tbd	R	A
Radio Communications Subscriber Unit Training	tbd	R	A
Radio System Maintenance Training	tbd	R	A
Vehicle Equipment Maintenance Training	tbd	R	A
Generator Training	tbd	R	A
Fire Suppression Training	tbd	R	A
HVAC Training	tbd	R	A
Establish System Cutover Plan and Schedule for vehicle cutovers to new system.	tbd	R	A
(For Cutover and Vehicle Installation) Notify departments of cutover time.	tbd		R,X
(For Cutover and Vehicle Installation) Vehicle available for installations per project schedule. SFMTA to provide 10 vehicles per day.	tbd	A	R
(For Cutover and Vehicle Installation) SFMTA inspect and approve all vehicle installations prior to acceptance.	tbd	A	R,X
Program 575 Portables	tbd	R	
SFMTA to provide 10 vehicles per day	tbd		R
Perform Non-rev vehicle Configs. A, B & C Installations and Harris Inspection	tbd	R	A
Perform Bus and Electric Trolley Installations and Harris Inspection	tbd	R	A
Perform LRV Installations and Harris Inspection	tbd	R	A



SFMTA Radio Replacement Project
Attachment #2 – Responsibility Matrix

March 22, 2012

Phase 4.5 Training & System Cutover Activity or Function	Sched Line	Harris	SFMTA
Perform Historic Street Car Installations and Harris Inspection	tbd	R	A
SFMTA coordinates approval of Historic Street Car installations by Market Street Railway	tbd	A	R,X
SFMTA provides approval to perform Cable Car survey and installation work	tbd		R,X
Perform Cable Car Installations and Harris Inspection	tbd	R	A
SFMTA coordinates review & approval of Cable Car installations by stakeholders.	tbd		R,X
Site Cleanup	tbd	R	A,X
720-hour/30-day System Availability Test	tbd	R	A,X
Deliver CDRLs signifying completion of Phase 4.5	tbd	R	C,X
SFMTA provides Written Conditional Acceptance of Phase 4.5	tbd		X

Substantial Completion and Final System Acceptance Activity or Function	Sched Line	Harris	SFMTA
Prepare and Issue Notice of Substantial Completion	tbd		R
SFMTA conducts inspection and combines with Harris inspection checklists to create Deficiency List	tbd	A	R
Correct Deficiency List items and request second SFMTA inspection	tbd	R	C
SFMTA conducts final inspection and issues Notice of Substantial Completion	tbd	A	R,X
SFMTA prepares and delivers to Harris the Final Acceptance Punch List.	tbd	A	R
Resolve punch list items and provide written notification to SFMTA	tbd	R	A,X
Submit Overall Performance of Safety & Health, Final Decontamination Documentation, Summary of Personnel Monitoring and Summary of Air Monitoring	tbd	R	C
SFMTA accepts all delivered equipment and accepts all drawings, manuals, documentation, CDRLs, equipment integration, equipment installations, correction of variances and final site clean-ups.	tbd	A	R,X
Warranty Begins	tbd	R	A

	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

TO: David Nolle, COR

Current Progress / Work Completed

<p>SIGNIFICANT PROGRESS / WORK COMPLETED THIS MONTH (September)</p> <p>WEEK OF 09/03/2011</p> <p>HARRIS</p> <p><u>Arapaho:</u></p> <ul style="list-style-type: none"> - Drawing and label updates <p><u>ATP Related Activities:</u></p> <ul style="list-style-type: none"> - None <p><u>BOA:</u></p> <ul style="list-style-type: none"> - 700MHz TX support <p><u>Buckner:</u></p> <ul style="list-style-type: none"> - Drawing updates <p><u>Bus</u></p> <ul style="list-style-type: none"> - CAD/AVL and Mobile Radio installation team continues to pre-assemble bus kits at the Customer's South Oak Cliff Bus Garage in preparation for production bus installations to commence. - Managed/monitored the fabrication of bus enclosure units. As of Thursday 36 were completed



	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

CROF:

- None

NRV/Revenue Vehicle Installs

- None

NWROF:

- The Customer's NWROF facility now has a Console position completely installed and is functioning properly.
- Drawing and label updates

Other:

- None

SLRV:

- SLRV's continue at two trains per day with (66) complete and (49) remaining. At the current rate of completion SLRV's installations are still on target for a mid October completion.

TMR:

- 700 MHz Station Testing and product support
- Drawing updates

Trapeze:

- None

	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

Training:

- Rev W of the training schedule has been submitted for approval

Schedule Update

Work completed for the previous week: For the week of September 3 thru September 9, 2011:

Continued manufacturing process for OPENSKY Backbone gear.

Continued manufacturing process for Mobile and Portable Radios and equipment.

