TECHNICAL SPECIFICATIONS
(TECHNICAL PROVISIONS)

SECTION TP02

DESIGN CRITERIA

August 28, 2009
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SECTION TP02
DESIGN CRITERIA

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TP02 DESIGN CRITERIA

While the scope of these Technical Provisions limits the amount of design required, it is the responsibility of the Contractor to ensure that all work, including new design and rehabilitation is performed in a manner that is consistent with the SFMTA operating environment. Thus, a select amount of design information is provided in this section, for reference purposes.

TP02.01 MUNI SYSTEM DESCRIPTION

A. General Description

The SFMTA refers to its light rail system as the San Francisco MUNI Metro. The Metro system has five lines which presently operate over 40.8 track miles. Because the lines overlap, they account for a total of 72.5 line miles, as follows:

- J-Church 10.9 line miles
- K-Ingleside 15.6 line miles
- L-Taraval 16.1 line miles
- M-Oceanview 18.2 line miles
- N-Judah 14.0 line miles

B. Operations

The Metro system operates in subway in downtown San Francisco and on surface alignments in San Francisco's other neighborhoods. Patronage averages 135,000 per day, served by a current fleet of 147 light rail vehicles (LRVs). The vehicles operate in one- or two-car consists on surface streets, and in mixed-route consists of up to four cars in the subway (for example, a consist may be composed of one K-line, one L-line, and two M-line cars; or one J-line and two N-line cars). Cars are coupled and uncoupled at tunnel portals located at the intersections of Duboce and Church Streets and Carl and Cole Streets, and at the West Portal.

The subway route is served by nine stations, one of which is at grade (the West Portal Station). At Embarcadero, Montgomery, Powell and Civic Center Stations, MUNI Metro shares station mezzanines with the Bay Area Rapid Transit system, enabling transfers between the two rail systems.

Metro trains begin operation on weekdays at 3:45 a.m., and weekends at 5:00 a.m. Revenue service ends at 12:37 a.m. each night when the last train leaves Embarcadero Station for Metro Center. On weekdays trains operate at 6- to 10-minute headways until 6:00 p.m., at 10- to 20-minute headways until 8:30 p.m., and at 20-minute headways after 8:30 p.m.

Metro trains operate on power supplied by 600-volt overhead lines. The power system is supplied by 12 substations located within the city limits. Each substation, depending on its location, is capable of serving from 2 to 13 feeder sections.

C. Track

The MUNI Metro system incorporates track on reserved surface right-of-way, in tunnels, and on surface streets shared with motor vehicle traffic. Approximately 80 percent of the system is on tangent track. The minimum curve radius is 42 feet, 7 1/2 inches (inside rail). Mainline track superelevation is generally 4 inches in the subway and 1 1/2 inches on the surface. Transition spirals are used on each superelevated curve. Curves within paved streets are not superelevated, unless such is required to meet the street cross section. Curves within the yard are not superelevated. A maximum train speed of 50 miles per hour is permitted in tunnels where conditions allow. Train speed within paved street segments is controlled by vehicular speed limits. All tangent and large-radius curved track is standard 4 foot, 8 1/2 inch gauge. Track gauge is slightly increased on sharp-radius curved track.

Within paved streets, the track profile follows that of the street. Within reserved right-of-way, the track profile also generally follows that of adjacent streets. The maximum grade on the system is 9 percent.

All rail within the system is continuous welded rail, except at the following locations: from Market Street to 18th Street on the J-Church line, and on Ocean Avenue on the K-Ingleside line. Bolted rail is used at these two locations. Standard six-hole insulated joints are used within the system where insulated joints are required.

Most of the special trackwork units have standard rail joints. Some non-insulated joints, however, have been replaced with field welds.

Direct fixation track with fasteners spaced 36 inches apart is used within the Metro subway tunnel. Elsewhere, all MUNI Metro track is either embedded track or tie and ballast track using sawn timber ties spaced 24 inches center-to-center. Special trackwork is fastened and anchored to timber ties (or tie blocks) with standard AREA tie plates, cut spikes, and rail anchors throughout the system.

Switches within the MUNI Metro subway have electrically operated switch machines. Elsewhere switches are manually operated, except for a few switches that are activated by train approach.

Any modifications to vehicle systems shall be designed for normal operation with no interferences over all track on the MUNI Metro system, which has the following general characteristics:

Track gauge	4 ft., 8 1/2 in.
Minimum lateral radius (to centerline)	45 ft., 0 in.
Maximum superelevation	0 ft., 6 in.
Minimum vertical radius, crest	310 ft., 0 in.
Minimum vertical radius, sag	460 ft., 0 in.
Maximum grade	9 percent
Minimum combined lateral and vertical radius	
Lateral	45 ft., 0 in.
Vertical	410 ft., 0 in.

The MUNI Metro system incorporates both AREA and street railway type trackwork. The street railway trackwork includes such features as flange-bearing special work and single point turnouts.

The standard rail for all new tee rail track construction is 100 lb/yd ARA-B in mainline track and 90 lb/yd RA-A in yard track. The standard rails for all new girder rail track construction are 128 and 149 lb/yd RE-7A. Girder rail is used only where the system operates within paved streets. The 128 lb/yd RE girder rail is used on tangent track, and the 149 lb/yd RE girder-grooved rail is used as the inside rail on tight-radius curved track.

D. Structures

Station platform height from top of rail	2 ft., 9 in.
Distance, centerline track to finished edge of platform	4 ft., 8 in.
Station platform length	
(minimum)	300 ft., 0 in.
(maximum)	400 ft., 0 in.

