TECHNICAL SPECIFICATIONS
(TECHNICAL PROVISIONS)

SECTION TP05

Truck Assemblies:

Trailer Truck Electric System Cable Assembly
(PSC-2) Replacement

Articulation Resilient Pin Replacement

Traction Motor Bearing Replacement

August 28, 2009
Rev. 4 Final

SECTION TP05
PSC-2 CABLE ASSEMBLY REPLACEMENT

TABLE OF CONTENTS

Section **Page**

PSC-2 CABLE ASSEMBLY REPLACEMENT

The Contractor shall design and install a replacement Trailer Truck Electric System Cable Assembly (PSC-2) on each LRV.

The Contractor shall design the cable modifications, manufacture or procure new cables, and install and test them on each vehicle.

TP05: SCOPE OF WORK

TP05.01 TRAILER TRUCK

The Contractor shall carefully disconnect, from the trailer (center) truck, the connectors from the two Receive Antennae, the two Transmit Antennae, the two brake calipers and the two tachometers.

The Contractor shall release the cable clamps, remove and dispose of the old cable assembly.

The Contractor shall clean the mating connectors, and contact pins or points on both the carbody and center truck of all dirt, grease and grime.

The Contractor shall design and manufacture or procure a replacement PSC-2 harness.

The Contractor shall install the new cable, properly connecting and securing it with sufficient cable slack for truck rotation and with no binding or chaffing against fixed or moving parts.

The Contractor shall properly reinstall the Caliper and Antennae cover plates.

The Contractor shall replace all cable clamp hardware with new.

The Contractor shall carefully reconnect the two carbody connectors and the other connectors.

The Contractor shall verify proper functionality of all affected systems per TP10 Inspections and Testing.

All materials and workmanship shall comply with the requirements of Section TP08.

A. Cable Assembly Possible Source of Supply:

DIGI-COM ELECTRONICS, vendor part number: 9558-15
5327 Jacuzzi St #3N, Richmond CA 94804
Contact: Mohammed R Ohady
Phone: (510) 525-3570
Fax: (510) 527-8187

SFMTA shall consider the above assemblies or approved equal. Alternate sources must be submitted to the SFMTA for evaluation, testing and approval. The submittal package shall

include appropriate schematics, component descriptions, and manufacturer's test reports. **[CDRL 5-001]**

TP05.02 RESILIENT PIN

The Contractor shall replace the Articulation Joint Resilient Pins.

TP05.03 TRACTION MOTOR BEARINGS

The Contractor shall replace all traction motor bearings with original type roller bearings.

TP05.04 SFMTA FURNISHED DRAWINGS, SCHEMATICS, AND DOCUMENTS

The SFMTA shall make available an LRV and dismounted center truck for the Contractor's inspection, measurement and testing to determine the necessary cable assembly lengths, and the receptacles installation conditions for mounting and wiring to the existing LRV circuit wires.

Copies of related drawings, schematics and documents from the SFMTA's archives will be made available to the Contractor. They are to be used for reference purposes only and do not necessarily reflect the existing configuration of the vehicles. It is the Contractor's responsibility to verify accuracy of all drawings and documents provided by SFMTA.

Basic cable layout details are provided for reference in Section TP16 of these Technical Provisions.

TP05.05 TASKS

A. Pre-Possession Test

The Contractor shall confirm, before taking possession of the vehicle, that the two Automatic Train Control (ATCS) Receive Antennae, the two ATCS Transmit Antennae, the two center truck tachometers and the two center truck caliper brake release switches are functioning by conducting an ATCS Yard Departure Test on the SFMTA's Track 1 at the Green facility. This test shall be Incorporated into the pre-overhaul test procedure and report referenced in TP10 of these Technical Provisions.

While SFMTA personnel will operate the LRV during the test, the Contractor shall conduct the test. All testing activities and documentation shall be compliant with TP10 Inspection and Testing section of these technical provisions.