Continued development and manufacturing process for CAD/AVL system.

Continued preparing Installation Work Plans and Details Submittals.

Contractor continued installation of Radio Console Hardware at CROF Site Location

Act ID	Description
1722	INSTAL Install (7) Radio Consoles - CROF LRT Ctr

Contractor completed installation of 700 MHz Radio Infrastructure Hardware to Bank of America Site Location

Act ID	Description
SA007087	Add 700MHz - Install BOA RBS Equipment

Contractor continued installation of LRV Mobile Radio Hardware

Act ID	Description
0245	INSTAL NDPOL Mobile LRT800 M5300 326units
0521	INSTAL Install LRT Hdw (except Radio) 326 Unit

Contractor continued installation, de-installation and re-installation of Pilot Test Bus #13, to ensure installation crews are properly trained

Act ID	Description
2290	INSTAL Install BUS Typ1 Hdw 18 Units Pilot Test
2320	INSTAL Prog/Install BUS 30 Units for Pilot Test

Contractor conducted System-wide Testing

	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

Act ID	Description
0255	TEST Acceptance Testing Integrated System
0256	TEST Mini Fleet Pilot Testing
CAD0131	INSTAL CAD/AVL Complete 30 burn
WEEK OF 09/10/2011	
HARRIS	
<u>Arapaho:</u>	
	- Drawing and label updates
<u>ATP Related Activities:</u>	
	- None
<u>BOA:</u>	
	- 700MHz TX support
<u>Buckner:</u>	
	- Drawing updates
<u>Bus</u>	
	- CAD/AVL and Mobile Radio installation team continues to pre-assemble bus kits at the Customer's South Oak Cliff Bus Garage in preparation for production bus installations to commence.



	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
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- Managed/monitored the fabrication of bus enclosure units. As of Thursday 36 were completed

CROF:

- None

NRV/Revenue Vehicle Installs

- None

NWROF:

- The Customer's NWROF facility now has a Console position completely installed and is functioning properly.
- Drawing and label updates

Other:

- Troubleshoot Backup/Restore Loading Issue

SLRV:

- SLRV's continue at two trains per day with (66) complete and (49) remaining. At the current rate of completion SLRV's installations are still on target for a mid October completion.

TMR:



	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
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- 700 MHz Station Testing and product support
- Drawing updates

Trapeze:

- None

Training:

- Rev W of the training schedule has been submitted for approval

Schedule Update

Work completed for the previous week: For the week of September 3 thru September 9, 2011:

Continued manufacturing process for OPENSKY Backbone gear.

Continued manufacturing process for Mobile and Portable Radios and equipment.

Continued development and manufacturing process for CAD/AVL system.

Continued preparing Installation Work Plans and Details Submittals.

Contractor continued installation of Radio Console Hardware at CROF Site Location

Act ID	Description
1722	INSTAL Install (7) Radio Consoles - CROF LRT Ctr

Contractor completed installation of 700 MHz Radio Infrastructure Hardware to Bank of America Site Location

Act ID	Description
SA007087	Add 700MHz - Install BOA RBS Equipment

Contractor continued installation of LRV Mobile Radio Hardware

Act ID	Description
0245	INSTAL NDPOL Mobile LRT800 M5300 326units



	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
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0521	INSTAL Install LRT Hdw (except Radio) 326 Unit
Contractor continued installation, de-installation and re-installation of Pilot Test Bus #13, to ensure installation crews are properly trained	
Act ID	Description
2290	INSTAL Install BUS Typ1 Hdw 18 Units Pilot Test
2320	INSTAL Prog/Install BUS 30 Units for Pilot Test
Contractor conducted System-wide Testing	
Act ID	Description
0255	TEST Acceptance Testing Integrated System
0256	TEST Mini Fleet Pilot Testing
CAD0131	INSTAL CAD/AVL Complete 30 burn
WEEK OF 09/17/2011	
HARRIS	
<u>Arapaho:</u>	
- Completion of open action items is underway at the Arapaho tower site with cable labeling and the updating of red-line drawings.	
- Updating labels and drawings	
<u>ATP Related Activities:</u>	
- None	
<u>BOA:</u>	
- None	



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Buckner:

- None

Bus

- An NCR was opened to document a WLAN Ethernet cable issue at the Customer's Bus Garages. An Ethernet cable was found to be not secured tight to the canopy trusses. Apparently, high winds or maybe heavy rain can cause the cable to slide off of the truss and sag down between zip ties which are holding the cable onto the trusses. CQCR met with subcontractor Trapeze at the South Oak Cliff Bus Garage to take photos and assess the situation. Trapeze presented a plan of action and has begun to correct the issue. The Customer's other two bus garage locations will also be reviewed as the WLAN was installed by the same crew at all three garage locations.
- Continued assembling enclosures for the bus installations

CROF:

- None

NRV/Revenue Vehicle Installs

- None

NWROF:

- None

Other:



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Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
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- System documentation
- Remote troubleshooting (as required)

SLRV:

SLRV's continue at two trains per day with (79) complete and (36) remaining. At the current rate of completion SLRV's installations are still on target for a mid October completion.