E. Primary Power

Line voltage at the MUNI Metro trolley wire ranges from 450 VDC to a maximum of 750 VDC. Occasional voltage spikes of 1800 volts peak with a duration of 30 milliseconds can be expected.

Vehicle equipment shall be designed and tested for operation at nominal 600 VDC power, but normal voltage variations and power isolation gaps shall not cause damage. Full performance of any vehicle system shall be provided down to 575 VDC. Performance may be degraded between 575 and 450 VDC.

For line voltages outside the normal 450-750 VDC limits, equipment may be designed to shut down or operate at modified performance levels.

Contact wire ranges in height from 12 feet, 2 inches to 19 feet. The wire size is 4/0 grooved.

TP02.02 VEHICLE CHARACTERISTICS

Basic car dimensions are provided for reference purposes. It is the responsibility of the Contractor to verify any dimensions required for design and rehabilitation work.

Length of car on centerline over anti-climbers (maximum)	73 ft., 0 in.
Length of car over coupler pulling faces (maximum)	75 ft., 0 in.±1/2 in.
Distance, center to center of trucks (maximum)	24 ft., 0 in.±3/8 in.
Truck wheel base (maximum)	6 ft., 3 in.
Truck wheel base (minimum)	5 ft., 10.5 in.
Wheel diameter, new wheels	0 ft., 28 in
Wheel diameter, worn wheels (condemning limit)	0 ft., 26 in.
Maximum overall car width at threshold	8 ft., 8 in.

Maximum overall car width at belt line	9 ft., 0 in.
Width of car at front corner posts (maximum)	5 ft., 7 in.
Width of side door openings (hi-low step)	4 ft., 6 in.
Width of left side front door (hi-low step)	3 ft., 0 in.
Height of car, top of rail to top of power collector (locked down)	11 ft., 6 in.
Height of car, top of rail to top of roof equipment (maximum)	11 ft., 6 in.
Height of car, top of rail to top of roof sheet (maximum)	11 ft., 0 in.
Height of car floor from top of rail	2 ft., 10 in. ± 1/4 in.
Height of centerline of coupler face from top of rail	1 ft., 5-1/2 in.
Minimum clearance, top of rail to coupler over vertical curves	0 ft., 4 in.
Minimum clearance, top of rail to truck and undercar components	0 ft., 2 in.
Height, floor to bottom of window sheet opening (minimum)	2 ft., 8 in.± 1 in.
Height, floor to headlining of car (minimum at low ceiling)	6 ft., 8 in.
Height, floor to ceiling at centerline (minimum)	6 ft., 11 in.
Height, door openings over car floor (minimum)	6 ft., 3 in.
Minimum width of aisle	2 ft., 8 in.
Minimum width of articulation corridor	4 ft., 2 in.
Maximum height, lower step from top of rail	1 ft., 2 in.
Minimum step tread depth	0 ft., 10 in.
Maximum width of gap between door threshold with steps in high position and subway station platform edge	0 ft., 41/2 in.
Carbody end overhang (center line truck to anticlimber surface)	12 ft., 6 in.
Carbody end overhang (center line truck to coupler face)	13 ft., 6 in.

TP02.03 GENERAL REQUIREMENTS

A. General Design Requirements

This Section establishes performance, environmental and general design criteria for the SFMTA Light Rail Vehicles and its systems. All equipment and components shall have a proven history of successful operation in revenue service similar to that of the SFMTA. Proof of proven operation shall be substantiated by submission of reliability/failure data, service time and location, modification information and maintenance records.

B. Submittals

In addition to other contract-required submittals, for proposed design modifications, the following items shall be submitted for approval of any design change or new component:

(a) Proof of proven operation, including reliability/failure data, service time and location, modification information, and maintenance records.

(b) Descriptive, analytical, and graphic data to substantiate the performance characteristics and dimensional requirements of the component.

(c) As-appropriate based on design changes to the systems specified in these Technical Provisions, static and dynamic vehicle outlines, including drawings, test results, and analyses to indicate that vehicle consists will negotiate all curves, tunnels, and surface conditions, including the overhead power line, on the existing system and new

extensions and layovers under MUNI's normal operating requirements and conditions, with no interference from other vehicles or wayside objects. .

(d) If necessary, analyses showing how acoustic noise and electromagnetic interference requirements will be met.

C. Environmental Criteria

The vehicle shall be capable of being operated, stored, and maintained at specified performance levels within the environment of the San Francisco MUNI Metro.

(a) Temperature Range: Between 25 and 100 degrees F.

(b) Relative Humidity: Between 5 and 100 percent.

(c) Wind: High winds are characteristic of the system right-of-way. Winter storms occasionally are accompanied by wind velocities up to 80 mph.

(d) Precipitation: Average annual rainfall is 15 to 20 inches. Storms occasionally bring 1 to 2 inches of rain within 24 hours.

(e) Moisture Acidity: Vehicle will be subjected over extended periods to moisture having a pH of 4.0.

(f) Fog: Heavy fog is characteristic of the area.

(g) Chloride Content: High-volume samples taken by the Bay Area Air Pollution Control District indicate that airborne suspended particles of chloride are to be expected in areas exposed to ocean and bay airflow. Maximum quantity measured during sampling was 13.9 micrograms per cubic meter.

D. Weight Criteria

As a baseline for performance design purposes, the following maximum weights are defined based on vehicle capacity:

(a)	AW0 Empty car weight	76,000 lbs
(b)	AW1 Seated load car weight (62 pass. + operator) (AW0 plus 9,700 lbs passenger load)	85,700 lbs
(c)	AW2 Seated plus standees (155 pass.+ operator) (AW0 plus 24,000 lbs passenger load)	100,000 lbs
(d)	AW3 Crush load car weight (220 pass.+ operator) (AW0 plus 34,000 lbs passenger load)	110,000 lbs

Passenger weight is assumed to be 154 pounds per person.

