

**TECHNICAL SPECIFICATIONS  
(TECHNICAL PROVISIONS)**

**SECTION TP09**

**QUALITY ASSURANCE REQUIREMENTS**

August 28, 2009  
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### SECTION TP09 QUALITY ASSURANCE REQUIREMENTS

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## TP09 QUALITY ASSURANCE REQUIREMENTS

### TP09.01 QUALITY PROGRAM SCOPE AND OBJECTIVES

To provide a quality product to SFMTA, the Contractor shall have planned and established a documented quality assurance program. The Contractor shall enforce the elements of the quality assurance program within all parts of its organization and with all manufacturers, subcontractors, and suppliers performing Contract work.

This section defines the minimum project quality assurance requirements. The objectives of the Contractor's QA Program for this project shall be both to assure that design, materials, processes and workmanship comply with the Specification, and that its design and manufacturing documentation are approved by the Contractor, by SFMTA as required, and released in a timely manner. The Contractor's quality system for this work shall utilize training, internal auditing, and periodic management review as means to support, maintain, and improve effectiveness of its quality program and its application to this work

### TP09.02 QUALITY SYSTEM AND IMPLEMENTATION

#### A. QA Manuals, Procedures, and Plans

The Contractor's Quality Assurance Manual shall cover all requirements of this Quality Assurance specification. The manual shall establish and communicate the company's quality policy, which shall be a clear statement of top management commitment and direction with regard to quality of its products and services. The manual shall establish authority for Quality Manual requirements and include or refer to all Contractor quality system procedures, explaining the hierarchical structure of quality system documents. Amendments may be included in the Contractor's Quality Assurance Manual to fully comply with the quality assurance requirements of this MUNI Contract.

Quality system documentation shall be consistent with the skills needed, methods used, and training resident among personnel performing Contract work in accordance with the requirements of this specification.

The Contractor shall submit for review and approval, 90 days after NTP, its proposed Project Quality Assurance Program Plan. **[CDRL 12-001]** This Plan shall identify the controls, processes, procedures, resources, and skills the Contractor will apply to satisfy project quality system requirements of the Contract. For each specified quality system requirement, the Plan shall identify how it will be satisfied, when, where, and by which job function. It shall include a flow chart of the manufacturing sequence with all planned inspections indicated. The chart shall indicate entities participating in the inspections and if inspections are customer-witnessed or hold-point verifications. Necessary inspection equipment, extraordinary measurement requirements, required personnel certifications, workmanship acceptance standards, methods of inspection, and required quality records documentation shall be identified in the Plan. The Plan may refer to specific sections of other Contractor documents, such as the Quality Manual and supporting procedures, if appropriate description of quality plan details applicable to this Contract are presented there.

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### **B. Management Responsibility for QA Program**

The Contractor shall assign to a member of its management the overall responsibility for implementing and maintaining its quality assurance program throughout the Contract period. The interrelation of all Contractor personnel affecting the quality of this Contract's products and services shall appear on the company organization chart. The Contractor shall provide for periodic reporting to management and management review of its quality system's effectiveness, taking appropriate action whenever so indicated.

The Contractor shall provide adequate trained resources to perform verification activities. These activities include inspections, test witnessing, monitoring its operations, participating in and supporting design reviews, and conducting internal quality audits.

### **C. Internal Quality Auditing**

Auditing is a crucial activity for maintaining effectiveness of quality systems. The Contractor shall establish and maintain procedures for internal quality system auditing. The Contractor shall schedule audits of its operations so that it assesses compliance with each Quality Manual section throughout its organization on a planned periodic basis. Contractor's auditors shall be independent of the operations they audit and perform audits in accordance with established auditing procedures. Auditors shall communicate results to appropriate personnel. Follow-up shall occur to verify and document that personnel have determined and applied effective corrective action with respect to deficiencies.

## **TP09.03 PLANNING FOR QUALITY**

Before performing Contract work, the Contractor shall have prepared written procedures to assure that SFMTA's requirements are met in planning the quality-related functions listed below.

### **A. Contract Review**

To ensure that SFMTA's requirements are met throughout the performance of Contract work, SFMTA requires the Contractor to review and continually consider Contract requirements, both as work is planned and as it is carried out. The Contractor shall take steps to ensure that all work reflects a thorough understanding of Contract provisions, and that any disagreements with Contract requirements are resolved through established channels for change control. Contract review shall also serve to assure that sufficient resources are available and applied to furnish products and services of the required quality within the time allotted under the Contract.

### **B. Design Control**

The Contractor and suppliers shall establish and maintain documented procedures to control and verify design of products and services while ensuring compliance with all Contract requirements. Design tasks shall be assigned to qualified personnel provided

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with adequate resources. To this end, the Contractor shall define, document, coordinate, and control sources of design input. This shall be accomplished by identifying interfaces between different groups, both within and outside its organization; then reviewing and updating design input on a regular basis to assure designs are adequate for their intended applications and free from conflict.

Design output, including drawings, specifications, instructions, software, and procedures, shall be documented in such a way that they can be verified as meeting design input requirements. Design output documents shall contain or refer to acceptance criteria and identify any design characteristics that are crucial to safety. The Contractor shall subject all design output to a documented system of review and authorized approval prior to releasing designs for procurement or manufacturing. This shall include SFMTA's prior approval for design documentation so specified.

At appropriate times during processes of design development, manufacturing, and testing, the Contractor shall validate design, confirming that it meets defined SFMTA requirements.

### **C. Document and Data Control**

The Contractor shall establish and maintain procedures for controlling all project documents and data. The Contractor's procedures shall identify who is responsible to maintain its master listing of documents, revision levels, and status. The Contractor shall ensure that documents are reviewed and approved prior to their release, and that current versions are available where needed. Obsolete documents shall be controlled to prevent unintended use, and if retained, segregated and suitably identified as obsolete.

Changes to released documents and data shall be subject to review and approval by the same functions and organizations that performed the original review, whether internal or external, unless other arrangements are justified, and approved.

### **D. Control of Purchased Items and Services**

The Contractor shall establish and maintain procedures to ensure that products and services purchased to complete this work comply with specification requirements. Procedures shall describe the Contractor's method of evaluating purchased items from subcontractors and suppliers on the basis of their ability to meet requirements, and establish methods of controlling subcontractor and supplier activities and products to obtain that result within the time allotted under the Contract. The Contractor's records of acceptable subcontractors and suppliers for this Contract shall be maintained and available for SFMTA's examination.

