

LOS ANGELES COUNTY

METROPOLITAN TRANSPORTATION AUTHORITY

LIGHT RAIL VEHICLE

**P2550**

**RUNNING  
MAINTENANCE  
AND  
SERVICE MANUAL**

**SECTION 08  
PANTOGRAPH**



LOS ANGELES COUNTY

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RUNNING MAINTENANCE  
AND  
SERVICE MANUAL

VOLUME M-01  
PART I  
THEORY OF OPERATION  
SECTION 08 - PANTOGRPH



# **SECTION 08**

## **PANTOGRAPH**

### **PART I**

#### **THEORY OF OPERATION**

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# SECTION 08

## PANTOGRAPH

### 08-I-01 INTRODUCTION

This Section of the Heavy Repair & Maintenance Manual is divided into three Parts:

- Part I: Theory of Operation
- Part II: Troubleshooting
- Part III: Maintenance

Each Paragraph is numbered accordingly, to avoid that paragraphs of the same Section, pertaining to a different Part, have the same number.

#### Part I - Theory of Operation

Part I gives a thorough overview of the System structure and operation, by means of descriptions, figures, photos, schematics, block diagrams and flow charts, together with references to other documents or Sections when needed.

#### Part II - Troubleshooting

It gives the Maintenance Technicians a path to troubleshoot the System in every condition by means of the available tools:

- The PTU, equipped with the specific SW program
- The IDU
- The Fault Isolation Table

The Part III - Maintenance consists of:

- Preventive Maintenance
- Corrective Maintenance
- Consumable Materials
- Test Equipment, Tools, & Special Tools

**08-I-01.a LIST OF ABBREVIATIONS, ACRONYMS AND SYMBOLS**

The Abbreviations, Acronyms and Symbols commonly used throughout this manual are given below with their related meaning.

<b>Abbreviation</b>	<b>Meaning</b>
AB.....	Ansaldo Breda
HV .....	High Voltage
LRV .....	Light Rail Vehicle
LV .....	Low Voltage
MV .....	Medium Voltage
N .....	Newton
NC .....	Normally Closed
NO .....	Normally Open
PTU .....	Portable Test Unit
SGT .....	Schunk Graphite Technology
TBS .....	To Be Supplied
TCMS .....	Train Control and Monitoring System

**08-I-01.b LIST OF DEFINITIONS**

The Definitions commonly used throughout this manual are given below with their related meaning.

<b>Definition</b>	<b>Meaning</b>
'A' body section.....	The section of an articulated vehicle containing the pantograph
'B' body section.....	The section of an articulated vehicle not containing the pantograph
AW0.....	Empty car operating weight
AW1 .....	Full seated load plus AW0
AW2 .....	Standees at 4 persons per square meter plus AW1
AW3 .....	Standees at 6 persons per square meter plus AW1
AW4 .....	Standees at 8 persons per square meter plus AW1

**08-I-01.c LIST OF MEASUREMENT UNITS AND SYMBOLS**

The Measurement Units commonly used throughout this manual are given below with their related meaning.

<b>Definition</b>	<b>Meaning</b>
A.....	Ampere
AC .....	Alternate Current
DC .....	Direct Current
ft .....	Foot
Hz.....	Herz
in.....	Inch
kg .....	Kilogram - approx 2.205 pounds
km .....	Kilometer - approx 0.621 miles
Km/h.....	Kilometers per hour
kN.....	Kilo-Newton - approx 224.809 pound force
kVA.....	Kilo Volt Ampere
kW.....	Kilo Watt
lb.....	Pound
lb-ft .....	Pound force
m .....	Meter - approx 3.28 feet
mm .....	Millimeter - approx 0.0394 inches
mph .....	Miles per hour
ms .....	Milli second
Pa .....	Pascal
rpm .....	Revolution per Minute
V.....	Voltage
Vdc .....	Volts Direct Current
W.....	Watt

## 08-I-02 THEORY OF OPERATION

### 08-I-02.01 General Description of the System

This chapter provides a general description of the Pantograph used on the LACMTA P2550 LRV.

The manufacturer of the pantograph is Schunk Graphite Technology (SGT).

The pantograph is a roof-mounted device designed to collect current from an overhead conductor (catenary) wire and feed the current into the vehicle for distribution to the various electrical components and devices.

Raising and lowering of the pantograph is controlled by the vehicle operator through the use of switches in the cab.

To raise and lower the pantograph from the vehicle inside with insufficient battery power a hand crank is provided.

The pantograph is light weight, durable, and possesses a high current carrying capability. It is also designed to allow the vehicle to travel in either direction.

The primary components of the pantograph assembly are listed below and shown in Figure 08-I-02.1.

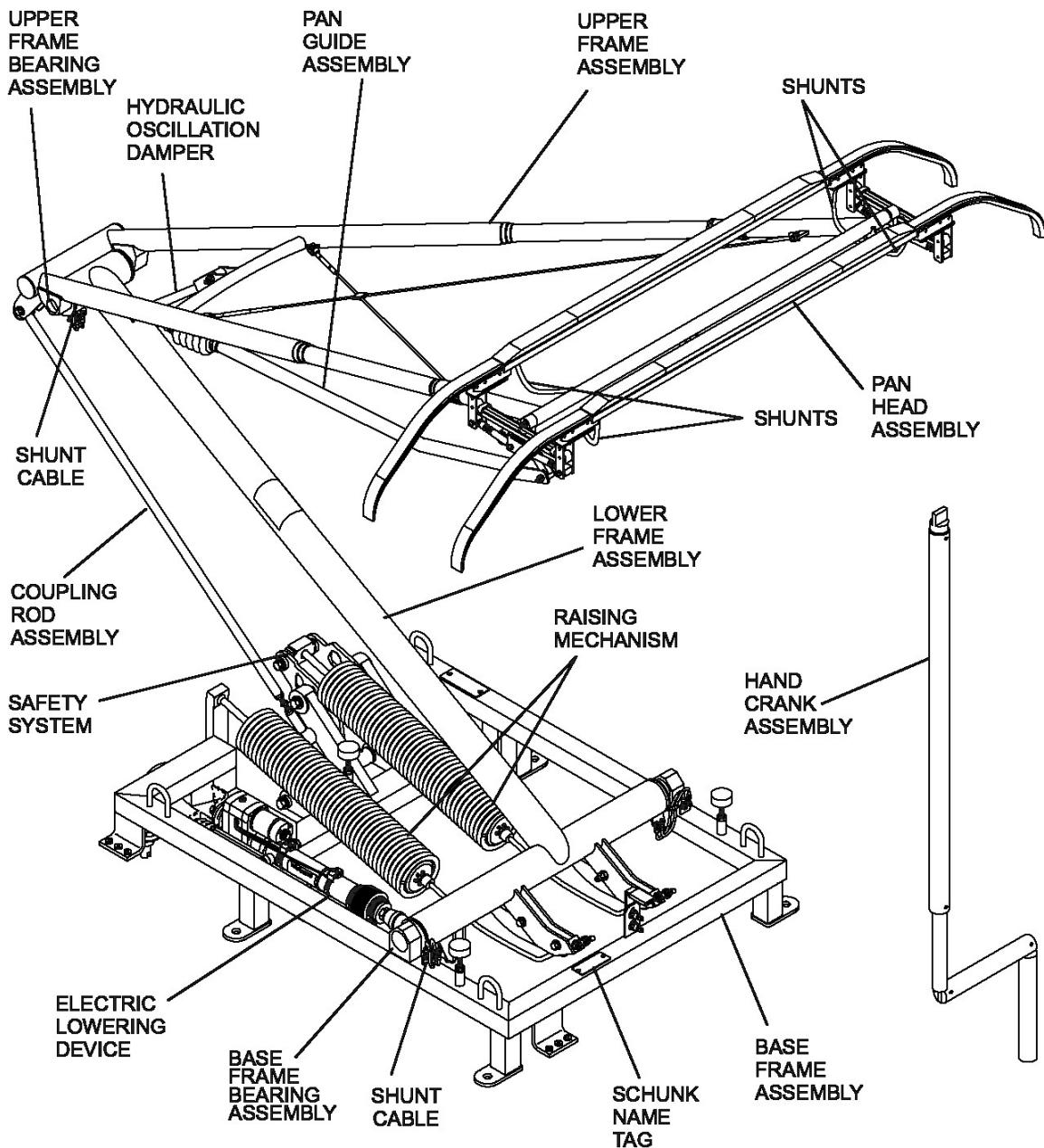
Descriptions and illustrations of the primary components follow Figure 08-I-02.1.

- Base Frame Assembly
- Lower Frame Assembly
- Upper Frame Assembly
- Hydraulic Oscillation Damper
- Coupling Rod Assembly
- Pan Head Assembly
- Raising Mechanism
- Electrical Lowering Device
- Safety System
- Pan Guide Assembly
- Base Frame and Upper Frame Bearing Assemblies
- Hand Crank Assembly

The purpose of the pantograph is to collect current from the overhead catenary to power the vehicle.