E. General Testing Requirements

The Contractor shall develop and maintain a test program in compliance with the requirements of TP10 and the requirements of each system design Technical Provisions section.

TP02.04 SHOCK AND VIBRATION

Equipment design and mounting arrangements shall be based on the specific location of the equipment on the vehicle and shall take into account the influence of adjacent components as well as the effect of normal vehicle operation. In addition to any shock or vibration encountered in normal operation, equipment shall withstand the following vibration levels:

(a) Components mounted on the carbody shall be designed and installed to successfully sustain a vibration test consisting of 0.1 g input along three mutually perpendicular axes over a frequency scan of 0.5 to 40 Hz at one octave per minute sweep rate with dwell of 15 seconds at each integral frequency.

(b) Components mounted on the truck frame shall be designed and mounted to withstand, without fatigue or deterioration for the life of the vehicle, the normally occurring random shock and vibration magnitudes present at the support points on the truck frame. These magnitudes shall be considered to be: vibrations of 1.0 g rms with a crest factor of 5 (ratio of peak to rms acceleration level), within a frequency range of 10 Hz to 10 kHz in all directions; and shocks of 20 g peak in the vertical axis and 6 g peak in the lateral axis, with pulse durations ranging from 4 milliseconds to 10 milliseconds, occurring up to 100 times per operating day.

(c) Axle mounted components shall be designed to withstand, at a minimum, continuous random vibrations of 10g rms within a frequency range up to 100 Hz in all directions; and shock pulses of 50 g in the vertical axis and 10g horizontally with durations ranging from 0.5 milliseconds to 2.0 milliseconds, occurring approximately 100 times per operating day.

(d) With the car stationary and with all auxiliary units operating simultaneously at rated capacity, the vertical or horizontal vibrations of floors, walls, seat frames, or any surface with which a passenger or operator can come in contact shall not exceed any of the following values:

(1) Displacement, peak-to-peak 0.10 in.
(2) Acceleration, peak value 0.02 g below 20 Hz
(3) Velocity, peak value 0.045 in./sec. above 20 Hz.

TP02.05 SYSTEM SAFETY REQUIREMENT

A. General

The car shall conform to all applicable laws, rules, regulations, standards and recommended practices specified within these Technical Provisions.

B. Failures

Protection shall be provided against failures, including software failures, which could cause an unsafe condition such that two or more sequential failures will be required for

such condition to occur. The first such failure shall not result in an unsafe condition and shall energize an alarm.

C. Fire Protection and Toxicity

All materials used on the car, except for incidental materials used in small parts (such as knobs, rollers, fasteners, clips, grommets and small electrical parts) which would not contribute significantly to fire propagation or smoke emission, shall conform to the following maximum toxic gas release limits, when tested in accordance with Boeing Specification Support Standard (BSS) 7239:

- Carbon Monoxide (CO) 3500 ppm
- Hydrogen Fluoride (HF) 200 ppm
- Nitrogen Dioxide (NO2) 100 ppm
- Hydrogen Chloride (HCL) 500 ppm
- Hydrogen Cyanide (HCN) 150 ppm
- Sulfur Dioxide (SO2) 100 ppm

SFMTA reserves the right to have testing performed on any production lot of material in addition to the tests required of the Contractor to demonstrate performance.

D. Potentially-Hazardous Electromagnetic Fields

The vehicle shall not produce any health hazard to the public, passengers, train crew, or maintenance personnel.

E. Fire and Life Safety

All vehicle components, subsystems, and systems shall be designed for the prevention of fire; protection of the public, employees, and emergency response personnel from injury due to fire, smoke, explosion, or panic due to fire; and protection of system elements from damage by fire or explosion.

F. Safety Under Normal Operating Conditions

The vehicle shall present a safe, hazard-free environment to passengers and operating and maintenance personnel to the extent practical, and as such, any system that is rehabilitated or redesigned shall take the following into account:

Passengers shall not be exposed to tripping hazards, sharp points and edges; any voltage of 50 V or more, including between cars on adjacent tracks; toxic materials; abrupt or unexpected accelerations; or similar hazards.

Normal and emergency equipment and controls which the passenger may operate shall be clearly identified, and operating procedures shall be presented in both text and graphic formats.

Exposure of maintenance personnel to lethal or injurious voltages shall be minimized through compartmentalization, interlocks, and similar measures. All equipment shall be free from sharp points and edges. All equipment enclosures containing hazardous materials, lethal or injurious voltages, or other risks shall be clearly labeled on both the outside and inside of the equipment enclosures.

TP02.06 CONTRACT DELIVERABLE REQUIREMENTS LIST

CDRL #	Title	Reference Paragraph

End of Section

TECHNICAL SPECIFICATIONS

(TECHNICAL PROVISIONS)

SECTION TP03

LRV AUTOMATIC COUPLER ASSEMBLY REHABILITATION

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SECTION TP03
LRV AUTOMATIC COUPLER ASSEMBLY REHABILITATION

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TP03: AUTOMATIC COUPLER ASSEMBLY OVERHAUL

TP03.01 GENERAL

The Contractor shall be responsible for the removal, cleaning, disassembly, overhaul, repair, testing and re-installation of the automatic coupler assemblies on all cars. This includes mechanical, electrical, and pneumatic elements.