B. Cable Replacement Procedure and Sign Off Sheet

The Contractor shall submit for approval a complete cable replacement procedure, including references to inspection and test procedures . This procedure shall be the same procedure as supplied to the Contractor's work crew. The procedure shall describe in detail the steps required to perform the replacement. This procedure **[CDRL 5-003]** shall be submitted for review and approval.

The Contractor is advised to pay close attention to phasing, as wiring the cable backwards is common and will cause a departure test failure. For each vehicle, the Contractor shall provide a

cable replacement sign off sheet **[CDRL 5-004]**. As each replacement is completed, the Contractor shall sign and date the sign off sheet, confirming that the work has been completed.

C. Acceptance Testing

Upon redelivery of the LRV to the SFMTA, the LRV shall be subject to acceptance tests as required by Section TP10 of these Technical Provisions, including identification of CDRLs. After passing the test, the Contractor shall provide and sign an acceptance test report. The Engineer will accept the replaced cable assembly by signing the test report.

These tests shall include at a minimum:

- Continuity test to confirm proper connections
- Yard departure test

D. First Article Inspection

The first overhauled 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 5-005]**

TP05.06 CONTRACT DELIVERABLE REQUIREMENTS LIST

CDRL #	Title	Reference Paragraph
5-002	Cable Replacement Procedure	5.05B
5-003	Revised Cable Replacement Procedure	5.05.B
5-004	Cable Replacement Sign Off Sheet	5.05.B
5-005	First Article Inspection Package	5.05.D

TECHNICAL PROVISIONS

SECTION TP06

LRV AIR SUPPLY UNIT REHABILITATION

August 28, 2009
Rev 4 Final

SECTION TP06
LRV AIR SUPPLY UNIT REHABILITATION

TABLE OF CONTENTS

Section **Page**

TP06: AIR SUPPLY UNIT REHABILITATION

TP06.01 GENERAL

The Contractor shall be responsible for the removal, clean, disassembly, overhaul, repair, testing and re-installation of the air supply unit (ASU). The air supply unit includes compressor/motor assembly, controls and air dryer assembly. After removal, the Contractor shall thoroughly clean the ASU and inspect for damage prior to commencing the work. Any damaged parts shall be replaced as part of the work.

SFMTA Light Rail Vehicles (LRVs) are equipped with Knorr Air Brake type STU14536 Air Supply Units. Most of the SFMTA ASUs have been fitted with Graham White type 995-225 air dryer units; however, an undetermined number still retain their original Knorr type LTZ-012H units. For ASUs with the original Knorr air dryers, the Contractor shall replace the unit with a new Graham White type 995-225 air dryer unit, which will be provided by the SFMTA. The Contractor will reduce the cost by the amount of Air Dryer Unit rebuild and only charge for the replacement labor.

The ASU shall be inspected and overhauled according to the San Francisco Muni LRV2 Heavy Repair and Workshop Manual – Section 6 "Air Compressor/Pneumatic System" except for the Air Dryer system which shall be rebuilt according to the Graham White Overhaul and Maintenance Manual #995-225. Parts subject to wear shall be dimensionally checked as part of the work. All elastomeric parts, hoses, seals, wire harnesses, damage and broken parts and other components as required in this specification shall be replaced. Parts exceeding wear limits and which can not be reconditioned shall be replaced in kind.

The Contractor shall be responsible for the mechanical refitting of the ASU into the LRV, and its pneumatic and electrical connections to the LRV.

SFMTA will make available to the Contractor drawings, schematics, and manuals from its archives. This information is for reference purposes and may not represent the existing configuration of the air supply unit and its installation.

TP06.02 SCOPE OF WORK – AIR SUPPLY UNIT

The Contractor shall remove, disassemble, inspect, repair/replace/overall, reassemble, test and reinstall the following assembles as part of the work to be performed:

- Air compressor
- Compressor motor
- Air dryer
- HVAC motor contactor
- LVDC terminal box

- Pressure switch
- Test fitting

The Contractor shall include sign-off sheets that shall be utilized during overhaul. A sign-off sheet shall be maintained for each coupler and submitted **[CDRL 6-003]** for insertion into the Car History Book. Each critical step in the overhaul shall be signed off by the responsible person.