The pantograph must be raised to collect current. When not in use, the pantograph is lowered to its rest position.

The pantograph can be raised and lowered using the vehicle control system. The pantograph incorporates a safety system that lowers the pantograph if an obstruction is encountered.

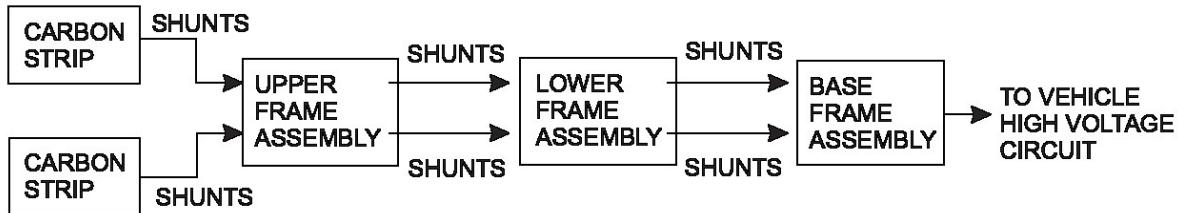


**Figure 08-I-02.1 Pantograph Assembly**

When in the raised position, the pantograph collects electrical current from the overhead conductor (catenary) for use as the vehicle's high-voltage power supply. (refer to Figure 08-I-02.2).

The carbon strips of the pantograph (or horns if overhead is severely off center) contact the catenary.

The metal-to-metal contact of the assemblies and electrical shunts provide a current path to the contact plate (high-voltage connection) on the side of the pantograph, where the vehicle wiring receives the current and connects it to the vehicle systems. The shunts provide a low resistance path between the assemblies, allowing the current to bypass the bearings at the pivot points.



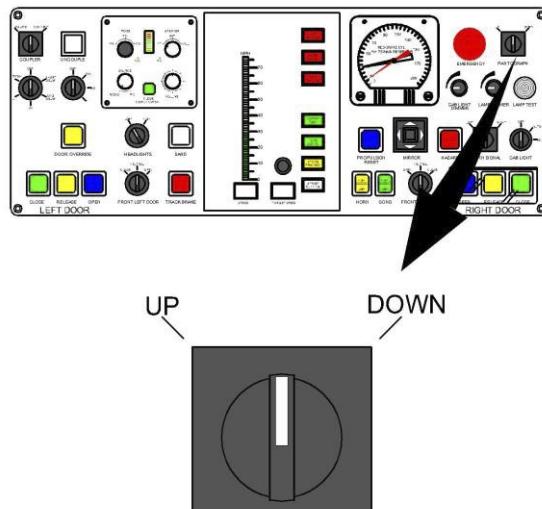
**Figure 08-I-02.2 Block Diagram**

#### 08-I-02.01.01 Raising and Lowering the Pantograph

Raising and lowering of the pantograph is typically done using the Pantograph switch on the Console in the vehicle cab.

The switch controls the operation of the DC motor and gearbox of the electrical lowering device.

The switch selects the operational direction of the motor to either raise or lower the pantograph.



**Figure 08-I-02.3 Pantograph Switch on the Console**

Two adjustable limit switches (S3 and S4) indicate raised and lowered position of the pantograph to the vehicle control circuit, which turns off the supply voltage when the pantograph reaches the raised or lowered position.

While the motor is running, it drives the gear train in the gear box (refer to Figure 08-I-02.5 and to sheets 049 and 050 of the LV Functional Schematics).

The rotary motion is geared to the brake/ball screw assembly, which produces a linear motion of the electrical lowering device of about 7.5 inches.

The damper assembly on the end of the electrical lowering device is attached to the lever on the lower frame assembly and either pushes or pulls on the lever depending on whether the pantograph is being raised or lowered.

During raising, the electrical lowering device pulls on the lever of the lower frame assembly.

The stretched springs of the raising mechanism contract and supply the force to rotate the lower frame assembly in its bearings.

The springs are attached to the lower frame assembly by the steel cable, which connects at the cam.

The lower frame assembly rises by pivoting on its bearings at the base frame assembly.

This motion raises the upper frame assembly, which also pivots up on its bearings due to the action on the coupling rod. The combined motions lift the pan head.

During lowering, the electrical lowering device pushes on the lever of the lower frame assembly and overcomes the force of the raising springs.

The lower frame assembly lowers by pivoting on its bearings at the base frame assembly. This motion lowers the upper frame assembly, which also pivots on its bearings due to the action on the coupling rod. The combined motions lower the pan head.

In the absence of sufficient battery power (or a power loss), the pantograph can be raised or lowered from inside the vehicle using the hand crank.

An opening in the vehicle interior (on the ceiling of the A car section, close to the aisle - refer to Figure 08-I-02.4) enables the hand crank ( refer to paragraph 08-I-02.02.12) to engage the coupling of the roof interface. A flexible shaft connects the gearbox to a roof interface.

Rotation of the hand crank turns the flexible shaft and drives the gears in the gearbox, causing movement of the pantograph.

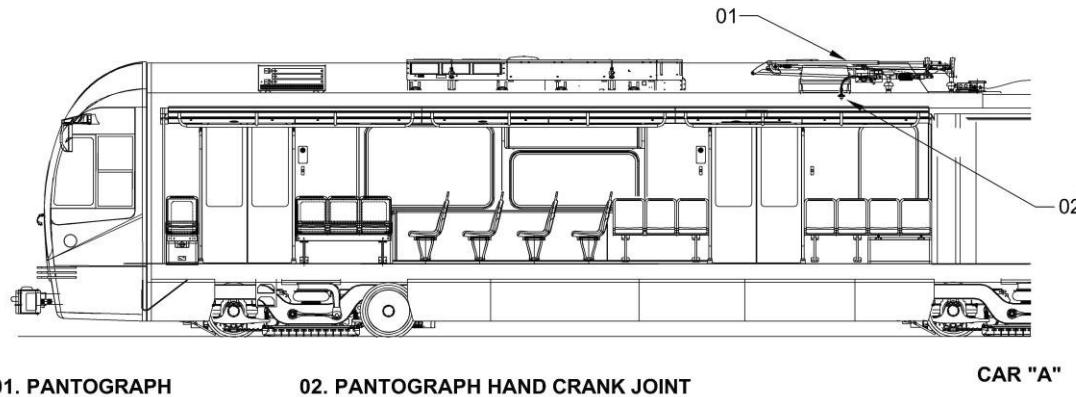
Rotation of the hand crank CW will raise the pantograph.

Rotation of the hand crank CCW will lower the pantograph.

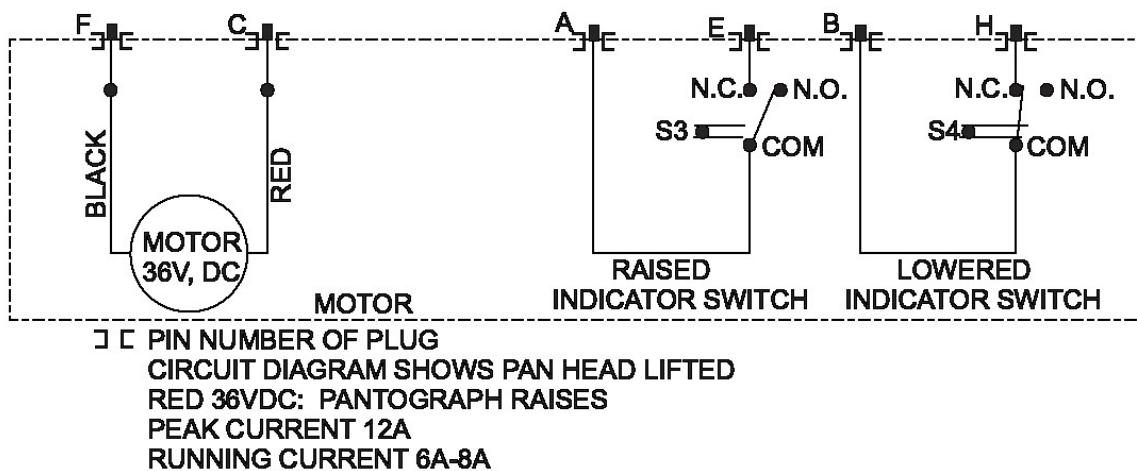
The hand crank is stored in its holder which is mounted on the wall behind the operators seat in the A-cab.

The Pantograph Command circuitry is provided with a diode (installed in the Electrical Locker "A") to eliminate the motor braking effect during the pantograph manual lowering ( Refer to DWG N° AA03ATW sheet 50 Rev 06 for Functional Schematic).

The hand crank has an insulator to prevent injury in the event it contacts an electrified portion of the pantograph.



**Figure 08-I-02.4 Pantograph Hand Crank Joint**



**NOTE:** The Pins are part of the Plug located on the Vehicle Roof by the Pantograph Assembly

**Figure 08-I-02.5 Vehicle Control Interface**

## i. System Characteristics

The reference data for the pantograph assembly are listed in Table 08-I-02.1.