Contractor shall ensure that purchasing documents describe clearly the products and services ordered, including precise description of items, relevant data, and all applicable specification requirements, codes, and standards. Requirements for quality assurance, documentation, testing, packaging, and shipping shall also be included, as applicable. The Contractor's purchasing procedures shall require purchasing documents to be reviewed by appropriate personnel for meeting specified requirements.

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Refer to Inspection and Correction Section TP9.05 for inspection verification requirements for purchased products.

### **E. Control of Customer-Supplied Products**

The Contractor shall establish and maintain procedures for controlling any products, equipment, or services furnished or loaned to the Contractor by SFMTA. Procedures shall ensure that all such items are properly accounted, stored, maintained, and protected from loss or damage. The Contractor shall report to SFMTA in writing any SFMTA-supplied items that may become lost, damaged, or degraded, and any items or services that are unsuited for the intended use.

## **TP09.04 QUALITY ASSURANCE PROVISIONS FOR WORK IN-PROGRESS**

### **A. Process Control**

A significant part of the Contractor's quality program shall be to prevent problems by controlling manufacturing processes, thereby lessening the demands on required inspection and correction activities. To this end, the Contractor shall identify and plan processes necessary to produce, under controlled conditions, products, and services of the specified quality. Where necessary to accomplish this, the Contractor shall prepare documented instructions and workmanship criteria, and monitor and approve production processes. Production equipment and processes shall be maintained as necessary to ensure that products satisfy specified requirements.

### **B. Product Identification and Traceability**

The Contractor shall establish and maintain procedures for identifying product, where appropriate, during all stages of production, installation, and delivery. As practical, individual items or lots shall retain unique identification of the items and their acceptance, rejection, or uninspected status.

## **TP09.05 INSPECTION, TESTING AND CORRECTION**

The Contractor shall maintain and apply sufficient resources for inspection and testing verification. While production worker inspection of output is strongly encouraged, inspection by trained Contractor inspectors who are independent of the means of production is required under this Contract. The Contractor shall establish and maintain inspection and testing procedures for this project that address the following quality functions:

### **A. Control of Inspection, Measuring, and Test Equipment**

The Contractor shall establish and maintain procedures to control, calibrate, and maintain inspection, measuring, and test equipment to demonstrate to SFMTA that products

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conform to requirements. Calibrated equipment shall be used consistent with the required measurement accuracy. The capability of test software and hardware used for inspection shall be checked periodically. Procedure shall include provisions for determining the validity of previous inspection and test results when measurement equipment is found out of calibration, and taking appropriate corrective action. Inspection, measuring, and test equipment shall be suitably stored to ensure continued accuracy and fitness for use.

### **B. Inspection and Test Status**

The Contractor shall identify by suitable means the inspection and test status of products throughout production and installation so that only acceptable products are used. The Contractor's Quality Assurance Plan shall identify the inspection authority responsible for releasing product as conforming at each stage of production.

### **C. Controlling Nonconforming Products and Services**

The Contractor shall establish and maintain a procedure to prevent the inadvertent use or installation of nonconforming product. Nonconforming products shall be segregated from acceptable items where practical. In any case, the Contractor remains solely responsible to prevent unauthorized use of nonconforming material.

### **D. Corrective and Preventive Action**

The difference between corrective and preventive action shall be clearly expressed in the Contractor's Quality Assurance Manual. Corrective Action procedures shall address actual nonconformities that have occurred. Preventive Action procedures shall address the potential for nonconformity. The Contractor shall establish and maintain procedures for taking corrective and preventive action that is appropriate to the size of the problems and commensurate with the risks they present.

Corrective Action procedures shall be effective in handling complaints from nonconformance reports and from all entities, including SFMTA. Methods shall include problem analysis, recording results, determining the most effective corrective action, verifying that corrective actions have been taken, and that they are effective.

Preventive Action procedures shall require use of all available information to eliminate potential sources of nonconformity. Methods shall include data and information analysis, determining the best approaches to preventing nonconformity, implementing and ensuring effectiveness of preventive action plans, and forwarding significant details of actions taken for review by management.

### **E. Use of Statistical Techniques**

Specific needs and requirements for statistical techniques in controlling production processes shall be identified in the Contractor's Quality Plan for the Project. Statistical quality control applications used in acceptance of parts, materials, or processes by the

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Contractor or its suppliers shall be fully documented and based on generally recognized and accepted statistical quality control methods.

### F. Inspections and Tests

Inspections and testing are specified as means for the Contractor to demonstrate specification compliance to SFMTA. As such, inspections and tests are tools for assessing the quality yielded by the Contractor and supplier quality systems and processes. The Contractor shall establish and maintain procedures for inspection/verification activities listed below. Procedures shall be suitably documented to provide objective evidence that specified product requirements have been met.

#### 1. First Article Inspection (FAI)

A First Article Inspection (FAI) will be performed jointly by SFMTA and the Contractor on each piece of equipment, and all major vehicle structures, the complete vehicle, and integration of vehicle systems. Equipment shall be shipped from the point of manufacture only after an FAI has been offered and either passed, or waived by SFMTA. The Contractor shall perform independent pre-FAIs when necessary to ensure that the subcontractor is prepared.

First Article Inspection will evaluate component and system maintainability where possible. FAI's shall be performed only on components built using approved production processes and tooling, and shall establish the standard of quality of workmanship for the balance of like components. The quality shall be established jointly by SFMTA, the Engineer, and the Contractor.

First Article Inspection will not be conducted until the design drawings of the article have been at least conditionally approved or approved. If conditionally approved drawings are used, the conditions for approval shall be satisfied at the FAI and represented by the inspection article.

The inspection work space shall provide a proper, well-lit environment for inspection of piece part, subassembly or car final assembly. When appropriate, the inspection article shall be displayed on a stand or table with all necessary inspection tools, go/no-go gauges, plug gauges and handling aids. Correct tools and labor to take mechanical or electrical measurements shall be provided, including tools and labor for disassembly and removal of covers. Functional testing shall be performed in conjunction with the FAI when practical.

The Contractor shall submit a plan which shall include a list and schedule for all FAI's to the Engineer for review and approval not later than 120 days after Notice to Proceed. [CDRL 12-002] No less than thirty (30) days before each FAI, the Contractor shall submit to the Engineer an FAI package for review and approval. The FAI shall not be conducted until the FAI package has been approved. The Engineer shall have the option of witnessing any or all FAI's. In the event the Contractor schedules qualification testing immediately following an FAI or in conjunction with the FAI, the qualification test procedures must be submitted to the



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Engineer for review and approval prior to testing. Prior to conducting any qualification test, the Contractor shall conduct a First Article Inspection (FAI) of each component.