A. AIR COMPRESSOR

The SFMTA ASU's are fitted with Knorr Air Brake type LP8851 air compressors. The Contractor shall disassemble and thoroughly inspect the compressor, and before commencing any reconditioning work, check the dimensions of parts subject to wear to determine if part reconditioning is feasible or replacement is required. The Contractor shall inspect and overhaul the compressor according to the San Francisco Muni LRV2 Heavy Repair and Workshop Manual – Section 6 "Air Compressor/Pneumatic System".

The crankcase assembly shall be inspected for damage, cracks and deformed/damaged threads. Replace any damaged or distorted studs.

The crankshaft shall be inspected for cracks and for wear on all bearing surfaces. If bearing surfaces are worn beyond acceptable conditions, replace the crankshaft.

Inspect cylinders for cracks and damage. All cylinders shall be reconditioned. If determined to be needed during inspection, bore the cylinders to next size up. If determined to be needed during inspection, provide and install new oversized pistons, new piston and spring rings. For all compressors, the Contractor shall perform the following work:

- Install new wrist pins.
- Install new wrist pin bearings.
- Install new wrist pin C-clips.
- Install new connecting rod and crankshaft bearings, including a new wear ring.
- Rebuild valve assemblies with new springs and flap valves.
- Install new filter element.
- Replace or rebuild check valve.
- Install new safety valves.
- Install all new gaskets and seals.

B. COMPRESSOR MOTOR

The SFMTA ASUs are fitted with either a Stone Safety or Tech Systems 9 horsepower, 1750 rpm, 600 volt dc, 14 amps full load, series wound motors, with external frame mounted buffer resistors. The Contractor shall disassemble and thoroughly inspect the motors, and before commencing any reconditioning work, check the dimensions of parts subject to wear to determine if part reconditioning is feasible or replacement is required.

The Contractor shall overhaul of the motors in accordance with the San Francisco Muni LRV2 Heavy Repair and Workshop Manual, Section 6 "Air Compressor/Pneumatic System" and as described by the following summary.

1. Motor Frame

For the motor frame, the Contractor shall perform the following work:

- Disassemble the motor clean and inspect all parts.
- Reuse, and repair, if necessary, the end bells and bearing seats and brush covers, and air inlets and resistor boxes (prime and paint).
- Replace bearings.
- Install new brushes and brush-holders.
- Replace resistor (3 resistors used for the stone safety motor, 2 for the Tech systems motor)

2. Motor Armature

For the armature, the Contractor shall perform the following work:

- Disassemble the motor and thoroughly clean all of the parts.
- Remove the commutator and shaft, strip away the armature coil windings.
- Inspect and core loss test the armature core laminations and install a new core as needed.
- Rewind the armature core with new coils using class H insulated windings, TIG welded to the risers and with new bandings installed.
- Install a new commutator.
- Inspect the shaft for damage/distortion and replace with new as necessary.
- Voltage test the new commutator, bar to bar and ground test. Current test armature winding. Surge test the armature winding. Surge test armature winding and commutator connected.

- Vacuum Pressure Impregnate (VPI) the rewound armature twice with Epoxylite resin # 478 or other suitable resin if approved by the Engineer.
- Cure and clean VPI'd armature.
- Turn, the commutator, undercut the mica and balance the armature with the drive coupling attached to the shaft end.
- Spin season the commutator.
- Measure and record the Total Indicated Runout in the sign-off sheet

3. Motor Stator

For the motor stator, the Contractor shall perform the following work:

- Thoroughly clean the stator assembly.
- Strip away all stator windings from the 2 main poles and the 2 interpoles.
- Abrasive blast the stator frame.
- Inspect the poles stack laminations and repair as needed.
- Rewind the stator with new coils using Class H insulated windings: main field, interpole.
- VPI the rewound stator twice with Epoxylite resin # 478 or other suitable resin if approved by the Engineer.
- Cure and clean VPI'd stator.