TP03.02 SCOPE OF WORK

A. GENERAL

The Contractor shall perform the following tasks during the overhaul:

- Removal and replacement from the vehicle, disassembly, cleaning, stripping, and repainting of the coupler per section 7 of the HRWM.
- Installation of new or rebuilt components listed in Section TP3.02B of these Technical Provisions
- Pre-delivery testing of the coupler, per Breda HRWM section 7, as defined in TP10
- Post-delivery testing of the coupler installed on the LRV, as defined in TP10

B. COUPLER COMPONENT OVERHAUL

The Contractor shall overhaul or provide new and install the following components:

1. Draft Gear

Overhaul by replacing all bearings, bushings, rubber springs, seals, grease fittings, washers and fastener.

2. Center Devices

Overhaul by replacing all bearings, disc spring, washers and fasteners.

3. Buffer Assembly

Overhaul by replacing all bearings, scraper, washers, fasteners and seals including rebuilding of the hydraulic buffer. All new welds shall be tested non-destructively.

4. Rubber Bellow

Provide new.

5. Support Spring

Provide new or rebuild by replacing all bearings and fasteners.

6. Mechanical Coupler Head

Rebuild by replacing all bearing, springs, pin, cable for the uncoupling handle and the rotating hook plate.

7. Operating Device

Rebuild electrical and mechanical parts.

8. Uncoupling Device/Guide Rail

Contractor shall rebuild the uncoupling device/guide rail by replacing all bearings, springs, grease fittings, washers and fasteners and rebuild the uncoupling cylinder.

9. Suspension Attachment (LH)

Contractor shall rebuild the suspension attachment by replacing all bearings, grease fittings, springs, washers, roll pins and lock nuts. The attachment bridge shall be inspected for cracks and repaired as needed. New welds shall be tested non-destructively.

10. Suspension Attachment (RH)

Contractor shall rebuild the suspension attachment by replacing all bearings, grease fittings, springs, washers, roll pins and lock nuts. The attachment bridge shall be inspected for cracks and repaired as needed. New welds shall be tested non-destructively.

11. Electrical Coupler (LH)

Contractor shall rebuild or provide new. Contractor shall use fixed contacts developed by Voith Turbo Inc. for SFMTA with part number 304006929, or equivalent as approved by the Engineer. Rebuild shall include providing new cable or contact device.

12. Electrical Coupler (RH)

Contractor shall rebuild or provide new. Contractor shall use fixed contacts developed by Voith Turbo Inc. for SFMTA with part number 304006955, or equivalent as approved by the Engineer. Rebuild shall include providing new cable or contact device.

13. Electrical Coupler (top)

Contractor shall rebuild or provide new. Contractor shall use fixed contacts and moving contacts developed by Voith Turbo Inc. for SFMTA with part numbers 304006930 and 304006927 respectively, or equivalent as approved by the SFMTA. Rebuild shall include providing new cable and accessories.

14. Limit Switch

Provide new.

15. Pneumatic Valves and Tubing

Provide new.

16. Cut-out Cock and Air Filter

Provide new.

17. Coupler Stops

Repair as needed and reinforce.

18. Coupler Face

Wear and flatness shall be verified and repaired as needed.

19. Manual Uncoupling Cable and Handle

Inspect and repair or replace as needed.

TP03.03 OVERHAUL PROCEDURES

The OEM manuals contain procedures that are sufficient for removing, disassembling, reassembling, installing, adjusting, and testing the complete door system; subsets of these are relevant to the scope-of-work defined herein. The Contractor shall generate work procedures to comprehensively define the scope of work associated with this overhaul, using the OEM Heavy Repair and Workshop Manual (HRWM) procedures as a basis.

The procedure shall include sign-off sheets that shall be utilized during overhaul. A sign-off sheet shall be maintained for each coupler and submitted **[CDRL 3-003]** for insertion into the Car History Book. Each critical step in the overhaul shall be signed off by the responsible person.

TP03.04 INSPECTIONS AND TESTING

The Contractor shall verify the condition and functionality of the car couplers before shipping each vehicle from the SFMTA shop to their rebuild facility. This inspection and testing shall be included in the Pre-Possession Inspection Procedure specified in Section TP10.02 of these Technical Provisions.

The Contractor shall also perform proper tests and inspections prior to shipping the completed car and upon deliver of the car to SFMTA, as detailed in Section TP10 Inspections and Testing in these Technical Provisions. Such tests will require coupling to another vehicle and demonstrating performance of all trainlined commands including but not limited to, propulsion, doors, communication, braking, coupling/uncoupling, auxiliary electric.

TP03.05 LABELS

The Contractor shall apply labels to all overhauled equipment to indicate when it was overhauled. The labels shall be of the same type as the OEM labels currently installed on the

equipment. The quantity and locations of labels shall be similar to the original labeling arrangement, consistent with the labeling plan specified in TP01, Section 1.07.O.

TP03.06 FIRST ARTICLE INSPECTION

The first rebuilt unit shall be presented to SFMTA for approval, prior to continuation of the rebuild effort. The Contractor shall support this process with a complete set of documentation, including test reports. **[CDRL 3-004]**

TP03.07 CONTRACT DELIVERABLE REQUIREMENTS LIST

CDRL #	Title	Reference Paragraph
3-004	Coupler Overhaul FAI Package	3.06

TECHNICAL SPECIFICATIONS
(TECHNICAL PROVISIONS)

SECTION TP04

DOOR OPERATOR & STEP SYSTEMS

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DOOR OPERATOR & STEP SYSTEMS

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TP04: DOOR AND STEP SYSTEMS

This Chapter describes the overhaul requirements for the Door and Step Systems on the SFMTA fleet of Breda-built LRVs. The Contractor is responsible for overhauling the door and step systems per the requirements of this section, and any other applicable portions, of this specification. Overhauled equipment shall be verified via testing to demonstrate that it functions in accordance with the Original Equipment Manufacturer's (OEM's) requirements, as defined herein, and in the referenced documents and manuals. Terminology used herein generally is the same as that utilized in the OEM manuals for these systems.