SFMTA will, at its option, participate in FAI's. The Contractor shall provide an individual notice to the Engineer for each FAI, a minimum of thirty (30) calendar days prior to the FAI. The Contractor shall not schedule more than two (2) FAI's on the same date without prior approval by the Engineer. Except where the requirement has been waived by the Engineer, the Contractor shall perform pre FAI's when it is needed to assure the subcontractor is prepared.

### **2. FAI Components, Equipment, and Apparatus**

Inspected "First Articles" (components, equipment, and apparatus) shall be retained for the duration of the manufacturing period and stored in a secure area at the Contractor's facilities. These items shall be made available for inspection and comparison at the request of the Engineer and/or SFMTA's on-site Inspector. These items may be utilized for production of the last cars with prior approval by the Engineer.

#### 1) Requirements

The following requirements shall apply to each FAI:

a. An FAI package shall be submitted to SFMTA in advance of the FAI to provide the following:

Schedule and Agenda of Inspection  
Vendor  
Vendor Address  
Vendor Phone Number  
Vendor Contact  
Component List with Latest Drawing Status  
Contractor Inspection Plan.

b. A complete set of approved or conditionally approved drawings and software documentation (with SFMTA comments) for the item to be inspected.

c. For purchased items, a copy of the Vendor's purchase order with commercial items excluded.

d. Completed Vendor inspection forms that control and document acceptance of in process work.

e. Completed Vendor and Contractor final inspection reports.

f. Completed test documents that reflect that the unit has passed.

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- g. Inspection work space that provides the proper environment for inspection of the piece part, subassembly, or car.
- h. When appropriate, display of the inspection article on a stand or table in a well lit workspace with all necessary inspection tools, go/no go gauges, plug gauges, and handling aids.
- i. Correct tools and labor to take mechanical or electrical measurements.
- j. Tools and labor for disassembly and removal of covers.
- k. Performance of functional testing.

### 2) Receiving Inspection and Testing

The Contractor shall utilize Receiving Inspection to verify that subcontractors and suppliers are meeting all requirements of the contract specification, and as listed on purchasing documents. The Contractor's procedure for this activity shall prohibit use including processing of purchased items and materials until they have been inspected per approved procedure and verified with respect to requirements. The inspection status of items shall be positively identified and recorded to support recall and replacement, should that be necessary.

### 3) In-Process Inspection and Testing

The Contractor shall ensure that all products are inspected and tested as required elsewhere in the Technical Provisions and the approved Acceptance Test Plan. Products shall be withheld from release to the next stage of production or delivery until required inspections and tests have been completed to the satisfaction of the Engineer.

### 4) Pre-shipment Inspection

Pre-shipment inspections shall be conducted for items that make up the work performed for this Contract. The Contractor shall provide SFMTA a minimum of ten (10) days notice for each inspection, including the agenda and list of items to be inspected. The Contractor shall ensure that all necessary drawings, specifications, standards, tools, and facilities are provided to support these inspections.

### 5) Final Inspection and Testing

The Contractor's Quality Assurance Program Plan shall identify all Final Inspections and Tests upon which the final release of vehicles and equipment are based. Products shall not be released for shipment to SFMTA until all final inspections and tests have been completed to SFMTA's satisfaction.

### 6) Inspection and Test Records

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The Contractor shall establish and maintain records that indicate whether products have passed required inspections and tests. Any items that have failed inspection or test shall have such failure documented and processed via the Contractor's nonconformance procedures. Inspection and Test Records shall identify the Contractor authority responsible for releasing inspected and tested products.

### TP09.06 TP12.06: QUALITY ASSURANCE SUPPORT SYSTEMS

#### A. Handling, Storage, Preservation and Delivery

The Contractor shall establish and maintain procedures for handling, storage, packaging, preservation, and delivery of items furnished under this Contract. The Contractor and suppliers shall implement procedures that:

- Identify methods for preventing damage or deterioration,
- Provide for secure storage that includes documented receipt and dispatch,
- Control packaging, packing, and marking processes,
- Provides methods for preserving and segregating products in production, assembly, and storage, and
- Preserve product quality following final inspection and testing until delivered.

#### B. Control of Quality Records

The Contractor shall establish and maintain procedures for handling, maintaining, and disposing of quality records, including pertinent quality records of subcontractors. Quality records may be in the form of paper copies, electronic files, or other media. All quality records shall be legible and traceable to the items they describe. Quality records shall be stored to prevent loss or damage, and shall be available for the Engineer examination upon request. The Contractor shall establish retention periods for quality records that shall be approved by the Engineer.

#### C. Quality Assurance & Training

The Contractor shall establish and maintain procedures to identify training needs as necessary to complete work successfully under this Contract. The Contractor shall provide appropriate training to personnel performing activities that affect the quality of products and services. Records of training needs and training completed shall be maintained.

#### D. Servicing During Warranty

The Contractor shall establish and maintain procedures for servicing delivered products during the warranty period that include verifying warranty requirements are being met. Procedures shall clarify the Contractor's servicing and warranty responsibilities in accordance with this SFMTA Contract. Both Contractor and any subcontracted servicing

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and warranty activities shall be planned and supported by suitable instructions, documentation, and competent, trained personnel.

The Contractor's staff shall collect and feed back to responsible Departments any information during the warranty period that supports servicing, design, and product improvements necessary to fulfill specification requirements reliably.

### TP09.07 CONTRACT DELIVERABLE REQUIREMENTS LIST

CDRL #	Title	Reference Paragraph
9-001	Quality Assurance Manual	9.02
9-002	FAI Schedule	9.05.F

**End of Section**

**TECHNICAL SPECIFICATION  
(TECHNICAL PROVISIONS)**

**SECTION TP10  
INSPECTIONS AND TESTING**

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### TP10: INSPECTIONS AND TESTING

#### TP10.01 GENERAL

Inspections and testing are specified as means for the Contractor to demonstrate compliance with the requirements of the Technical Provisions to SFMTA. As such, inspections and tests are tools for assessing the quality achieved by Contractor and supplier quality systems and processes. The Contractor shall document, through the Quality Assurance and Quality Control Plan and the Master Test Program Plan [CDRL 10-001], the processes and procedures that are in place to demonstrate that the work is completed in compliance with the Contract requirements.