4. Motor Assembly and Test

The Contractor shall prime and paint the motor frame gloss black enamel, reassemble the motor with new bearings, rings, and retainers matched to the motor frame end bells and new standard hardware.

The Contractor shall install new armature leads, field leads, brush leads, thermal switches as appropriate, new bus bars.

Adjacent to the original nameplate, the Contractor shall install a new permanent metal nameplate stamped with the rewind completion date and the Contractor's company name.

The Contractor shall continuity test, insulation test, and hi-potential test all stator windings and leads and impedance test the completed motor, as required in Section TP10 of these Technical Provisions.

For final motor acceptance, the Contractor shall load test the motor on a dynamometer to the full load capability (9 hp).

The Contractor shall record in the acceptance test report, the test data for insulation temperature rise, insulation resistance, seating of brushes, commutator film build-up, commutation and full-load regulation tests, rotation CW and CCW speeds, vibration, dielectric strength, armature rotational runout and endplay.

C. AIR DRYER UNIT

Most of the SFMTA ASUs have been fitted with Graham White type 995-225 air dryer units; however, an undetermined number still retain their original Knorr type LTZ-012H units.

For ASUs with Graham White air dryers, the Contractor shall rebuild the units as described in the Graham White Overhaul and Maintenance manual #995-225. Additionally, the contractor shall install new desiccant bags, a new coalescer, a new final element filter and a new muffler.

The Contractor shall inspect the other components for excessive wear or damage and repair or replace the components as necessary to assure proper function.

D. HVDC MOTOR CONTACTOR

For the HVDC motor contactor, the Contractor shall perform the following work:

- Disassemble the motor contactor and thoroughly clean all of the parts.
- Replace contacts
- Replace relays
- Replace conical springs.

E. LVDC TERMINAL BOX

For the LVDC terminal box, the Contractor shall perform the following work:

- Disassemble the terminal box and thoroughly clean all of the parts.
- Replace wire harnesses

F. PRESSURE SWITCH

For the pressure, the Contractor shall perform the following work:

- Replace pressure switch.

G. TEST FITTINGS

For the test fittings, the Contractor shall perform the following work:

- Disassemble the fitting and thoroughly clean all of the parts.

- Replace spring, o-ring and circlip.

H. OTHER COMPONENTS

The Contractor shall perform the following work:

- Install all new rubber components including the resilient mounts.
- Install new hose assemblies.
- Install a new pressure switch.
- Install all new standard hardware.
- Rebuild all test fittings.
- Paint the air frame black enamel.
- Paint the terminal box both in and out (inside with non conductive paint).
- Repair as necessary and clean the inter and after-coolers.
- Rebuild the motor/compressor coupling.
- Repair the air pipe if necessary.
- Install new high voltage contactor assembly with appropriate rating.
- Rebuild the low voltage contactor assembly.
- Provide and install new air cock.

TP06.03 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.

TP06.04 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 will a complete set of documentation, including test reports. **[CDRL 6-004]**

TP06.05 ADJUSTMENT AND TESTING

The Contractor shall perform detailed functional and performance tests for the complete ASU, as defined in Section TP10 of these Technical Provisions. The tests shall demonstrate that the ASU is fully operational prior to installation and that the ASU is properly interfaced when installed. As a minimum, test procedures shall include:

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

Test procedures and reports, as specified as CDRLs in TP10, shall be submitted to the SFMTA for approval. The Contactor shall provide a test report for each ASU. The report shall include description of tests, detailed description of the ASU under test including serial numbers, instrumentation setup, all raw data collected/actual test results (pass/fail is not acceptable data entry), all data reduction forms and summary of the results.