TP04.01 DESCRIPTIONS

A. LRV Configurations

The LRVs were procured in two groups that have distinct differences; particularly as pertains to the door system. These differences are detailed herein to the extent relevant to the scope of work. The vehicle groups are:

- **LRV2: Vehicles 1400 through 1476**
- **LRV3: Vehicles 1477 through 1550**

The LRV2 cars were accepted between November of 1996 and July of 1999; the LRV3 cars were accepted between March of 2000 and September of 2003. The terms LRV2 and LRV3 are used interchangeably with the vehicle groups identified above.

B. OEM Manuals

1. Accuracy

The OEM manuals have been utilized to generate the listing of assemblies, components, and parts described herein. Although there are known to be a small quantity of minor errors with respect to the labeling of some illustrations and parts, there are none known that influence the Contractor's ability to accurately identify the parts requiring rehabilitation.

2. Part Quantities, Part Numbers & Part Groupings

The quantities of each item associated with the various door system components and assemblies are not defined herein and must be discerned from the equipment and manuals by the Contractor.

The OEM changed the Bill Of Material (BOM) groupings for some door system assemblies between the LRV2 and LRV3 manuals, with the LRV3 BOMs having separate illustrations and parts lists for subassemblies that were included with the parent assemblies in the LRV2 manuals. The parts groupings herein do not reflect the groupings in the OEM manuals for some assemblies, as the LRV3 groupings were reassembled to match that of the LRV2 manuals in order to generate overhaul requirements for common assemblies. The contractor shall review the OEM manuals to obtain part numbers and total quantities for all door system elements requiring overhaul for each operator and car type.

3. Procedures

OEM manual procedures identify differences between each operator and car type to the extent that these differences influence completion of the procedures. Thus, OEM manual procedural references herein often do not require delineation between operator and car types.

4. Special Tools

Some procedures in the OEM manuals require "special tools" to complete. The contractor will be provided one complete set of all special tools required to perform defined processes, which shall be returned to the Authority upon completion of the work; additional special tools may be provided by the Authority on a case-by-case basis, at its discretion, based on availability.

C. Door Opening Configurations

Each LRV has eight door openings, of which there are three different door-opening widths, as defined below:

- There are four 54-inch door openings
- There are two 47-inch door openings
- There are two 36-inch door openings

Each door opening has two door panels except for the 36-inch door opening, which has one.

D. Door Operator Configurations

There are two distinctly different door operator configurations present in the fleet. The following describes these configurations and the cars each is installed on:

1. 36-Inch Door Openings

The door operators for the 36-inch door openings are the same on all cars. These openings have a single door panel driven by a single door operator assembly equipped with an interior manual door release mechanism and both interior and exterior crew-switch controls.

2. 47-Inch Door Openings

- **LRV2**
  There are two door panels, each of which is driven by a single door operator assembly, i.e., two operators per opening. These doors are equipped with interior and exterior manual door release mechanisms and crew-switch controls, each of which controls both door operators.
- **LRV3**
  There are two door panels, both of which are driven by a single door operator assembly, i.e., one operator per opening. These doors are equipped with interior and exterior manual door release mechanisms and crew-switch controls.

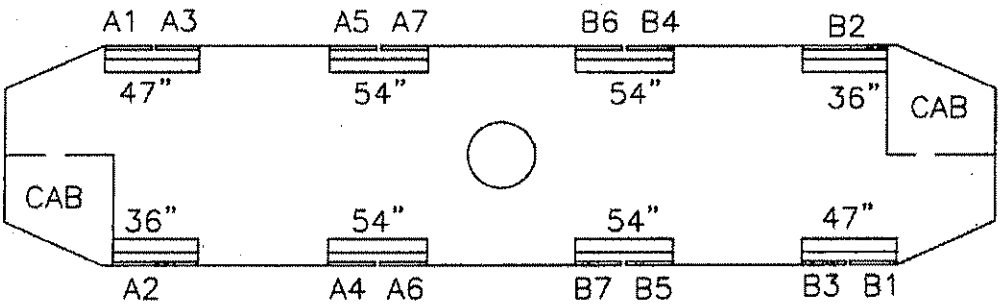
3. 54-Inch Door Openings

- **LRV2**
  There are two door panels, each of which is driven by a single door operator assembly, i.e., two operators per opening. These doors are equipped with only an interior manual door release mechanism; no crew switches.
- **LRV3**
  There are two door panels, both of which are driven by a single door operator assembly, i.e., one operator per opening. These doors are equipped with only an interior manual door release mechanism; no crew switches.

All door operator configurations consist of overhead-mounted, bi-parting, except for the 36-inch single-panel operators, outside-sliding, plug-doors. The door operators are controlled by an electronic control unit, one per door operator.

E. Door Panel Configurations

Each door panel is constructed of an extruded aluminum frame with bonded skins. There are five unique door panel types installed onto each LRV. The diagram below conveys the car layout and depicts the established convention for identifying each door panel:



The following groupings are of like door panel configurations:

- Center Left-Hand Door Panels: A5, A6, B5, B6
- Center Right-Hand Door Panels: A4, A7, B4, B7
- End Left-Hand Door Panels: A1, B1
- End Right-Hand Door Panels: A3, B3
- Single End Door Panels: A2, B2

Each door panel configuration includes a window in the upper portion; panels A1, A3, B1, and B3 also have a window in the lower portion of the panel.

TP04.02 STEP SYSTEM DESCRIPTION

A. Step Configurations

The step system accommodates both high- and low-level boarding through each of the eight door openings. There are three distinct step configurations, one for each of the three door opening widths.