#### TP10.02 PRE-POSSESSION INSPECTION AND TESTING

Prior to taking possession of the LRV at the SFMTA property, the Contractor shall conduct inspections and tests to determine the state of the vehicle. All inspections and tests shall be documented in the:

- Pre-possession Inspection Procedure [CDRL 10-002]
- 

The Contractor shall inspect and note the as-is condition and completeness of the vehicle and identify any damage and missing parts. Any subsequent damage and missing parts not noted on the report and which were not concealed at the time of the Pre-possession Inspection shall be the Contractor's responsibility to correct. The results of the inspection shall be summarized in the Pre-possession Inspection Report and agreed to by both parties.

The Contractor shall perform verification tests on the vehicle systems as a single vehicle to determine the baseline functionality of the vehicle. At a minimum, this shall include:

The results of the test shall be summarized in a report and agreed to by both parties. The In addition, the following vehicle systems shall be tested:

- ATCS (departure test)
- All trainline functions
- All coupler functions
- Air supply system
- Doors and steps
- Propulsion
- Braking
- Lighting
- Communications.

While SFMTA personnel will operate the LRV during the tests, the Contractor shall conduct the test. All testing activities and documentation shall be included in the Pre-possession Test Report.

## **INSPECTIONS AND TESTING**

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### **TP10.03 INSPECTION**

The Contractor shall establish and maintain procedures for the inspection/verification activities listed below. Procedures shall be suitably documented to provide objective evidence that specified product requirements have been met.

#### **A. General**

The Contractor shall notify SFMTA's Resident Inspector of any unforeseen work that was not apparent at the time the Pre-possession Inspection was conducted that becomes evident once the work has commenced. Such work shall not be undertaken prior to evaluation and disposition by SFMTA.

This Contract requires that inspections of the Contractor's work and materials, as well as of the supplier's materials, parts and components, be the responsibility of the Contractor and be performed at the Contractor's facilities or as appropriate at the subcontractors' facilities, giving opportunity to correct any inadequacies found under factory conditions.

Further inspection by the Contractor at the Contractor's facility shall determine any damage in transit, plus any unforeseen that may become apparent. SFMTA and the Engineer may also inspect selected items, with or in addition to those of the Contractor or its supplier. Such inspection shall in no way negate or lessen the Contractor's responsibility for proper inspections.

The Contractor shall be solely responsible for ensuring that they and their suppliers provide the necessary inspections in accordance with the approved Quality Assurance Plan submitted in compliance with TP09.

#### **B. Resident Inspectors**

Resident Inspectors may be provided by SFMTA in the Contractor's plant(s) and the manufacturing and assembly facilities of its Subcontractors and Suppliers from the start of any substantive work on the first vehicle set of equipment until the last vehicle is shipped.

The Resident Inspector will assist in assuring that the Contractor meets all Contract requirements on the vehicles by the Contractor.

#### **C. Access to Plants**

Authorized representatives of SFMTA shall have access at all times during working hours to those areas of the Contractor's and subcontractors' plants involved in the design, manufacture, or testing of the vehicles or any parts thereof.

A testing laboratory may be designated as an authorized SFMTA representative for the purpose of testing vehicles or any parts thereof.

SFMTA may station its own inspectors at the Contractor's or subcontractors' and Suppliers' facilities during the term of the Contract. The inspectors shall be authorized to inspect all work done, materials furnished, take measurements, determine quality of work performed, and make periodic assessments of the Contractor's, Subcontractors' and Suppliers' work. The Inspectors shall also assess the Contractor's, Subcontractors', and Suppliers' compliance with the



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configuration management requirements identified in the Quality Assurance Plan for all technical documents.

The Contractor shall provide, at each facility, an office for the resident inspector with the following:

1. Access to parking nearby
2. Lockable doors and windows
3. Access to restrooms nearby
4. Desk, file cabinet, chairs, telephone, internet connection
5. Access to fax and copy machines

The facility and its contents shall be subject to the approval of the Engineer.

The inspector shall have access to and be provided with copies, upon request, of all Contract drawings, diagrams, data, test procedures and reports, and information used in connection with the Contract. Any requested documents and information shall be provided to the inspector as expeditiously possible to avoid program delays.

Maintenance and services shall be provided at each site by the Contractor throughout the term of the Contract. Such maintenance and services shall include, but are not limited to:

- Janitorial services for cleaning office and parking spaces
- All utilities
- Security measures and area protection equivalent to that used by the Contractor
- Uniform lighting in the office of not less than 100-foot candles at desk height
- Same level of maintenance and service as provided for Contractor employees, as a minimum.

### **D. Cooperation**

The Contractor shall extend and shall ensure that its subcontractors extend to SFMTA and its representative's full cooperation and necessary facilities to permit the convenient inspection of all materials, work, and equipment supplied.

This shall include access to copies of all drawings (including unincorporated but approved changes), diagrams, data (along with verification that they are current releases), non-conformance and inspection reports, modifications and change notices, and status reports for the aforementioned information, which may be needed to properly inspect and evaluate the design, construction, assembly, installation, workmanship, clearance, tolerance, and functioning of the equipment and parts thereof.

There shall be a suitable means to inspect and test all parts and equipment at the Contractor's facility, including final mechanical and electrical tests of all vehicle systems.

## **INSPECTIONS AND TESTING**

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SFMTA representatives shall be permitted an agreed upon period of time to conduct each of their inspections. In no case shall formal inspections be scheduled at or near the end of a work shift without the prior approval of SFMTA.

### **E. Rejections**

The Engineer or the SFMTA Inspector shall have the right to reject material and workmanship which does not fully conform to the Technical Provisions or to approved Contractor's and suppliers' drawings and specifications.

When repetitious rejections are identified by SFMTA representative at any Contractor or subcontractor facility due to its failure to maintain proper quality, the condition will be cause for withdrawal of SFMTA inspection. The work shall be stopped until satisfactory improvement has been instituted and an agreement is reached for continuing work.

### **F. Defective Work**

Should the Engineer or Inspector have evidence that defective work has been permitted by the Contractor or a subcontractor, or that defective materials have been used, and should an examination of work partly or fully completed be requested, the Contractor or subcontractor shall provide the appliances and labor to conduct such investigation and inspection as may be required, as well as all QA material inspection sheets showing inspections of that material or item to the date in question.

Any imperfect construction or materials which may be disclosed shall be corrected promptly. If investigation discloses no defect, the delay caused by such investigation will be considered as beyond the Contractor's control.

### **G.**

### **H. Rejected Material**

Material or apparatus intended for use on these vehicles, or the parts thereof, which has been rejected by authorized representatives of SFMTA or Contractor, or found unsuitable, or not in conformity with the Technical Provisions, shall be corrected to fully comply with the Technical Provisions, or clearly marked and disposed of so as to assure that such material or apparatus will not be used or offered for use again on these vehicles. Conforming material shall be substituted without delay.