TMR:

- None

Trapeze:

- None

Training:

- Rev W of the training schedule has been submitted for approval

Schedule Update

Work completed for the previous week: For the week of September 17 thru September 23, 2011:

Continued manufacturing process for OPENSKY Backbone gear.
Continued manufacturing process for Mobile and Portable Radios and equipment.
Continued development and manufacturing process for CAD/AVL system.
Continued preparing Installation Work Plans and Details Submittals.
Contractor continued installation of Radio Console Hardware at CROF Site Location



	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

Act ID	Description
1747	INSTAL Install (7) Radio Consoles - CROF Police
Contractor continued preassembling IVLU Enclosures for installation of CAD/AVL Mobile Hardware	
Contractor continued installation of LRV Mobile Radio Hardware	
Act ID	Description
0245	INSTAL NDPOL Mobile LRT800 M5300 326units
0521	INSTAL Install LRT Hdw (except Radio) 326 Unit
Contractor conducted System-wide Testing	
Act ID	Description
0255	TEST Acceptance Testing Integrated System
0256	TEST Mini Fleet Pilot Testing
CAD0131	INSTAL CAD/AVL Complete 30 burn
WEEK OF 09/24/2011	
HARRIS	
<u>Arapaho:</u>	
– Arapaho Sweep Tests and Photos were prepared for submission to the Customer.	
<u>ATP Related Activities:</u>	
– ATP for Two-Way Radio, Network and 700 MHz Sub-systems prepared for submission to the Customer	
<u>BOA:</u>	

	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

- 700 MHz combiner support and antenna checks

Buckner:

- Buckner Sweep Tests and Photos were prepared for submission to Customer

Bus

- The WLAN Ethernet cable issue has been resolved at the three Customer's bus garage locations. Trapeze (subcontractor) has appropriately secured all of the Ethernet cables to the canopy trusses without compromising the WLAN system.
- Production CAD/AVL and Mobile Radio installations began Wednesday 9/28/11. There just over 600 buses in the Customer's fleet located at three separate bus garages. Production installations are beginning at the South Oak Cliff Bus Garage where the Pilot buses completed their respective CAD/AVL installations.
- South Oak Cliff Bus install support, handset noise.

CROF:

- TCC console install support

NRV/Revenue Vehicle Installs

- None

NWROF:

- None



	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

Other:

- System documentation
- DPOL Test Results prepared for submission to the Customer
- Pre-Substantial Completion inspections have commenced at RRP sites which will generate punch-list items per site as part of the close out process for the project. Currently we have completed Trinity Mills Road and Buckner Tower Sites.
- Remote troubleshooting (as required)
- Inventory spreadsheet known as the "Monstrosity" is in the process of being updated. Once complete, the spreadsheet will reflect the current status of deliveries, (radios in stock, radios installed, radios delivered to the Customer as uninstalled) as well as radios remaining to be delivered to the PMO from Lynchburg).
- Final delivery of Trapeze CAD/AVL equipment is expected to occur the week of 3 October. 32 IVLU kits will be delivered along with installation kits to complete the delivery of CAD/AVL equipment.

SLRV:

- SLRV's continue at two trains per day with (89) complete and (26) remaining. At the current rate of completion SLRV's installations are on target for mid to late October completion.
- TCC Test Results prepared for submission to the Customer

TMR:

- TMR Sweep Tests and Photos were prepared for submission to the Customer

	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

Trapeze:

- CAD/AVL ATP Test Results prepared for submission to the Customer

Training:

- Final courses are being planned for completion by end of December if possible. Harris and all related vendors are being approached to see if we can pull dates into 2011 if at all possible. Many courses are already booked through the end of 2011 by vendors but Harris is asking for "right of first refusal" in those cases.

Schedule Update

Work completed for the previous week: For the week of September 24 thru September 30, 2011:

Continued manufacturing process for OPENSKY Backbone gear.

Continued manufacturing process for Mobile and Portable Radios and equipment.

Continued development and manufacturing process for CAD/AVL system.

Continued preparing Installation Work Plans and Details Submittals.