B. Step Operations

The step system utilizes pneumatic power for raising and lowering the step treads to provide floor-level boarding at platforms and step boarding at street level, respectively. When the steps are positioned for high-level boarding and the doors are opened, a plate extends from beneath the outboard step tread to reduce the car-platform gap passengers must negotiate when entering or exiting the cars. The operations of the step system are synchronized with that of the door operators such that step and extension-plate movements are completed at the appropriate times with respect to door panel movements.

TP04.03 OVERHAUL REQUIREMENTS

A. Resource Documents

The OEM manuals for the LRVs will be at the disposal of the Contractor for use as needed to perform the overhaul of this equipment. These manuals contain detailed instructions for the removal, inspection, installation, adjustment, testing, and as needed overhaul, of the door and step system assemblies and components. A key aspect of these manuals is the Specific Safety Precautions associated with these various activities. The equipment and processes described herein have inherent dangers associated with their being handled other than in accordance with the OEM's recommendations. The Contractor is required to be thoroughly familiar with these precautions and is responsible for the safety of the equipment in addition to that of the personnel performing the work. SFMTA shall not be responsible for incident caused due to neglect, carelessness, lack of proper attention, or willful misuse of equipment.

B. Document Conflicts

All door system assemblies, components, and parts shall be overhauled in accordance with this specification and any applicable OEM requirements. Should the contents herein conflict with OEM requirements, the Contractor shall identify the conflict to the SFMTA for disposition. In such cases, the SFMTA shall have the option of choosing which conflicted requirement must be adhered to without incurring additional costs.

C. Terminology

- Whenever the term "overhaul" is used herein, it shall mean the level of effort designated for a component or assembly, including, but not limited to, cleaning, refinishing, repair, or replacement.
- Whenever the term "replace in kind" is used herein, it shall mean replacement with identical OEM parts, or SFMTA approved equal. The SFMTA is not obligated to accept other than OEM parts, unless the OEM part is obsolete, and may require the Contractor to perform whatever reasonable verification activities it desires in order to demonstrate that the alternative is acceptable based on its being equivalent or superior to the OEM part per Section 1.04.C.1 of these Technical Provisions.
- The costs associated with proving that an alternative is equivalent or superior to an OEM part shall be borne by the Contractor.

- Whenever the term "replace" is used herein, it shall mean replacement with components compliant with applicable material and workmanship standards. This term is utilized primarily for hardware, where compliance with applicable standards is sufficient to demonstrate equivalence to the OEM part.
- Whenever the term "reuse" is used herein, it shall mean disassemble, clean, inspect, verify, refinish and lubricate as needed, reassemble, and reinstall onto the overhauled assemblies; this term reflects estimation that none will require replacement, unless otherwise specified.

D. Hardware/Fasteners

All hardware and fasteners, including, but not limited to, screws, bolts, nuts, clips, washers, lock-washers, shrink wrap, c-clips, tie straps, shaft-keys, springs, shrinkable tubing, cotter pins, retaining rings, bushings, roll pins, clips, gaskets, and etc., on, or in, overhauled assemblies, components, or parts, shall be replaced unless identified for reuse herein.

E. Labels

The Contractor shall apply labels to all overhauled equipment to indicate when it was overhauled. The labels shall be of the same type as the OEM labels currently installed on the equipment. The quantity and locations of labels shall be similar to the original labeling arrangement, per the labeling requirement in TP1.07.O of these Technical Provisions.

F. Overhaul Procedures

The OEM manuals contain procedures that are sufficient for removing, disassembling, reassembling, installing, adjusting, and testing the complete door system; subsets of these are relevant to the scope-of-work defined herein. The Contractor shall generate work procedures to comprehensively define the scope of work associated with this overhaul, using the OEM Heavy Repair and Workshop Manual (HRWM) procedures as a basis. There shall be sections, or separate procedures, as follows, for the major assemblies:

- Removal from cars
- Disassembly
- Overhaul
- Assembly
- Installation & Adjustment
- Testing

The Contractor's overhaul procedures shall include, but shall not be limited to the following, as applicable:

- A list of tools and materials required to complete the procedure, including cleaning products, coatings, lubricants, paints, and other items as required.
- Equipment handling instructions
- Equipment storage instructions
- Safety warnings, including all warnings from the OEM manuals
- Illustrations when needed for clarity
- Torque values and requirements for torque marking

- Use of thread-adhesives and/or lubricants
- Bill of Material for all replacement parts
- Any instructions required to safely ensure comprehensive completion of the overhaul efforts
- Any other procedures required herein

The majority of the above-defined content is available in the manuals.

The Contractor shall submit for approval overhaul procedures **[CDRL 4-001]** to the SFMTA prior to completing any overhaul activities.

Once approved by SFMTA, the contractor shall not change the overhaul procedures without prior SFMTA approval.

TP04.04 Removal, Disassembly, and Inspection of Equipment

A. Removal

The door system equipment shall be removed from the cars in accordance with procedures contained in the OEM manuals. The procedures for removing the door and step system equipment reflect removal of all equipment, and in some instances, the removal procedure includes the disassembly procedure. Since not all door and step system equipment will be overhauled, some equipment will not need removal from the cars.

All door and step system equipment that requires overhaul shall be removed from the cars for overhauling. Any equipment, components, or parts that shall be removed to facilitate removal of equipment to be overhauled, shall be cleaned and reinstalled with new hardware, unless the attachment is designed for repeated removal and reinstallation. The contractor shall identify any items that must be removed, or partially removed, to facilitate completion of the scope-of-work, which are not required to be overhauled, as well as the cleaning and hardware replacement details, to the Authority for approval prior to beginning overhaul efforts on the third car.