## INSPECTIONS AND TESTING

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### I. Inspection Costs

The costs of SFMTA's inspection and compensation to SFMTA inspection personnel will be the responsibility of SFMTA and no provision for these costs shall be included in the bid prices.

If a test or inspection, such as a First Article Inspection, must be repeated as a result of a lack of preparation on the part of the Contractor or its suppliers, the costs of SFMTA project and inspection personnel, including engineering services consultant, shall be the responsibility of the Contractor.

### TP10.04 TEST REQUIREMENTS

#### A. General

All test procedures shall include the description of the functions being tested, the performance parameters being verified, and the quantifiable pass/fail criteria. The required tests and adjustments shall be performed on the vehicles systems repaired, replaced and overhauled under this Contract and are grouped into four classifications:

1. Type Tests performed on components, systems, and complete Vehicles. These tests will be performed at the supplier, manufacturer, independent laboratory, independent facilities, Contractor facilities, or at SFMTA. These tests shall demonstrate that all required functions and performance parameters are satisfied.
2. Routine Tests performed on all components and complete vehicles. These tests will be performed at the supplier, manufacturer, independent facilities or Contractor facilities. These tests shall demonstrate that all functions are achieved and operate as intended.
3. Pre-Delivery (Routine) Tests performed on all complete vehicles. These tests will be performed at the Contractor's final assembly facility. These tests shall demonstrate the equipment and systems are properly integrated into the vehicle.
4. Acceptance Tests performed on all complete vehicles at SFMTA.

The Contractor shall provide at least 5 working days notice to the Engineer prior to the start of any test referred to herein. Prior to shipment to SFMTA, each vehicle shall be fully inspected by the Contractor and any part, device or equipment requiring adjustment, repair, or replacement shall be corrected by the Contractor. After receipt at SFMTA and prior to acceptance testing, SFMTA will completely inspect each vehicle for compliance with the specification, and the Contractor shall correct all discrepancies at its expense to the satisfaction of the Engineer. This shall not relieve the Contractor of its obligation to correct defects.

All working and moving parts, and all operating devices and controls of each vehicle and its equipment, as germane to and affected by the overhaul activities in the scope of this contract, shall be tested and put in operating condition by the Contractor before the vehicles are presented for Acceptance.

## **INSPECTIONS AND TESTING**

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All tests, specified in the Technical Provisions, shall be conducted by the Contractor at its expense. SFMTA shall make available to the Contractor, test train operating crews and all other individuals required by SFMTA policies at SFMTA's expense. If the Contractor must re-test due to test failure, and the re-test requires additional SFMTA crew expenses, the Contractor shall reimburse SFMTA for those expenses.

These tests shall be conducted at such times and on such portions of SFMTA lines as mutually determined by the Engineer and Contractor. Each vehicle shall be subjected to all tests to show compliance with the specified performance.

The Contractor shall supply all recorders, sensors, pickups, and wiring. When instrumentation is used on-board the vehicle, it shall use battery power. Access to the vehicles' 120 V AC supply shall only be allowed at SFMTA discretion. Internal combustion engine driven generators will not be permitted. The equipment shall not be damaged by the conditions specified in TP02. Uninterruptible Power Supplies (UPS) provided by the Contractor shall be used, if needed to ensure the integrity of the instrumentation through all vehicle operating conditions. Isolation amplifiers and voltage dividers shall be provided as part of the instrumentation package to isolate the inside vehicle instrumentation wiring and equipment from high voltages; no exposed terminals with potential differences greater than 50 V shall be permitted. The accuracy and response of the instrumentation shall be sufficient to determine the degree of compliance with the Technical Provisions and design data.

The Contractor shall perform all tests specified herein unless the Contractor can provide test reports acceptable to the Engineer which indicate that equipment furnished under this Contract is identical to equipment, which has been previously tested for the same application and can show compliance with the requirements of the Technical Provisions. The Engineer shall review such submittals for test methodology and test results. If, as a result of the review, the Engineer has comments and/or questions related to the test methodology and/or test results and/or the applicability of the test methodology, the Engineer shall notify the Contractor in writing, within 30 days of receipt of the submittals. The Contractor and its subcontractors may, at their option, perform additional testing as they deem necessary as part of the quality assurance program. Unless indicated otherwise, all costs associated with any tests performed shall be borne by the Contractor.

In the event of a failure to meet the Technical Provisions requirements in any test, necessary corrections shall be made by the Contractor at its expense, and the failed test shall be rerun in its entirety at the Contractor's expense. Depending on the test deficiency, the Contractor may be required to perform additional system or vehicle level tests to confirm acceptability of the corrective action.

SFMTA reserves the right to perform, at its own expense, additional operating tests of each vehicle separately, or in consist, to verify the acceptability of the vehicles. These additional tests will be conducted within 30 days after completion of Contractor acceptance testing. The Contractor may be required to participate and furnish technical assistance for such tests. If the result of the testing indicates that the vehicle was non-compliant with the Technical Provision (in line with the stated purpose of the testing), the vehicles in question shall be returned to the Contractor for correction, and subsequently made available to the Engineer which will have an additional 30 days to retest.

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### **B. Vehicle Acceptance Testing Facilities**

The Engineer shall coordinate the track occupancy concerns between the desired on-track vehicle testing, track construction, systems construction, and systems testing. The Contractor shall give a minimum of one 24-hour business days written notice of crew and track requirements to the Engineer or when canceling or postponing a previously scheduled test. The Engineer gives no assurance to the Contractor that the requested number of hours per day, time of day, or number of days per week of track time will be available for testing.

All expenses and costs incurred in the removal of vehicles from the designated delivery point for correction of defects shall be borne by the Contractor.

### **C. Master Test Program Plan**

A Test Matrix of all tests to be performed on all material, equipment and systems supplied under the contract shall be submitted with the Master Test Program Plan and shall be updated as required throughout the test program. SFMTA will not witness any testing until there is an approved Master Test Program Plan. The Master Test Program Plan shall meet the following requirements:

1. Tests shall be grouped in the following categories:
  - a. Component or system routine tests
  - b. Vehicle routine tests
  - c. Vehicle acceptance tests
  - d. Material tests, including smoke, flammability, toxicity, physical characteristics, etc.
  - e. Component or System type tests
  - f. Vehicle type tests
2. Each line item test in the matrix shall include data fields for the following:
  - a. Name of test
  - b. TP references for the test
  - c. Location of the test (contractor or sub-contractor's facility, independent test lab, SFMTA, etc.)
  - d. Number of units to be tested
  - e. Contractors document number, including latest revision identification, for the associated procedure and report

## **INSPECTIONS AND TESTING**

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- f. Letter reference providing status (disapproved, accepted, etc.) of the test document
- g. Other data to which the Contractor and SFMTA mutually agree

The Master Test Program Plan, previously identified as CDRL 10-001, shall be submitted within 180 days after NTP and shall be updated as required.