**Table 08-I-02.1 System Characteristics**

Characteristics	Specifications
Maximum extension height above bottom of roof insulator to top of carbon strip.	151.57 in. (3850 mm)
Height above bottom of roof insulator with pantograph down to top of carbon strip.	$16.91 \pm 0$ in. (429 mm)
Pan head width	13.58 in. (345 mm)
Pan head length	$78.25 \pm 0.39$ in. ( $1987.5 \pm 10$ mm)
Carbon strip length	42 in. (1066.8 mm)
Carbon strip material	Metal-impregnated carbon
Weight	523 lbs. (237 kg)
Rated voltage	750 Vdc
Peak voltage	900 Vdc
Current-rated	1800 A
Current-peak	2700 A
Nominal contact force	20.9 lbs. (93 N)
Paint color	Dark Grey RAL 7024
Rated speed	65 mph (105 km/h)

## 08-I-02.02 System Components

### 08-I-02.02.01 Base Frame Assembly

The base frame (refer to Figure 08-I-02.6) is used to mount the pantograph to the top of the vehicle. The base frame is mounted on insulators to prevent the 750 Vdc from shorting out to the LRV roof (car body).

The frame is a welded structure consisting of two side rails, front end cross member, two transverse square tubes, brackets, and current connections.

Lifting lugs are welded at the four corners.

The vehicle current connections are welded in to the front end cross member and the left and right side rails.

One shunt cable connection point is welded to each side rail.

The fixed bearing housing is welded to one side rail and the floating bearing housing is welded to the other side rail.

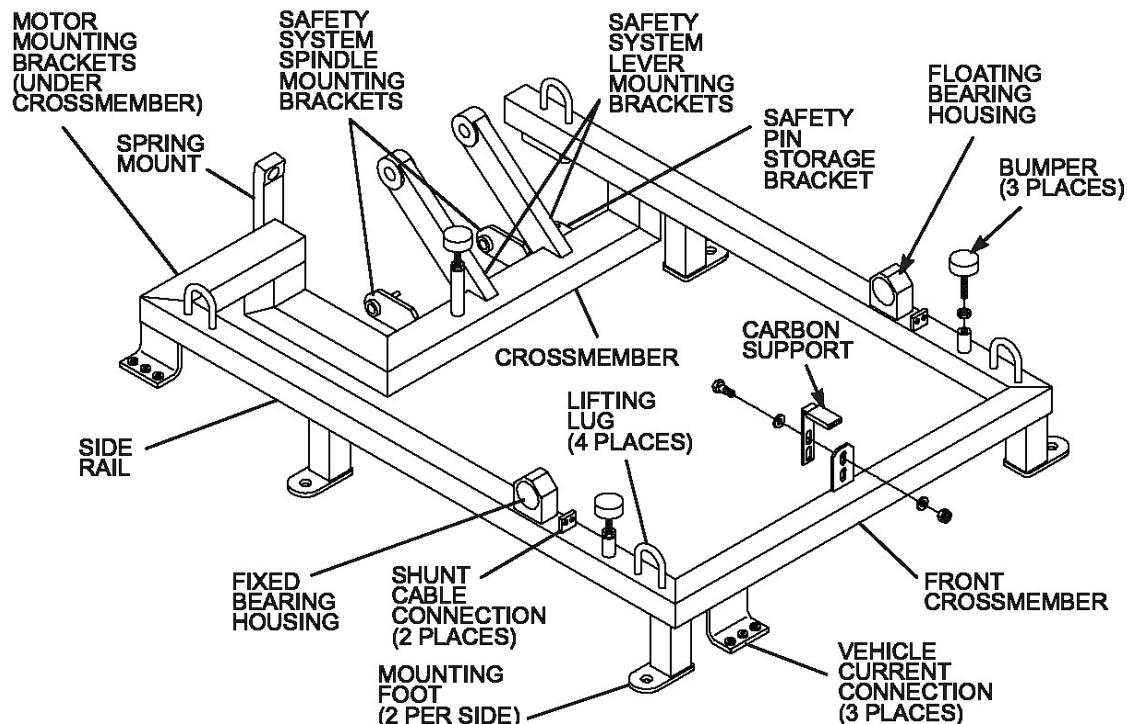
The brackets for the motor of the electrical lowering device, the lever and spindle of the safety system, and the spring support of the raising mechanism are welded to the tubes.

The cross member has a bracket that is used to store the safety pin during operation. The safety pin is removed from the bracket and installed into the Safety System during maintenance.

A carbon support assembly and three support bumpers are installed on the frame to support the other assemblies when the pantograph is in the down position.

The carbon support assembly supports the pan head assembly, the two front support bumpers support the upper frame, and the rear support bumper supports the lower frame assembly. The height of the carbon support is adjustable by slots on the support piece.

The height of the three support bumpers is adjustable by means of threaded connections.



**Figure 08-I-02.6 Base Frame Assembly**

### 08-I-02.02.02 Lower Frame Assembly

The lower frame assembly (refer to Figure 08-I-02.7) is a welded, tubular structure. The upper end has two shunt cable connections, attaching brackets for the hydraulic oscillation damper, and a threaded block that is used to attach the bolt of the pan guide assembly.

Threads in the upper-end end caps are for the bolts that attach the bearings of the upper frame assembly.

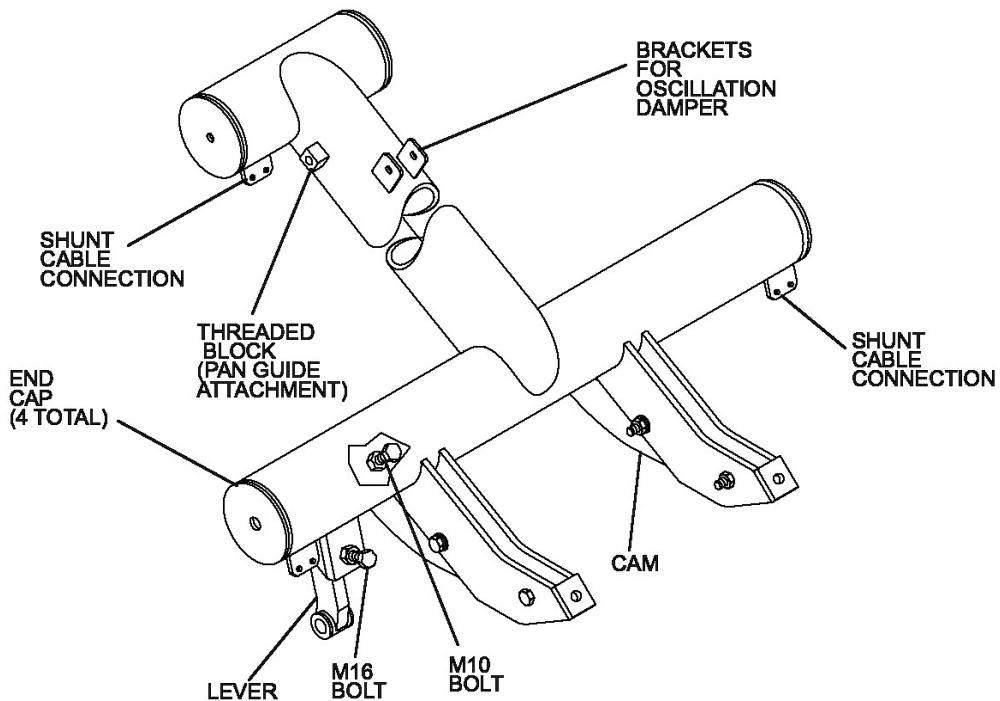
The lower end has two shunt cable connections, two cams, a lever, and an M16 bolt that acts as a stop for the lever in the direction to lower the frame (resting position).

Threads in the lower-end end caps accept the bolts that attach the bearings of the base frame assembly.

The spring-loaded cables of the raising mechanism pass through the grooves and attach to the cams.

The spring force acts to pivot the lower frame assembly upwards.

The two M10 bolts change the position of the cam and thus modify the contact pressure.



**Figure 08-I-02.7 Lower Frame Assembly**

The electrical lowering device connects to the lever of the lower frame assembly.

The electrical lowering device pulls on the lever to allow the raising mechanism springs to pivot the lower frame assembly upwards, thereby raising the upper frame assembly and the pan head assembly.

The electrical lowering device pushes on the lever to overcome the spring force and lower the frame assembly.

#### 08-I-02.02.03 Upper Frame Assembly

The upper frame assembly (refer to Figure 08-I-02.8) is a welded tubular structure.

The pan head end has a transverse tube with two shunt cable connections, two end bushings and a center bushing.