Contractor continued installation of Radio Console Hardware at CROF Site Location

Act ID	Description
1747	INSTAL Install (7) Radio Consoles - CROF Police

Contractor completed preassembling the available IVLU Enclosures for installation of CAD/AVL Mobile Hardware

Contractor continued installation of LRV Mobile Radio Hardware

Act ID	Description
0245	INSTAL NDPOL Mobile LRT800 M5300 326units
0521	INSTAL Install LRT Hdw (except Radio) 326 Unit

Contractor began installation of Revenue Bus Mobile Radio Hardware

	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

Act ID	Description
0370	INSTAL Prog/Install BUS 574 U M5300(900MHz) 90%
0570	INSTAL Install BUS Typ1 Hdw (exc Radio) 567 Unit
0595	INSTAL Install BUS Typ2 Hdw (exc Radio) 70 Unit
0620	INSTAL Install BUS Typ3 Hdw (exc Radio) 4 Unit
Contractor conducted System-wide Testing	
Act ID	Description
0255	TEST Acceptance Testing Integrated System
0256	TEST Mini Fleet Pilot Testing
CAD0131	INSTAL CAD/AVL Complete 30 burn

Submittals this Period

- Total Submittals Made: 594
- Total Submittals Approved: 464
- Total Submittals Pending Approval: 10

Contract Schedule Update

- Monthly Contract Schedule Update (01320-031-00) will be submitted 10/11/2011.
- Design/Fabrication/ Delivery Installation Schedule Report Information, is included with the Monthly Contract Schedule Update.

Quality Control

- None

	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

Hazard Analysis Activities

- Hazard Analysis is due quarterly as a separate submittal. Submittal 01047-042-00 was submitted 09/06/2011 and has been approved. Submittal 01047-043-00 will be submitted 10/11/2011.

Safety Report

- Richard Bush has submitted the monthly safety report for the previous month and will have the next report submitted October 15th.

Other Items

- None

Narrative Summary

NARRATIVE SUMMARY & 4 WEEK LOOK AHEAD:

Four week look-ahead (detail attached)

Week of 10/10/11

- System documentation update
- SLRV Mobile Radio installs to continue
- Production buses continue CAD/AVL installations
- Pilot buses continue to be monitored
- Support System Engineer and Network Engineer
- Mobile install and Bus pilot support as needed
- The Customer's 700 MHz coverage testing continues
- CROF labeling and drawings

	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

Week of 10/17/11

- System documentation update
- SLRV Mobile Radio installs to continue
- Pilot buses continue to be monitored
- CROF labeling and drawings
- Support System Engineer and Network Engineer
- Mobile install and Bus pilot support as needed
- 700 MHz coverage testing

Week of 10/24/11

- System documentation update
- SLRV Mobile Radio installs to continue
- Pilot buses continue to be monitored

Week of 10/31/11

- System documentation update
- SLRV Mobile Radio installs to continue
- Pilot buses continue to be monitored

	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
Attachment #4 Statement of Work	Document Submittal #: 01320-062-00	Prepared by: Harris PM
	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

QUALITY CONTROL PERFORMANCE STATEMENT

- None

Awaiting disposition from DART on the following submittals:					
SPECIFICATION SECTION	SUBMITTAL #	REV #	TITLE (DESCRIPTION)	DATE SENT	CORR. #
01010	002	00	Software License Agreements	8/16/2011	0800
16810	022	01	Arapaho 700 MHz Radio Cabinet IWP	9/27/2011	0851
16816	010	00	Cable Test Results	10/4/2011	0853
16845	003	00	Train Control Center Test Results	10/4/2011	0854
16845	004	00	DPOL Test Results	10/4/2011	0855
16810	025	00	Apapaho Sweep Tests and Photos	10/4/2011	0856
16810	026	00	TMR Sweep Tests and Photos	10/4/2011	0857
16810	027	00	Buckner Sweep Tests and Photos	10/4/2011	0858
16816	009	01	CAD/AVL ATP Results	10/4/2011	0859
16814	040	00	ATP for Two-Way Radio, Network and 700 MHz Sub-Systems	10/4/2011	0861

	Correspondence #: XXXXXX	Contract #: 1240 RRP (Radio Replacement Project)
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	Doc Title: Sample Monthly Progress Report (September 2011)	Sent Date: 12/01/2011

Awaiting receipt of the following submittals from Subject Matter Expert:

– None

ACTION ITEMS	Y/N*	IMPACT**	PERSON RESPONSIBLE	DEADLINE

*Whether or not the issue affects contract requirements

** Impact: Very Low, Low, Medium, High or Very High per CQC Plan Issue/Risk Management Table.

Note: Monthly Installation Photographs (01345-012-00) will be submitted concurrently with this Monthly Progress Report as photograph presentations are prepared.

Client Issues Pending or Notes

If you have any questions or revisions for the next monthly Progress Report, please call. Thank you.

Signature: _____

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