The contractor shall identify any door system elements that will not be removed from the cars in order to complete the scope-of-work, i.e., the door controllers and relay panels, as to ensure that door system equipment not included in the scope-of-work are not unnecessarily handled by the Contractor. The contractor shall not be permitted to remove such door system equipment from the cars for use in off-car testing of overhauled door system equipment without prior written authorization from the Authority.

B. Disassembly

The HRWM contains detailed disassembly procedures. These procedures often include figures from the Illustrated Parts Catalog (IPC), which reflect the required level of disassembly for components to be overhauled.

C. Inspection

The Contractor is to identify damages to any component intended for reuse as soon as the damage is observed. This is necessary in order to avoid interruptions to the overhauling processes and disputes related to the cause of the damage.

All components that are to be reused shall be cleaned and inspected after disassembly. Should obvious damage be identified, other than through nondestructive testing activities, after completion of the cleaning and inspection activities, they shall be construed to have been caused by the Contractor, and shall be the responsibility of the Contractor to repair/replace.

TP04.05 Door System Overhaul

The following sections define the overhaul requirements for the various door system assemblies and subassemblies. Overhaul requirements for components that are common to more than one assembly may not be repeated for each assembly, but are applicable to all assemblies having the component.

A. Rubber and Plastic Parts

1. All rubber and plastic parts shall be replaced.

B. Rubber and Plastic Parts

1. All door system wiring harnesses and terminal strips shall be inspected and repaired as necessary, including replacement of any damaged bridge diodes

C. Door Panel

1. The door panel shall be cleaned
2. All seals shall be replaced in kind, except for the window seals, which need not be removed.
3. The sensitive edge is to be replaced in kind, and includes the tube for attachment to the pressure wave switch
4. The mating carbody-mounted seals with which the door panels interface shall all be replaced in kind

D. Pressure-wave Switch

1. The switch shall be replaced in kind
2. The insulator and all hardware, including the cover hardware, shall be replaced

E. Hanger

1. The geometry of the hanger assembly components shall be verified
2. All hardware/fasteners shall be replaced
3. The hanger slide-bearings shall be replaced in kind

F. Fixed Arms

1. All hardware/fasteners and the loop clamp shall be replaced
2. The bearing shall be replaced in kind
3. The spindle nut and carrier shall be replaced
4. The eccentric rod shall be cleaned and reused, 25% are estimated to require replacement

5. The welded fixed arm bracket assembly shall be cleaned and 100% non-destructively tested for cracks and other damage or defect, *25%* are estimated to require replacement

G. Bottom Linkage Assembly

1. All hardware/fasteners shall be replaced
2. The "special shouldered bolt" that attaches the push-pull rod to the ball joint shall be reused
3. The ball joint shall be reused, *25%* are estimated to require replacement
4. The block shall be reused
5. The Eckart Mechanism shall be cleaned, lubricated, and have new bearings installed
6. The push-pull rod shall be reused

H. Traversing Wheel Assembly

1. Wheel brackets shall be replaced in kind
2. Guide rails shall be reused

I. Door Operator Assembly

1. The operators shall be completely disassembled
2. All hardware/fasteners shall be replaced
3. All limit switches shall be replaced in kind, actuators and insulators shall be replaced
4. All bearings shall be replaced in kind, unless otherwise specified
5. The five preceding items also apply to the each of the following door operator subassemblies, unless otherwise indicated:

1. Upper Telescope Assemblies

1. Coiled cords and m-base connectors shall be replaced in kind
2. Shrink tubing shall be replaced
3. Coiled cord end-pieces and mounting brackets may be reused
4. Coil cord guide rods shall be reused
5. Rubber bumpers shall be replaced
6. Spindles, spindle-nuts, and spindle coupling shall be reused
7. Spindle inner race and coupling set screw shall be replaced

2. Roller Carriage Assemblies

The following requirements are comprehensive of each carriage assembly configuration; however, not all carriage assemblies have all components listed below, therefore, these requirements are as applicable to each configuration:

1. Roller carriage brackets are to be reused
2. All bearings, roller and bushing, shall be replaced in kind
3. Bearing shafts shall be reused; both types
4. Gears shall be reused

3. Gearbox Assembly

1. Planetary gearbox shall be reused

2. Both flanges and bearings shall be reused
3. Bellows shall be replaced in kind
4. Shrink tubing, and harness ties shall be replaced

4. Motor Bracket Assemblies

1. All bearings and bearing bushings shall be replaced in kind
2. Cam assemblies shall be reused
3. Pull-spring shafts may be reused; springs shall be replaced
4. Thrust washers and Delrin rings shall be replaced in kind
5. Unplug arms and shafts may be reused, including the ball bearing shafts
6. The motor brackets, release pulley, toothed segment shall be reused

5. Motor Assemblies

There are two different door operator motor assembly configurations:

- LRV2

  The DC motors are equipped with two proximity switches that detect metal plates mounted on the motor shaft. When the shaft is rotating, these sensors are used to determine speed, direction, and position of the door panel. The wiring harness for this motor-sensor configuration terminates with a circular nine-pin connector.

- LRV3

  The DC motors are equipped with an optical encoder to determine speed, direction, and position of the door panel. The wiring harness for this motor-sensor configuration terminates with a rectangular 12-pin connector.