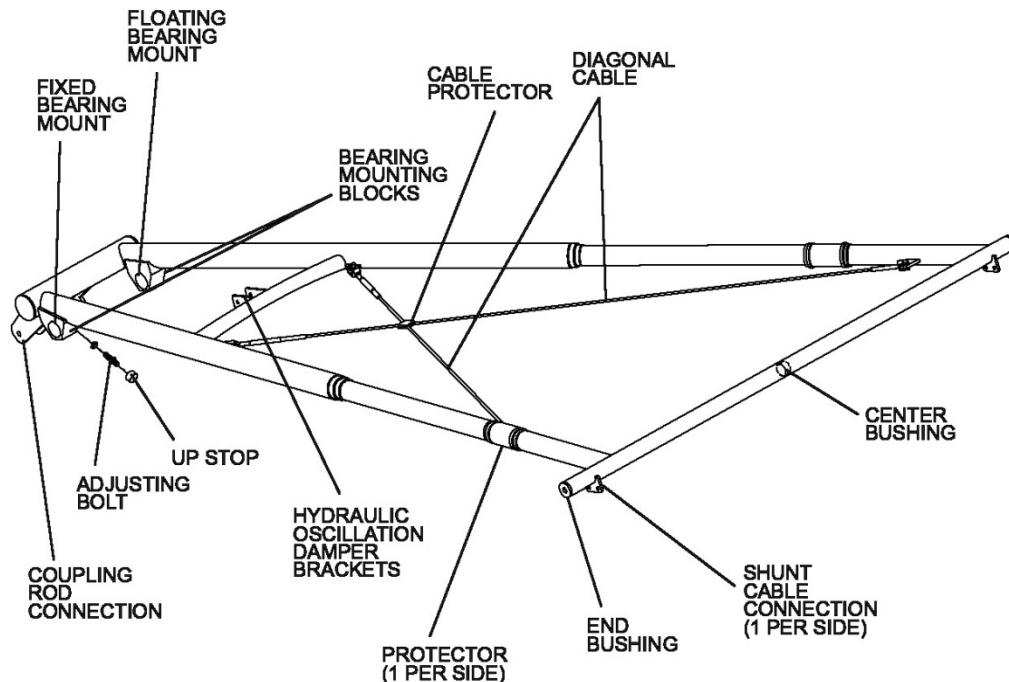
The spindle of the pan head fits inside the bushings of the transverse tube, thus attaching the upper frame to the pan head.

The pivot end has a transverse tube with two shunt cable connections, two blocks for pivot bearings, an attachment for the coupling rod, and an adjustable uplift stop.

This end attaches with ball bearings to the upper end of the lower frame assembly. A cross member includes a bracket to attach the hydraulic oscillation damper.

Two diagonal cables, equipped with adjustable turnbuckles, provide strength to the frame.

The upper frame assembly pivots upwards on the pivot bearing mounts as the raising mechanism raises the lower frame assembly due to the action of the coupling rod.



**Figure 08-I-02.8 Upper Frame Assembly**

#### 08-I-02.02.04 Hydraulic Oscillation Damper

The hydraulic oscillation damper (refer to Figure 08-I-02.9) is a fluid-filled shock absorber.

The damper is connected between brackets of the upper frame assembly and the lower frame assembly.

The damper functions to dampen all oscillations that occur as the vehicle moves down the track.

By absorbing the oscillations, the damper allows the contact strips to maintain constant contact with the catenary.

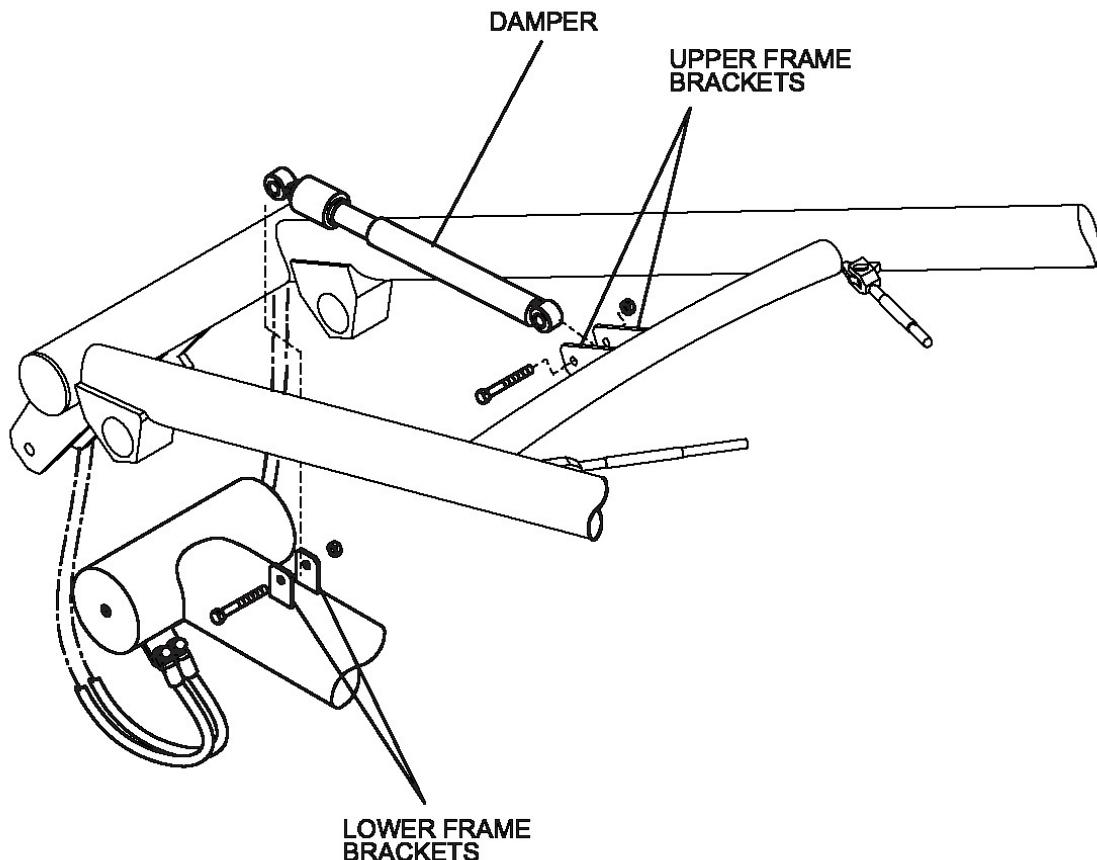


Figure 08-I-02.9 Hydraulic Oscillation Damper

### **08-I-02.02.05 Coupling Rod Assembly**

The coupling rod assembly (refer to Figure 08-I-02.10) has a long tube and a short tube coupled with a turnbuckle.

The long tube attaches to the upper frame assembly with a double ball bearing arrangement.

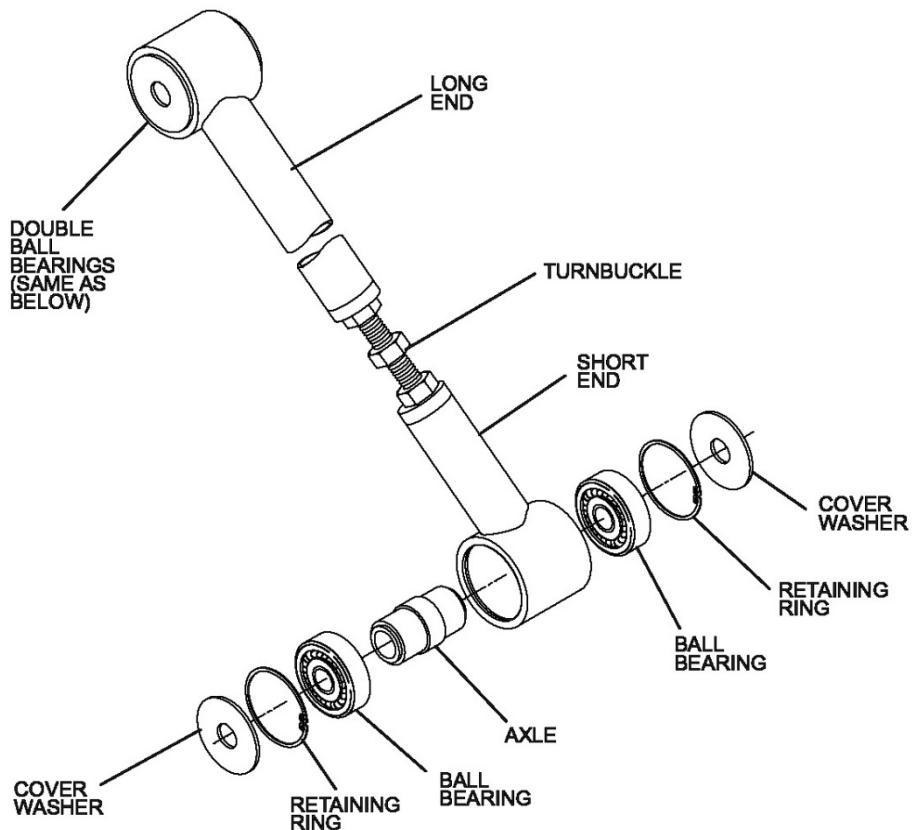
The short tube attaches to the spindle lashing of the safety system with a double ball bearing arrangement.