Approval of the Test Plan by SFMTA does not relieve the Contractor of responsibility to meet the requirements of the Technical Provisions.

### **TP10.05 COMPONENT AND SYSTEM TYPE TESTING**

The summary requirements for component and system level type tests shall be provided in the Master Test Program Plan. As applicable, the entire system shall be tested such that the functional operation of each vehicle subsystem shall be simulated. The first component and system manufactured using the approved work procedures shall be designated for type testing. All components and interfaces shall be of the production configuration. As required, the Plan shall include any intermediate testing and functional verification required in the course of performing the work to ensure that the assembled components function properly.

The Contractor shall be responsibility to ensure that all tests required by the Technical Provision are performed in accordance with the requirements of the approved Test Plan and test procedures. As a minimum, test procedures and reports shall be submitted to verify the functions and performance of the as assembled equipment prior to installation. All required production routine tests shall be successfully completed prior to commencing component and system type tests. These type tests shall include:

- Cable/wire harness assemblies
- Air Supply Unit and controls
- Door operators
- Step Assemblies
- Coupler Assemblies

### **TP10.06 VEHICLE LEVEL TYPE TESTING**

These tests shall demonstrate that all components and systems as integrated into the vehicle comply with the functions and performance parameters defined in the Technical Provisions. All equipment, as indicated in the approved Master Test Program Plan, on each vehicle supplied under this Contract shall be given a vehicle level type test at the Contractor's facility prior to shipment to assure proper operation. The first vehicle to be modified shall be designated for vehicle level type testing. Test procedures shall be provided for approval to the Engineer and test reports for each vehicle shall be approved by the Engineer prior to shipment from the Contractor's facility. Copies of all test reports for each vehicle shall be submitted to SFMTA at the time the vehicle is delivered. Unless otherwise specified, the vehicle level type testing shall be performed at the Contractor's facility.

## **INSPECTIONS AND TESTING**

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The overhauled equipment shall be installed and adjusted using procedures developed in accordance with the OEM manuals. All adjustments shall be made and verified prior to conduct these tests. Should the Contractor conclude that the test cannot be completed due to an issue associated with a component that is outside the scope-of-work of this overhaul, the issue shall be presented to SFMTA for disposition, which may include the repair or replacement of the failed component by SFMTA personnel, or issuance of a replacement for installation into the vehicle by the Contractor's personnel to enable completion of the test.

These type tests shall verify proper functions and performance of equipment and systems as install in the vehicle. All required vehicle routine tests shall be successfully completed prior to commencing any type tests. These type tests shall include:

- Cable assemblies
- Air Supply Unit and controls
- Door operators
- Step Assemblies
- Coupler Assemblies

### **TP10.07 PRODUCTION (ROUTINE) TESTS**

All equipment and systems, as indicated in the approved Master Test Program Plan, on each vehicle supplied under this Contract shall be given a routine test (production test) at the manufacturer's facility prior to shipment to the Contractor to assure proper adjustment and operation Prior to shipment to the Contractor. Test procedures shall be provided for approval to the Engineer and test reports shall be made available for approval at the Contractor's plant.

No equipment shall be submitted for test until a physical examination of the product has been successfully completed that confirms the equipment has been manufactured to the design accepted. Each unit shall successfully complete its routine test before it is released for shipment to the vehicle builder.

Test procedures and test reports shall be submitted to the Engineer for approval, and shall become the property of SFMTA. Test Reports shall be included in each Car History Book.

The test to be performed by each manufacturer and the Contractor on each vehicle component or subsystem shall be in accordance with the applicable industry standards listed in the Technical Provisions and the approved Master Program Test Plan.

### **TP10.08 PRE-DELIVERY (VEHICLE ROUTINE) TESTS**

The completed vehicle shall be subjected to a series of tests, as indicated in the approved Master Test Program Plan, to verify that the vehicle and its systems are fully functional prior to shipment from the Contractor's final assembly facility. All vehicles shall successfully complete all vehicle routine tests prior to requesting the Engineer's signature of the Release for Shipment document. The Contractor's production test shall include all tests and adjustments, which can be made prior to delivery in order to keep vehicle acceptance testing and adjustments to a

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minimum. Completion of the vehicle routine tests shall result in the vehicle being considered ready to run.

Complete series of tests shall be made on all vehicle systems which are affected by the work performed as part of the Contract to demonstrate proper functional and performance operation as specified. All fault and failure operations and indications for all vehicle systems shall be tested. The specifics of these tests shall be provided in the test procedures submitted for approval. If any component, equipment or system fails a routine test, it will not be approved for shipment until any and all deficiencies have been corrected and the non-comply item has been retested and passes.

Test procedures and test reports shall be submitted to the Engineer for approval, and shall become the property of SFMTA. Test Reports shall be included in each Vehicle History Book .

In addition to the required functional routine tests, the following routine tests shall be conducted on all vehicles:

### **A. Water Test:**

Doors and roof articulation of each vehicle shall be given a complete test for watertightness. The tests shall be performed before installation of sound deadening material, thermal insulation, and interior finish. Water shall be sprayed from nozzles which are spaced no more than three (3) feet from, and aimed directly at, the surface being tested. The nozzles shall be positioned no more than seventeen (17) inches apart in an equilateral triangle pattern and shall produce an overlapping spray pattern. Not less than 0.625 gallon per minute shall be delivered to each square foot of surface being tested, and the nozzle velocity of the water shall not be less than 150 feet per second. All spray applications for complete vehicle body assembly shall run for ten (10) minutes before the inspection for leaks and shall run continuously during the inspection. A local test can be used. The Contractor shall submit, as part of the watertightness test procedure, an analysis of the water test fixture and apparatus demonstrating that all water nozzle pressures, amounts, and directions meet the requirements of this Section. Leakage due to pre-existing damage, noted in the pre-overhaul inspection report, and not within the scope of this overhaul effort, shall not be deemed a failure of this test.

### **B. Door and Step Cycle Test:**

All door operators and steps on each vehicle shall be adjusted and tested to ensure correct operation per OEM test procedure SF3VF 6/15.