1. All motors, sensors, encoders, and connectors shall be replaced in kind
2. Wiring harnesses shall be replaced
3. LRV2 transmitter brackets and pulse generators may be reused
4. The motor shaft coupling and pinion shall be reused. NOTE: these components shall be attached to the motor shaft, and one another, using 4-mm roll pins instead of the 3-mm pins reflected in the OEM manuals

6. Door Out of Service Switch Assembly

1. Rotary switch shall be replaced in kind
2. Double-flange nylon-bearings shall be replaced
3. The adapter pin, mounting bracket, cylinder and housing assembly, spacers, and retainer plate shall be reused

7. Emergency Release Cables

1. Interior emergency release cables shall be replaced in kind
2. Exterior emergency release cables shall be replaced in kind

TP04.06 Step System Overhaul

The following sections define the overhaul requirements for the various step system assemblies and subassemblies. The mobile step assemblies shall be removed from the cars in accordance

with approved overhaul procedures. They shall be completely disassembled, cleaned and inspected. All rubber and plastic parts shall be replaced.

1. All hardware/fasteners shall be replaced
2. All limit switches shall be replaced in kind
3. All limit switch actuators and insulators shall be replaced
4. All tubing shall be replaced
5. All valves, mufflers, bushings and seals shall be replaced in kind
6. All springs shall be replaced in kind
7. All bearings, including the orbital and flange bearings, shall be replaced in kind
8. All rubber components, except the step treads, shall be replaced
9. All side track assembly frames shall be replaced in kind
10. Wiring harnesses shall be inspected and repaired where damaged
11. Diode assemblies on terminal strips shall be replaced if bent or broken (assume 25%)
12. Wiring harnesses and terminal strips may be reused, or replaced if damaged (assume 25%)
13. Wear surfaces shall be cleaned and dimensionally verified
14. Corrosion shall be removed and finishes restored on corroded components. It is estimated that light corrosion will exist at interfaces that are not visible while assembled, i.e., within linkage pivot joints
15. Both main and extension cylinders shall be cleaned, dimensionally verified, have all seals replaced, and be reused. It is estimated that *10%* of the extension cylinders will require replacement

TP04.07 Assembly, Installation & Adjustment, and Testing of Equipment

Refer to TP10 Inspection and Testing for the detailed requirements for the test and inspection program, as well as the CDRLs associated with the inspection and test of doors and steps.

A. Assembly

The overhauled equipment shall be assembled using procedures developed in accordance with the OEM manuals and shall utilize the same lubricants used on the original equipment and by the Authority's personnel. Assembly procedures shall include any intermediate testing and/or functional verifications required to ensure that the assembled components will function properly. Each assembly shall have sign-off sheets for workers to document that their efforts were conducted in accordance with applicable procedures, and aid in failure and/or quality assurance investigations; pass/fail entries shall be required in the sign-off sheet for all required intermediate tests and/or functional verifications performed by the assembler, including the proper application of torque marks. Multiple components may be included on tabulated sign-off sheets with approval of the Authority. Sign off sheets **[CDRL 4-003]** shall be submitted for inclusion in the Car History Book.

B. Installation & Adjustment

The overhauled equipment shall be installed and adjusted using procedures developed in accordance with the OEM manuals. Each installation shall have sign-off sheets for workers to document that their efforts were conducted in accordance with applicable procedures, and aid in failure and/or quality assurance investigations; pass/fail entries

shall be required in the sign-off sheet for all required intermediate tests and/or functional verifications performed by the installer.

C. Testing

1. Prerequisites

Power and/or air shall not be applied to overhauled equipment installed on the cars until a Contractor's Quality Assurance (QA) representative signs-off indicating that all Assembly and Installation & Adjustment sign-off sheets have been completed, and reflect successful completion of all testing and/or functional verifications performed prior to installation and/or as part of the installation process, and the Authority's representative signs verifying the same.

The Authority's representative shall be afforded the opportunity to be present when power and/or air is first applied to overhauled equipment installed back into the cars, and whenever an official acceptance test is conducted.

2. Test Types

In addition to any tests the Contractor establishes, the Authority requires that the door and step systems be 100% tested using the original door and step acceptance test procedures developed by the OEM, which the Authority will provide to the Contractor for this purpose. The entire test shall be completed by the Contractor, including those portions that verify the functionality of non-overhauled door and step system components, such as lights, switches, and chimes, as their functionality could be impacted by the scope of the overhaul efforts.

The contractor shall make all adjustments required in order to successfully pass the acceptance tests, even if the adjustments are required to components the contractor did not remove or modify, as overhauled equipment with new seals and other components may need the items with which they interface to be adjusted to achieve proper functionality.

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 the Authority for disposition, which may include the repair or replacement of the failed component by Authority personnel, or issuance of a replacement for installation into the car by the Contractor's personnel to enable completion of the test.

Both static and dynamic tests shall be conducted by the Contractor. This shall include, but shall not be limited to, continuity tests, insulation-resistance tests, functional tests, clearance tests, ADA requirements tests. All test procedures shall be submitted by the Contractor to the SFMTA for review and approval.

3. Acceptance Test Logistics

This test shall be completed on Authority property, at a time and location of its choosing, after the overhauled cars are returned, and as a condition of their acceptance by the Authority. A minimum of three working days notice must be

given in advance of an official vehicle-level test date; the Authority will accommodate testing with less notice, at its discretion, whenever possible.

TP04.08 First Article Inspection

The first rebuilt unit shall be presented to SFMTA for approval, prior to continuation of the rebuild effort. The Contractor shall support this process with a complete set of documentation, including test reports. **[CDRL 4-004]**

TP04.09 Remaining Stock

All remaining stock purchased in anticipation of replacement based on estimated percentages in these Technical Provisions shall become the property of SFMTA.

TP04.10 Contract Deliverable Requirements List

CDRL #	Title	Reference Paragraph
4-001	Overhaul Procedures	4.03.F
4-003	Sign-off Sheets	4.07.A
4-004	FAI Package	4.08.

End of Section