Although the bearings do not need lubrication, grease is packed in the space between both double ball bearing arrangements to prevent condensation and rust.

Changing the length of the assembly with the turnbuckle changes the contact force.

During the raising process, the coupling rod assembly causes the upper frame assembly to pivot upwards as the springs in the raising mechanism pull the lower frame assembly upward.

The coupling rod assembly transmits the force from the upper frame assembly to the shear pin in the safety system.



**Figure 08-I-02.10 Coupling Rod Assembly**

### 08-I-02.02.06 Pan Head Assembly

The pan head assembly (refer to Figure 08-I-02.11) consists of the electrical current gathering items and the suspension items.

The primary current gathering items are two carbon strip assemblies, four shunt cables, and four end horns.

Each carbon strip assembly includes a metal impregnated graphite/carbon contact strip.

The carbon contact strip is bonded with adhesive to the carrier over its full length.

A wire mesh electrical contact strip insures good electrical contact between the carbon contact strip and the carrier.

The four shunt cables connect from the carbon strip assembly to the upper frame and provide a low impedance current path.

The end horns are aluminum carriers that extend beyond the carbon strip on both sides of the pantograph.

Their purpose is primarily to prevent the catenary wire from becoming caught under the pan head assembly (while transitioning from one catenary wire to another) and damaging the catenary.

The primary suspension items are one spindle, two rocker suspensions, one leaf spring, one underlying spring, two rocker boxes, four guiding units, and four carbon holders.

The pan head assembly is attached to the upper frame assembly by the spindle, which is installed inside the cross member of the upper frame assembly.

The spindle is keyed to the rocker suspensions at each end.

The spindle pivots on bearings of the rocker suspension. Each rocker suspension is attached to a centrally located rocker box.

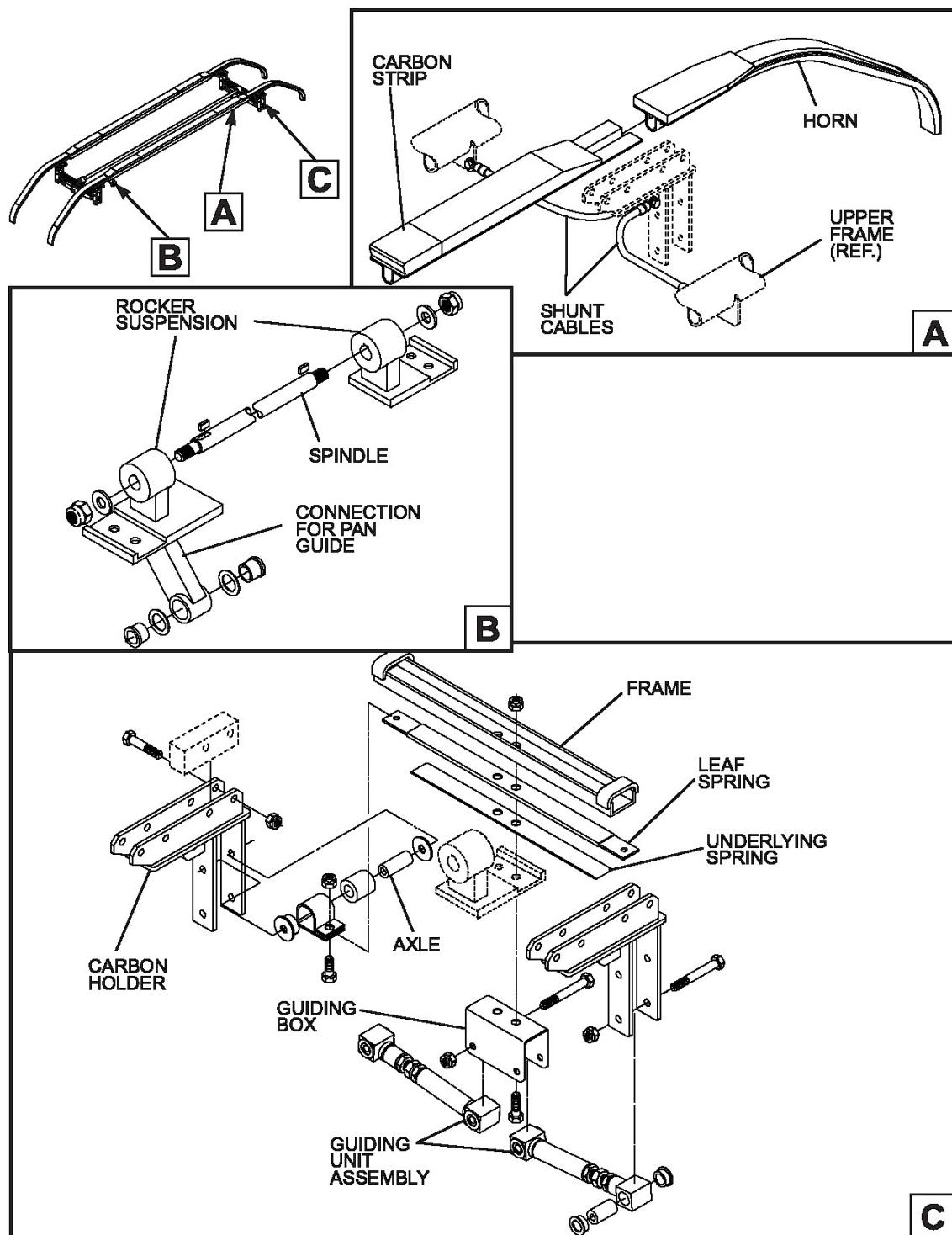
Each rocker box is joined to the bottom of a carbon holder housing by a guiding unit.

The guiding units are adjustable in length. This allows the carbon strip assemblies to be adjusted so that the wire-contact surfaces are parallel with each other.

The upper end of each carbon holder is joined to the end of the leaf spring by a screw through the hollow axle.

This forms an independent suspension that allows the carbon strips to follow the catenary wire. One rocker suspension has an extension arm that attaches the pan guide assembly.

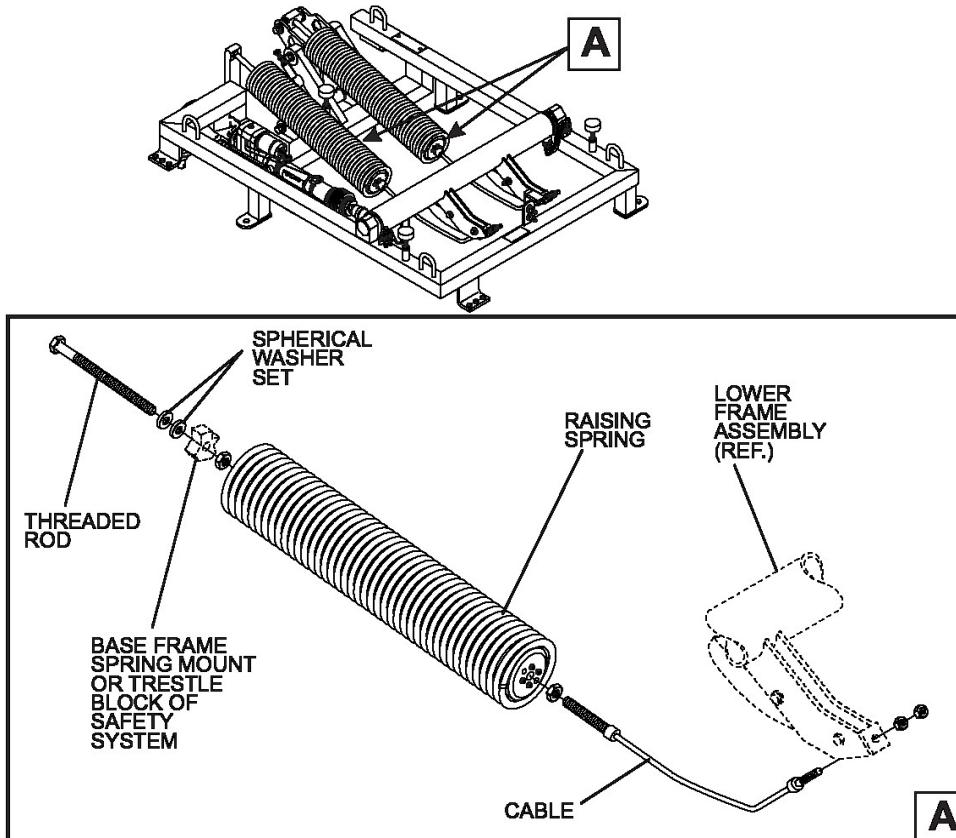
The suspension components support the carbon strip assemblies and keep them in proper alignment with the overhead wire.



**Figure 08-I-02.11 Pan Head Assembly**

### 08-I-02.02.07 Raising Mechanism

The raising mechanism (refer to Figure 08-I-02.12) consists of two raising springs, cables and attaching bolts.