TP06.06 FLOAT OF REBUILT AIR SUPPLIES

At the SFMTA's discretion, The Contractor shall create a "float" of spares by rebuilding up to eight SFMTA air supplies.

At the discretion of the SFMTA, a portion of the spare air supplies will be sent to the SFMTA facility and the remaining units will be used by the contractor for the replacement portion of the rebuild program.

TP06.07 SFMTA FURNISHED DRAWINGS, SCHEMATICS, AND DOCUMENTS

The SFMTA shall make available reference documents listed in this section. It is the Contractor's responsibility to verify accuracy of all drawings and documents provided by SFMTA.

TP06.08 CONTRACT DELIVERABLE REQUIREMENTS LIST

CDRL #	Title	Reference Paragraph

CDRL #	Title	Reference Paragraph
6-003	Sign-off Sheets	6.02
6-004	ASU Overhaul FAI Package	6.04

TECHNICAL SPECIFICATIONS

(TECHNICAL PROVISIONS)

SECTION TP07

LRV ROOF ARTICULATION WIRING HARNESS REPLACEMENT

August 28, 2009
Rev. 4 Final

SECTION TP07
ARTICULATION WIRING HARNESS REPLACEMENT

TABLE OF CONTENTS

TP07: ARTICULATION WIRING HARNESS REPLACEMENT

TP07.01 GENERAL

The Contractor shall design and install removable wiring harness cable assemblies in the roof area above the articulation bellows on each LRV.

The Contractor shall design the harness modifications, manufacture new harnesses, and install and test them on each vehicle.

TP07.02 SCOPE OF WORK

A. DESIGN REVIEW

As this is a new design, the Contractor shall prepare design review arrangement under worst-case conditions of vehicle movements for review and approval. **[CDRL 7-001]** and The Contractor shall submit drawings and samples of all assemblies, connectors, wires, and cables to SFMTA for review and approval in the package.

B. B END MODIFICATION.

Above the articulation bellows on the SFMTA's LRVs are seven cable assemblies. Each cable assembly consists of multiple insulated wires, enclosed in an outer jacket, hard-wired to the "B" half of the vehicle and terminated at the "A" half with a multiple pin bayonet connector. The Contractor shall develop a comprehensive wiring list for these circuits and submit them to SFMTA for review and approval. **[CDRL 7-003]**

The Contractor shall shorten the existing cable assemblies on the "B" half of the car and install bulkhead receptacles. An appropriate bulkhead plate or box shall be fitted to mount the receptacles. The receptacles shall match and mirror the receptacles on the "A" half of the car.

The Contractor shall prepare and submit for approval a modification procedure that describes both the electrical and mechanical work and sequence to be performed. **[CDRL 7-004]**

C. A END CONNECTOR REPLACEMENT

The Contractor shall replace and re-pin the bulkhead receptacles on the "A" half of the car with new.

D. JUMPER CABLES

The Contractor shall manufacture "jumper cable" wiring harnesses to bridge the circuits between the two banks of bulkhead receptacles. The jumper cable assemblies shall be built with new wires, outer protective jackets, and bayonet connectors.

All wires within the seven jumper cable assemblies, EYP7, EYP8, EYP9, EYP10, EYP11, EYP12, and EYP13 shall use the proper wire gauge and wire marker identification as indicated in the attached wiring reference list.

The contractor is responsible for maintaining the integrity of connecting the wires to the matching identified contacts on the receptacles as indicated in the wiring reference list in Section TP16. The SFMTA does not guarantee the accuracy of these contacts, the Contractor shall verify the accuracy of these drawings and lists.

The articulation Jumper Cables shall be wired identical to the attached wiring reference list.

Any variances discovered by the Contractor from the attached list are to be submitted to the SFMTA for correction. **[CDRL 7-006]**

The jumper cable assemblies shall be designed to be able to withstand the service and environmental conditions as specified in Section TP02 of these Technical Provisions.