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### C. Wiring Test:

When all new wiring is completed on each vehicle, the Contractor shall test each wire to verify continuity and proper polarity, connections, and wire identification. The Contractor shall perform a high-potential ground insulation test as listed below on all new wiring. All components and systems shall be in place when the high potential tests are performed, except that electronic or other low-voltage devices which may be damaged by the test voltages may be disconnected and their wire connections suitably jumpered. The Contractor shall jumper the various wires in a system to insure that all parts of the system are tested. These tests shall be conducted at the Contractor's plant to demonstrate compliance with the requirements of this Section prior to vehicle shipment.

#### 1. Wiring Continuity Test

All new wiring shall be tested on each vehicle to ensure continuity and correct polarity of equipment and devices. All wiring connections and terminals shall be examined for tightness.

#### 2. Insulation Resistance Tests

Insulation resistance tests shall be conducted before high potential tests are conducted. Tests shall be conducted to verify the state of the insulation to the wiring assembly and harnesses

The following insulation resistance limits shall apply under all environmental conditions including high humidity when new wiring assemblies and harnesses on the vehicle of a given voltage class are connected in parallel:

Nominal Circuit Voltage dc or ac rms	Minimum Insulation Resistance
Below 90 volts	2 mega ohms at 500 Vdc
90 to 300 volts	4 mega ohms at 1,000 Vdc
Above 300 volts	5 mega ohms at 1,000 Vdc

#### 3. High Potential Tests

A high potential test shall be conducted after the insulation resistance test is completed and passed. Tests shall be conducted to qualify the state of the insulation of the wiring assemblies and harnesses.

The test shall be conducted by applying the test voltage, as listed below, for a period of one (1) minute, across the insulation being tested, the test shall be passed if there is no insulation breakdown or excessive leakage current. The test voltage shall be at a frequency of 60 Hz with a sinusoidal wave form. V, in the formula below, shall be the nominal system voltage for a circuit:

Nominal Circuit Voltage Volts dc or ac rms	Test Voltage, ac rms
Below 300 volts	$2 V + 1,000$ volts
Equal to or above 300 volts	$2.25 V + 2,000$ volts

## **INSPECTIONS AND TESTING**

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Standard apparatus may be production tested for one (1) second at a test voltage twenty (20) percent higher than the above listed one (1) minute test voltage. Alternative high potential test criteria may be proposed, subject to approval by the Engineer.

### **4. Coupler:**

The tests listed in this section shall be conducted on all vehicles with the coupler properly adjusted. No single vehicle functionality tests may fail unless already noted in the pre-possession test report.

- Single vehicle functionality verification; doors, steps, propulsion, braking, ATCS, and communications.
- Single vehicle isolate/connect switch functionality.

### **5. Air Supply Unit:**

The Contractor shall perform detailed functional and performance tests for complete ASU. The test procedures shall demonstrate that ASU is fully operational and that the ASU is properly interfaced when installed. As a minimum, test shall include:

- Leakage
- Temperature rise
- Capacity and efficiency
- Operating current and voltage
- Pressure output
- Start/stop settings

## **TP10.09 ACCEPTANCE FOR REVENUE SERVICE TESTS**

Each vehicle delivered shall be subjected to tests, as indicated in the approved Master Test Program Plan, performed by the Contractor on SFMTA property. The tests shall be satisfactorily completed and approved by SFMTA as a condition of acceptance.

Test procedures and test reports shall be submitted to the Engineer for approval for inclusion in the Master Test Program Plan, and shall become the property of SFMTA. Test Reports shall be included in each Car History Book.

### **A. Inspection and Repair Requirements**

After receipt of each vehicle at the SFMTA site and before it is operated, it shall be vehicle fully inspected jointly by SFMTA and the Contractor, and any part, device, or apparatus that requires adjustment, repair, or replacement shall be recorded by the Contractor who shall make such adjustment, repair, or replacement before acceptance testing is begun. All expenses and costs incurred in any necessary removal of vehicles from the designated

## INSPECTIONS AND TESTING

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delivery point and their return there for correction of defects shall be borne by the Contractor.

### **B. Functional Tests**

A complete, orderly, and comprehensive check of each vehicle system affected by the work shall be performed to assure its proper operation before commencement of test track operation. SFMTA-owned PTE shall not be used to perform any test. If any PTE is required, such PTE shall be furnished separately by the Contractor. Devices bypassed by the use of PTE (Master Controller, door-open, and door-close buttons for example) shall also be functionally checked. The Engineer reserves the right to test/check the vehicles as deemed necessary.

The following tests shall be performed with another vehicle coupled to the overhauled vehicle. Tests shall be performed on both Couplers. The vehicle with the overhauled Coupler shall always be the lead controlling vehicle.

- Doors, steps, local door control, and communications.
- Emergency door release, passenger emergency stop
- Couple, uncouple, isolate/connect.
- ATCS YDTD verification.
- J line right-of-way propulsion/braking test.
- All trainline functions
- All systems affected by the articulation jumper replacement

After operating the LRV on the MUNI system, the Contractor shall test the cable assemblies and connectors for continuity and circuit function, environmental wear, and inspect the assemblies for chafing, binding, and tangling. Individual conductors within the bundles shall be inspected for chafing, pulling, and environmental ingress.

While SFMTA personnel will operate the LRV during the test, the Contractor will conduct the test

The Contractor shall submit an acceptance test report form to the Engineer for approval. The Contractor shall fill out the report form, documenting the results of each test procedure. The Contractor shall sign and date the form upon completion.

If any component, equipment or system fails an acceptance test, it will not be accepted until any and all deficiencies have been corrected and the non-comply item has been retested and passes.

### **C. Miscellaneous Tests**

At a minimum, the following tests shall be performed on each vehicle at SFMTA, when the vehicle is declared ready for test:

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- Auxiliary circuits and equipment shall be tested for proper operation.
- All interior and exterior vehicle lighting shall be tested for proper function, including emergency operation.
- The proper functioning of the radio
- Any fault or failure operation and indication testing requiring road test and not completed elsewhere
- Lengths, heights, and locations of electrical jumpers and any other end connections shall be validated .
- Coupler installation shall be verified or adjusted to proper height and level.
- Air springs shall be leveled in accordance with SFMTA procedures.

### **TP10.10 PILOT CAR 500-MILE 30 DAY TEST**

The first LRV delivered shall be placed into service following execution of the "Acceptance for Revenue Service" certificate, and shall run for 500 miles or 30 days, whichever comes first. The Contractor, with assistance from SFMTA shall regularly inspect the rehabilitated systems to verify proper performance.