**Figure 08-I-02.12 Raising Mechanism**

At the lower frame assembly, each cable is attached by nuts to a cam of the lower frame assembly.

At the base frame assembly, a threaded rod attaches one raising spring assembly to a bracket of the base frame assembly and a second threaded rod attaches the other raising spring assembly to the safety system.

The spring force is adjustable by changing the position of the threaded rods.

A special spanner wrench, which engages the two holes of the raising spring end cap, (refer to Figure 08-I-02.13) is used for this adjustment to prevent the raising spring from rotating while the threaded rods are turned.

The amount of spring force determines the force of contact between the carbon strips of the pan head and the catenary wire.

The contact force of the pantograph, in its entire range of operation, is an important parameter that has a direct effect on the life of the carbon strips and, in particular, the Catenary. The required Value of the Contact Force is **20.9 lbs. (93 N)** ( $\pm 10\%$ ).

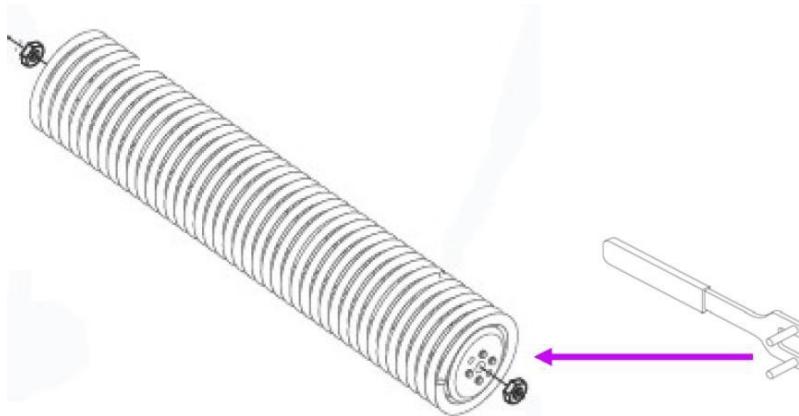
Excessive Contact Force will cause rapid premature wear of the Carbon Strips. The Carbon Strips have a wear line at the **1/8 inch (3 mm)** dimension to facilitate the inspection.

Figure 08-I-02.14 is a sample that shows the graph of raising curve force, lowering curve force, and friction.

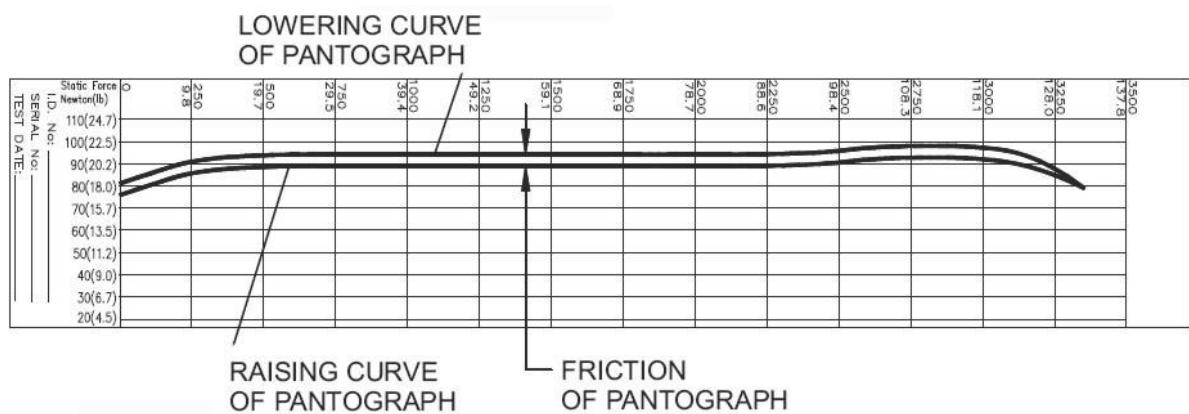
The raising springs are extended when the pantograph is in the lowered position.

The force of the extended springs acts via the cables to pivot the lower frame assembly upward.

The brake of the ball-screw assembly in the electrical lowering device keeps the pantograph in the down position unless the motor or and crank retract the ball screw. The lower frame assembly can then pivot upward.



**Figure 08-I-02.13 How to use the Spanner Wrench**



**Figure 08-I-02.14 Typical Static Force Chart**

## 08-I-02.02.08 Electrical Lowering Device

The Electrical Lowering Device (refer to Figure 08-I-02.15) consists of a Linear Actuator And Associated Components.

### The Linear Actuator & Brake Screw Assembly

The linear actuator is a motor/gearbox assembly that includes:

- A DC motor
- An internal gear train
- A brake/screw assembly
- Concentric outer and inner tubes

The brake/screw assembly converts the rotary motion of the gear train to a linear motion with a stroke of about 7.5 inches.

The brake prevents rotation of the ball screw when no current is applied to the motor. The outer tube is attached to the gearbox housing and does not move.

The inner tube is attached to the brake/ball screw assembly and extends and retracts with the linear motion of the ball-screw assembly.

One end of the bellows is clamped to the outer tube and the other end is clamped to the inner tube.

This provides a protective seal around the inner tube, as the inner tube extends and retracts from the outer tube.

### The Damper

The inner tube is connected to the damper assembly by an insulator to isolate the electrical lowering device from the high voltage in the lower frame assembly.

In the assembled pantograph, the damper assembly is connected to the lever of the lower frame assembly by the pin.

This arrangement allows the stroke of the electrical lowering device to push and pull on the lever of the lower frame assembly.

The damper assembly includes an elastomer spring that compensates for mechanical vibration during raising and lowering.

### Manual Input or Vehicle Control System Input.

The extension and retraction of the electrical lowering device can be by manual input or by vehicle control system input.

Manual input is by the flexible shaft. The flexible shaft is connected between the gear box input connection and the roof adaptor.

The hand crank connects to the coupling of the roof adaptor.

When the hand crank is used, the flexible shaft drives the gear train of the electrical lowering device.

Vehicle control system input is by electrical connection to the d-c motor via the electrical plug and wiring within the conduit.

### **The Proximity Switches and the Actuating Magnet**

The vehicle control system applies a voltage of the polarity required to cause the d-c motor to extend or retract the electrical lowering device.

Proximity switches S3 and S4 signal to the vehicle control system when the pantograph is in the down or raised position.

This tells the vehicle control system to switch off the voltage.

The actuating magnet for the proximity switches is bonded to the back end of the inner tube.

The magnet moves with the tube, so that it will be positioned under one of the proximity switches in the fully extended or retracted position of the brake/ball screw assembly.

The position of the proximity switches is adjustable to set the correct actuation point precisely. The operating position of the switches is adjusted at installation on the vehicle to insure the accuracy of the setting. Improper adjustment can result in the pantograph not raising to the required height (23 feet 8 5/8 inches) which might cause the pantograph to lose contact with the catenary or the premature failure of the electric lowering device because the motor never turns off.

A label on the pantograph alerts maintenance personnel of the importance of the adjustment.

Two insulators connect the mounting bracket to brackets of the base frame assembly. The insulators isolate the electrical lowering device from the high voltage in the base frame assembly.

Refer to Dwg N° AA03ATW Rev 11 Sheet 49 & 50 for Pantograph Functional Schematics