Each wire shall have a terminal marker at both ends per the requirements of Section TP08 Materials and Workmanship of these Technical Provisions. Each Jumper Cable shall be identified with a metal collar at each end.

E. CABLE SUPPORT SYSTEM

The Contractor shall install the pre-fabricated jumper cables with a support system above the bellows to control the motion of the cables, to prevent the cables from tangling, chafing, and binding. Sufficient cable loop or slack shall be provided to eliminate fatiguing of the wires while the vehicle moves through turns (horizontal and vertical) without too much slack. The harnesses shall slope down from the connectors to prevent water from accumulating at the connector seal or in the connector in case of harness failure. The Contractor shall submit the drawings indicating arrangements under worst-case conditions of vehicle movements for review and approval. **[CDRL 7-007]**

F. INSTALLATION TESTING

As part of the Acceptance Testing, the Contractor shall test each circuit of the cable assemblies for continuity, insulation, and circuit function.

The cable assemblies shall be tested under static cold circuit conditions and under dynamic hot circuit conditions. The Contactor shall conduct these car tests with the Contractor provided Break-Out Connection Boxes.

TP07.03 MATERIALS AND WORKMANSHIP

All materials and workmanship shall comply with the requirements of Section TP08 Materials and Workmanship of these Technical Provisions.

The connectors shall be of the original watertight bayonet style as used on the "A" side of the car. The name-brand such as ITT, Veam or Commital, or approved equal as detailed in the attached part number list shall be used unless otherwise first approved by the Engineer.

TP07.04 SFMTA FURNISHED DRAWINGS, SCHEMATICS, AND DOCUMENTS

The SFMTA shall make available an LRV for the Contractor's inspection, measurement and testing to determine the necessary cable assembly lengths, and the receptacles installation conditions for mounting and wiring to the existing LRV circuit wires.

Copies of related drawings, schematics and documents from the SFMTA's archives will be made available to the Contractor. They are to be used for reference purposes only and do not necessarily reflect the existing configuration of the vehicles. It is the Contractor's responsibility to verify accuracy of all drawings and documents provided by SFMTA.

Jumper wire lists are provided in Section TP16 Supplemental Drawings and Reference Drawings.

TP07.05 INITIAL INSPECTION AND DYNAMIC TESTING

The Contractor shall conduct a pre-modification inspection to determine the as-is condition and completeness of the roof articulation harnesses prior to initiating the modifications. The Contractor shall prepare and submit for approval an inspection report, describing the condition of the harnesses towards a successful modification of the vehicle. See Section TP10 Inspections and Testing for all test requirements and CDRL identification..

The prototype vehicle shall be subjected to dynamic testing under service conditions to show if the cable harnesses are able to flex without buckling, tangling, or binding through all service speeds and turns (horizontal and vertical), and be able to withstand environmental conditions.

The dynamic test shall include an endurance component to show that the cable assemblies will perform correctly without failure or degradation in 3000 miles of actual service conditions.

At the end of the 3000 mile period, 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. See Section TP10 of these Technical Specifications for test requirements.

TP07.06 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 7-008]**

TP07.07 SPECIAL TOOLS

The contactor shall provide two (2) carsets of test break-out boxes as required in Section TP14 Special Tools and Equipment. One carset shall be used for the static and dynamic testing of the installed cable assemblies and one shall be used for bench testing of the cable assembles during repair and replacement of the circuit wires. The bench testing unit shall illuminate a lamp for each conductor when continuity exists between the end connectors.

TP07.08 CONTRACT DELIVERABLE REQUIREMENTS LIST

CDRL #	Title	Reference Paragraph
7-002	Cable Design Submittal Package	7.02.A
7-003	Wiring list.	7.02.B
7-005	Cable Replacement Procedure	7.02.B
7.006	Wiring List Corrections	7.02.D
7-007	Cable movement drawings	7.02.E
7-008	Cable Installation First Article Inspection	7.06