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## TP10.11 CONTRACT DELIVERABLE REQUIREMENTS LIST

CDRL #	Title	Reference Paragraph
10-001	Master Program Test Plan	10.01
10-002	Pre-Possession Inspection Procedure	10.02
10-003	Pre Possession Inspection Report	10.02

End of Section



**TECHNICAL SPECIFICATIONS  
(TECHNICAL PROVISIONS)**

**SECTION TP12**

**TECHNICAL DOCUMENTS AND TRAINING**

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**TP12: TECHNICAL DOCUMENTS**

**TP12.01 GENERAL REQUIREMENTS**

The Contractor shall provide update pages for the LRV Maintenance Manuals and the Integrated Parts Catalog for the Articulation Wiring Harness modification.

**[CDRL 12-001] CONTRACT DELIVERABLE REQUIREMENTS LIST**

CDRL #	Title	Reference Paragraph
12-001	Technical Document Updates	TP12.01

**End of Section**



**TECHNICAL SPECIFICATIONS  
(TECHNICAL PROVISIONS)**

**SECTION TP13**

**RELIABILITY, MAINTAINABILITY,  
SYSTEM SAFETY AND  
LIFE CYCLE MAINTENANCE**

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### SECTION TP13 RELIABILITY, MAINTAINABILITY, SYSTEM SAFETY AND LIFE CYCLE MAINTENANCE

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## **RELIABILITY, MAINTAINABILITY, SYSTEM SAFETY AND LIFE CYCLE MAINTENANCE**

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### **TP13: RELIABILITY, MAINTAINABILITY, SYSTEM SAFETY AND LCM**

#### **TP13.01 RELIABILITY**

The functional design of the LRV overhauled and redesigned systems shall provide reliability and maintainability characteristics that provide a high degree of reliability and durability, and minimize downtime during preventive and corrective maintenance activities and troubleshooting and fault isolation. The intent is to maximize on-time performance, minimize time delays, minimize unscheduled repairs, minimize service failures, optimize safety, and optimize maintainability and durability by increasing diagnostics and fault isolation, providing test points and designing for ease and accessibility of troubleshooting, active maintenance, and repair without sacrificing quality, safety and individual system performance.

In general, reliability of the LRVs shall be attained by adherence to service-proven designs of equipment. Hardware and software shall be selected to achieve superior levels of reliability through adherence to the following criteria:

- Use of systems and components, the reliability of which has been proven in similar operating conditions and service to that which these LRVs are to provide.
- Use of the simplest possible equipment to attain the desired functions and performance.
- System or component derating.
- Increased factors of safety.
- Selection of high-quality components.
- Development of an operational profile used in making the reliability predictions and analyses for each vehicle, system and subsystem in determining the percent of non-moving profile based on the time percent of the moving profile.

#### **TP13.02 MAINTAINABILITY**

The linkage between maintenance and design is a major contributing factor for providing a high degree of reliability and minimizing downtime. Maintenance requirements to be considered in the design include:

- Rapid and positive identification of replaceable defective components
- Unit exchange of major components
- Modular design, "plug-and-play" mounting
- Define wear-out limits to provide a clear margin of performance over the maintenance objective
- Minimize the number of maintenance tasks such as calibrations, adjustments, and inspections

In the overhaul and/or redesign of systems and components the Contractor shall not require that maintenance be performed more frequently than 92-day intervals, except where approval has

## **RELIABILITY, MAINTAINABILITY, SYSTEM SAFETY AND LIFE CYCLE MAINTENANCE**

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been given specifically in writing by the Engineer for a shorter interval, or previously accepted by SFMTA in the original LRV design.

### **TP13.03 SYSTEM SAFETY**

The Contractor shall maintain a comprehensive System Safety Program as referenced in Section TP01 of these technical provisions.

The general safety design requirements shall be incorporated into the design of all vehicle systems affecting safety:

- Only components with high reliability and which have been proven in conditions similar to the projected service shall be utilized.
- All devices not guaranteed fail-safe shall be assumed capable of failing in permissive modes.
- All electronic circuits and software shall be assumed capable of failing in permissive modes.
- Systems shall be based on closed-circuit principles in which energized circuits result in permissive conditions, while interrupted or de-energized circuits result in restrictive conditions.
- All vital circuits not wholly within the system apparatus enclosure shall be double-wire and double-break, with the exception of connections to non-vital circuits, which may be single-wire and single-break.
- Any component or wire becoming grounded shall not cause a permissive condition. Safety circuits shall be kept free of any combination of grounds that will permit a flow of current equal to, or in excess of, 75% of the release value of any safety device in the circuit.
- Circuit impedances, signal encoding, shielding, layout, and isolation shall be selected to minimize the effects of interference to the extent that safety is maintained under all conditions.
- Commands that result in permissive conditions shall be propagated by no less than two independent signals, both of which must be present before the permissive condition can occur. The lack of either signal shall be interpreted as a restrictive command.
- Systems controlled by variable level signals shall be arranged such that zero signal level results in the most restrictive condition. At least one enabling signal, however, independent from the variable control signal, shall be present before the control signal can modulate the system to a more permissive level.
- Circuit breakers and fuses shall be guaranteed by the manufacturer to successfully interrupt circuit overcurrents. Circuit breakers and fuses shall be applied such that the maximum circuit fault currents cannot exceed the manufacturer's guaranteed operating ranges.
- Systems that rely on structural integrity for safety shall have sufficient safety factors such that failures are not possible within the life of the vehicle under all possible conditions.

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- Systems subject to wear shall not wear to permissive states within a period less than three times the overhaul period under the worst-case combination of duty cycle, environment, and all other influences. Such devices shall be clearly indicated as SAFETY CRITICAL in the maintenance manuals.
- Mechanical systems which apply force to achieve safe states shall not depend upon the application of fluid pressure or electrical energy, unless specifically approved.
- All locks, catches, and similar devices affecting safety shall be either self-engaging without application of power, or, if engaged by application of power, shall remain fully and safely engaged in the absence of power.
- All systems shall function safely under all combinations of supply voltages, fluid pressures, shock, vibration, dirt accumulation, and SFMTA's environment.
- All safety-related systems, and devices within those systems, shall be clearly identified as SAFETY CRITICAL in all maintenance manuals, procedures, and training materials.

### **TP13.04 LIFE CYCLE MAINTENANCE**

The Contractor shall support SFMTA's Life Cycle Maintenance (LCM) program by providing updates to existing drawings, procedures, and bills of material where necessary to accurately represent the state of the LRV and its systems after the overhaul effort. These documentation requirements are provided in TP01 of these Technical Provisions.

**End of Section**