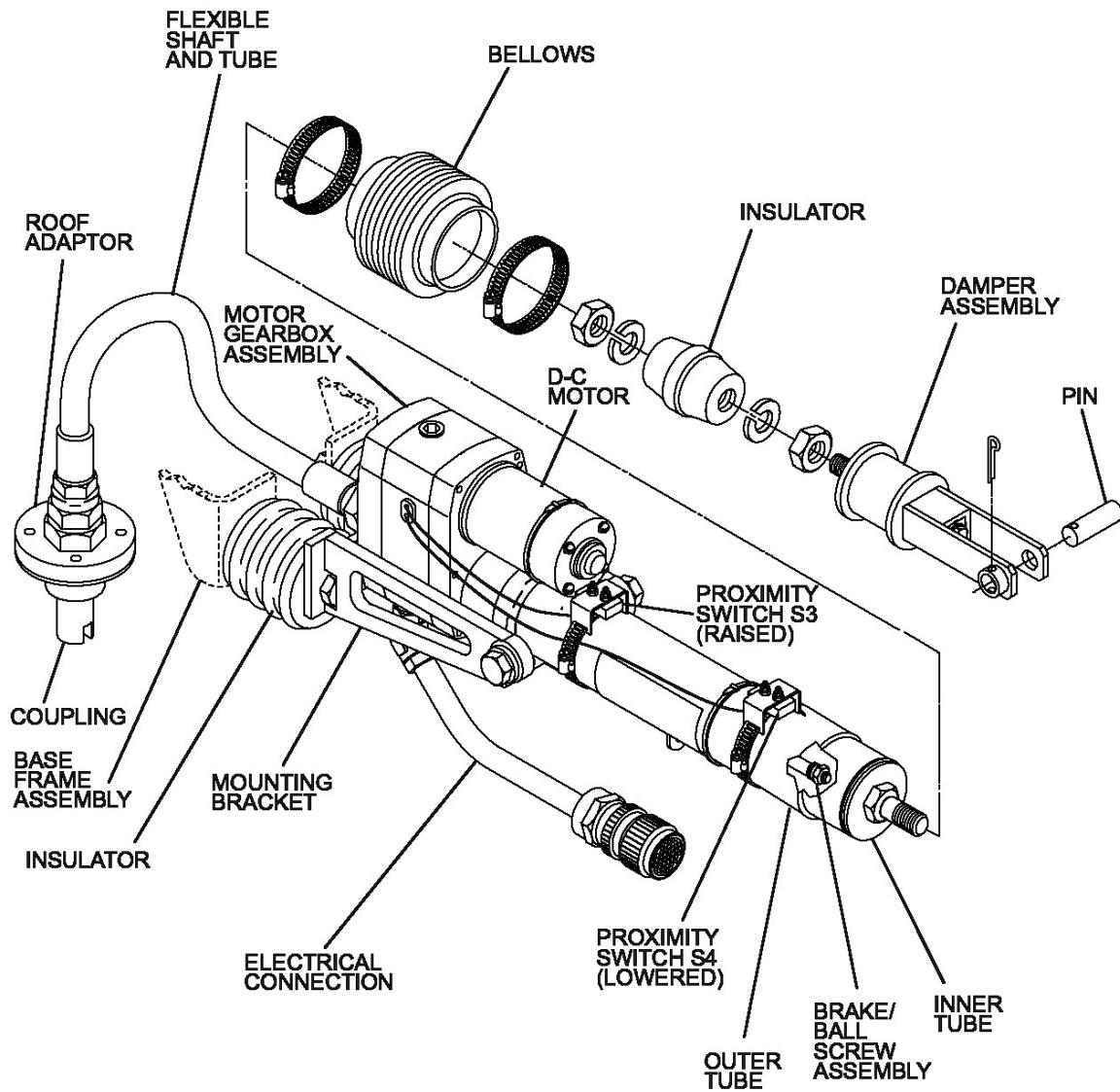
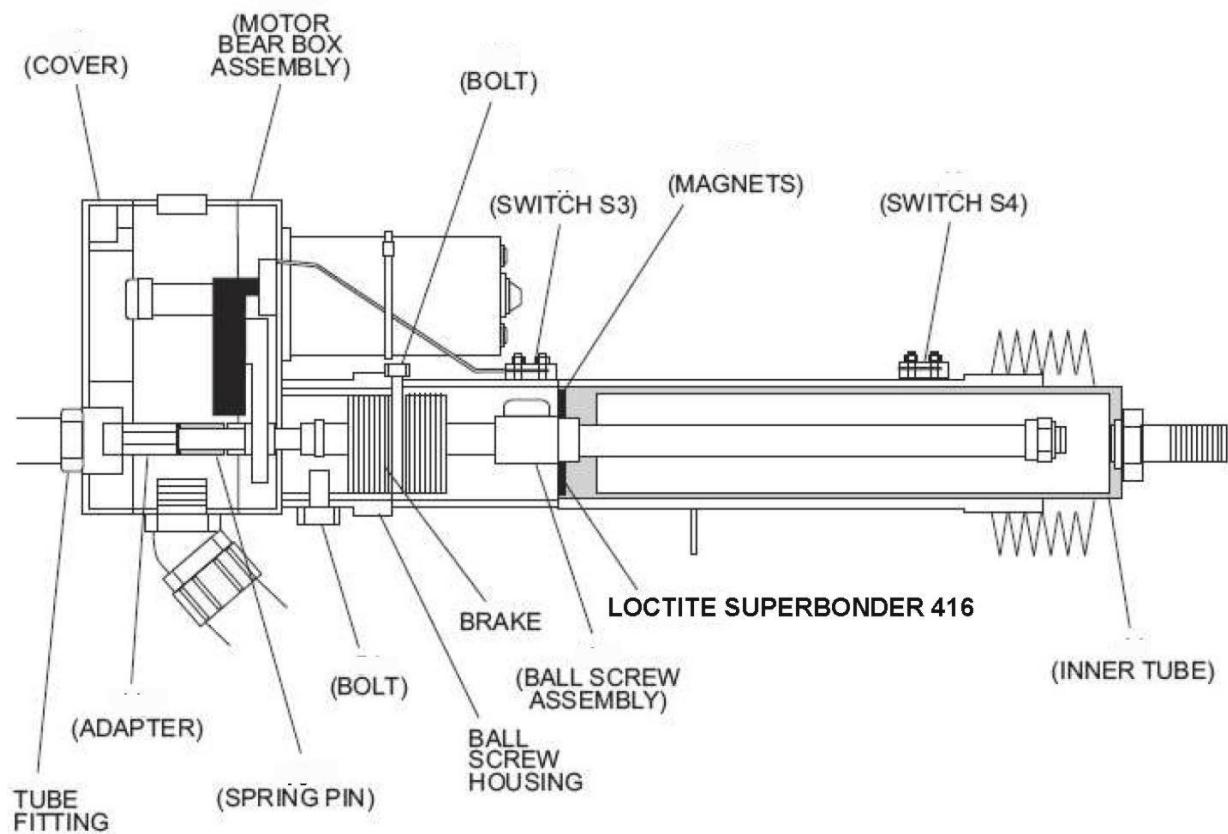


Figure 08-I-02.15 Electrical Lowering Device  
Sheet 1/2



**Figure 08-I-02.15 Electrical Lowering Device**

**Sheet 2/2**

## 08-I-02.02.09 Safety System

The safety system (refer to Figure 08-I-02.16) consists of the lever and the spindle lashing joined by the shear pin.

### The Lever and the Spindle Lashing

The lever and the spindle lashing are attached to brackets on the base frame assembly.

One raising spring is anchored to the trestle block by a threaded rod.

The coupling rod attaches to the spindle lashing, and transmits the force from the pan head and upper frame assembly to the shear pin.

### Purpose of the Safety System

The safety system prevents severe damage to the pantograph or catenary wire due to excessive contact force.

If the encountered force is too great, the shear pin breaks (by design) and allows the lever to rotate. This removes half of the spring force that keeps the pantograph raised.

Thus, the pantograph collapses to its lowered position.

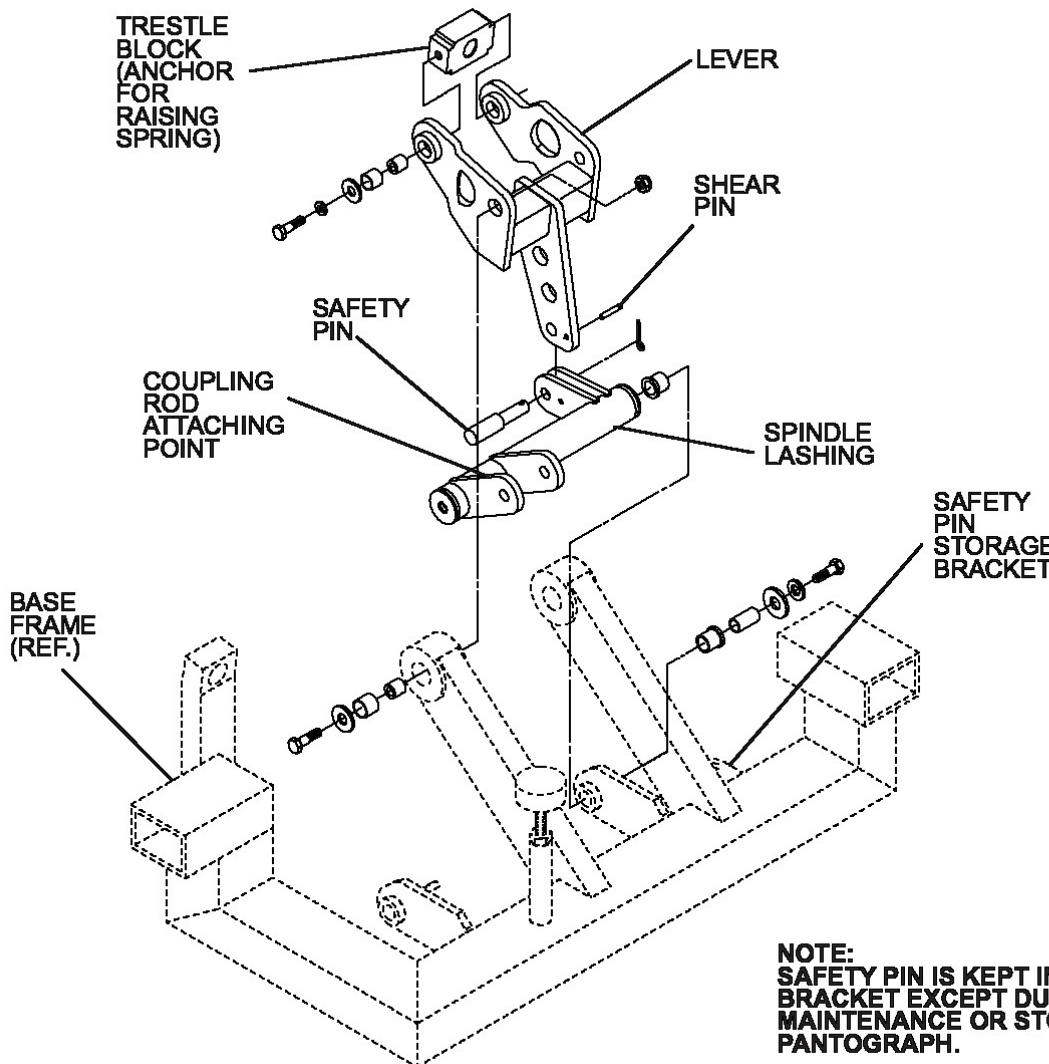
### The Safety Pin

The safety system accepts a safety pin (which is normally stored on a bracket of the base frame assembly) to prevent accidental collapse while work is performed on a raised pantograph and/or severe injury from the sudden rotation of the lever if the shear pin were to break while maintenance is being performed on the pantograph assembly.

A warning tag, mounted on the base frame assembly, alerts maintenance personnel to use the safety pin.

The safety pin installs in a set of holes adjacent to the shear pin.

The safety pin should have a loose fit in the safety device, if the safety pin is tight and very difficult to remove then this could be an indication that the shear pin has sheared. If this is the case, then DO NOT remove the safety pin until the shear pin has been inspected and replaced as needed. If the safety pin is hard to insert then this could be a sign that the shear pin has deformed and is about to fail. If this is the case then safely remove and replace the shear pin.



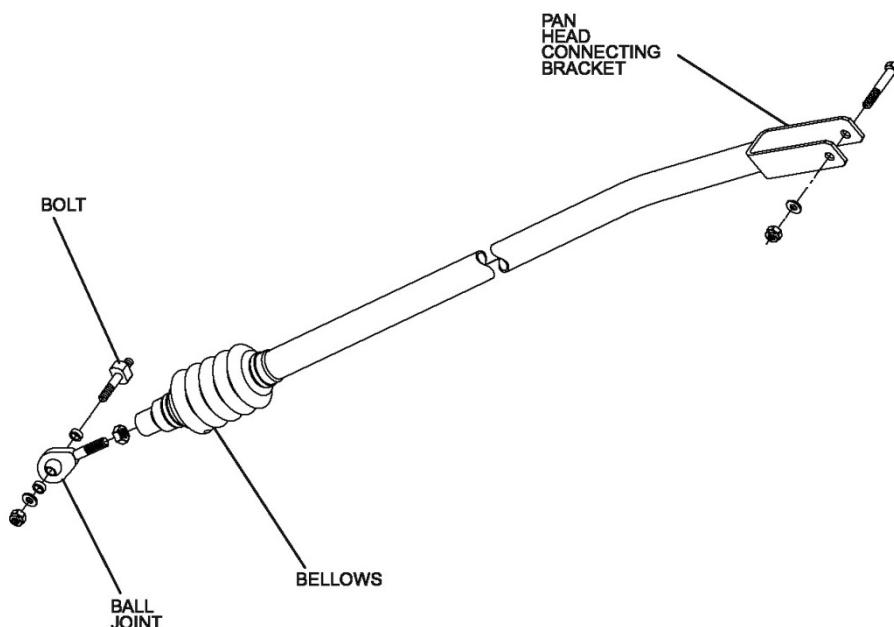
**Figure 08-I-02.16 Safety System**

### 08-I-02.02.10 Pan Guide Assembly

The pan guide assembly (refer to Figure 08-I-02.17) is a metal bar. A U-shaped bracket at one end attaches the bar to the rocker suspension of the pan head assembly. A ball joint and bolt at the other end attach the bar to the threaded block of the lower frame assembly.

The ball joint connects via a bellows-covered piston arrangement to the metal bar.

The pan guide assembly assists in keeping the pan head level and in contact with the catenary wire and allows the pan head to pivot symmetrically from its level position. The position of the ball joint is adjustable to set the pan head level with an equal pivot displacement to either side.



**Figure 08-I-02.17 Pan Guide Assembly**

### 08-I-02.02.11 Base Frame And Upper Frame Bearing Assemblies

The bearing assemblies for the base frame and upper frame (refer to Figure 08-I-02.18) are very similar.

The bearing assembly consists of two pairs of ball bearings that are located in mounting blocks.

Each pair of bearings mounts on an axle that has insulation bonded to the axle.

The axles and bearings are retained by bolts that extend through the mounting blocks and screw into the frame assembly, thus securing the bearings.

The bearing arrangement differs in that one is fixed and one is floating.

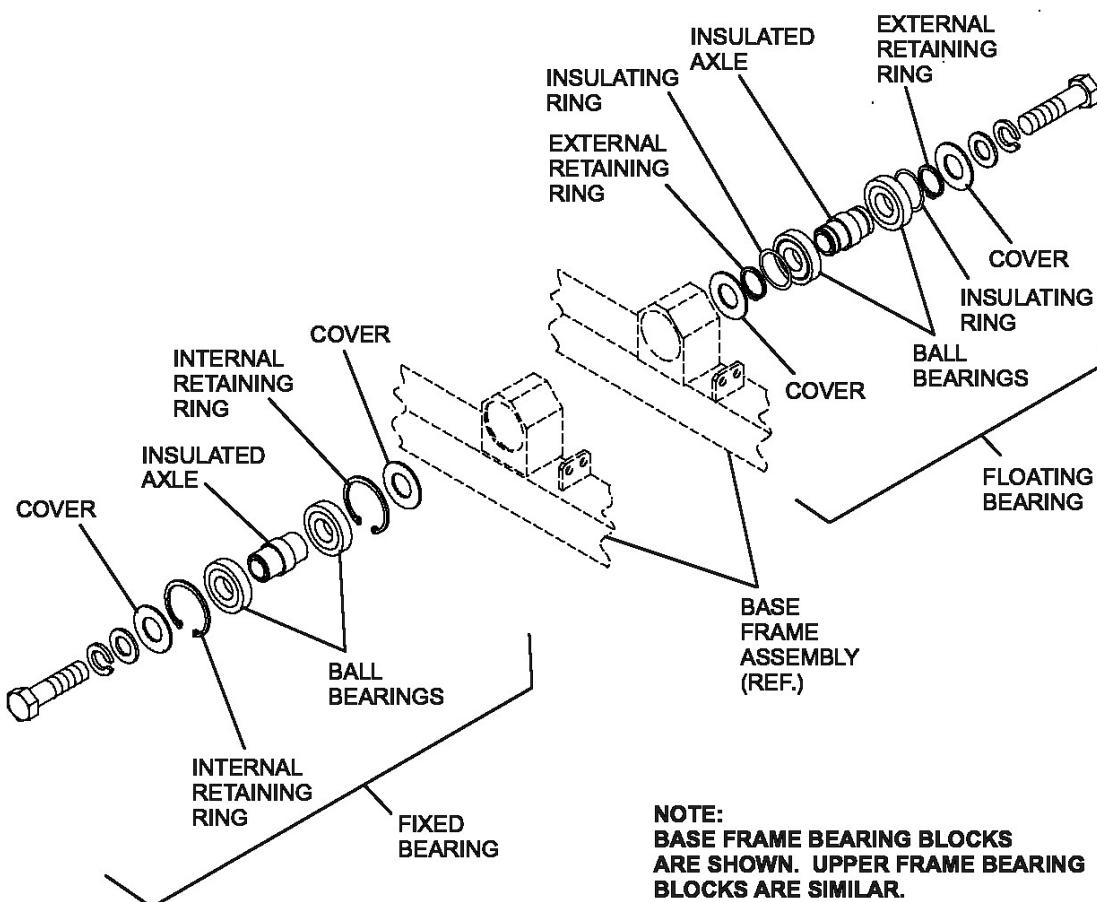
The fixed bearings are fixed to the mounting block with internal retaining rings positioned against the outer races of the bearings. In addition, the floating bearings have insulating rings between the bearings and the external retaining rings.

Covers protect the bearings from foreign matter.

The floating bearings are fixed to the shaft with external retaining rings positioned against the inner races of the bearings.

Although the bearings do not need lubrication, grease is packed in the space between the bearings to prevent condensation and rust.

The use of insulation aids in preventing current flow through the bearings.



**Figure 08-I-02.18 Base Frame and Upper Frame Bearing Assemblies**

### 08-I-02.02.12 Hand Crank Assembly

The hand crank assembly (refer to Figure 08-I-02.19) includes a handle, insulator, and coupling.

The handle is hinged to allow forming a crank.

When in use, the coupling on the end of the insulator mates with the coupling of the roof adapter.

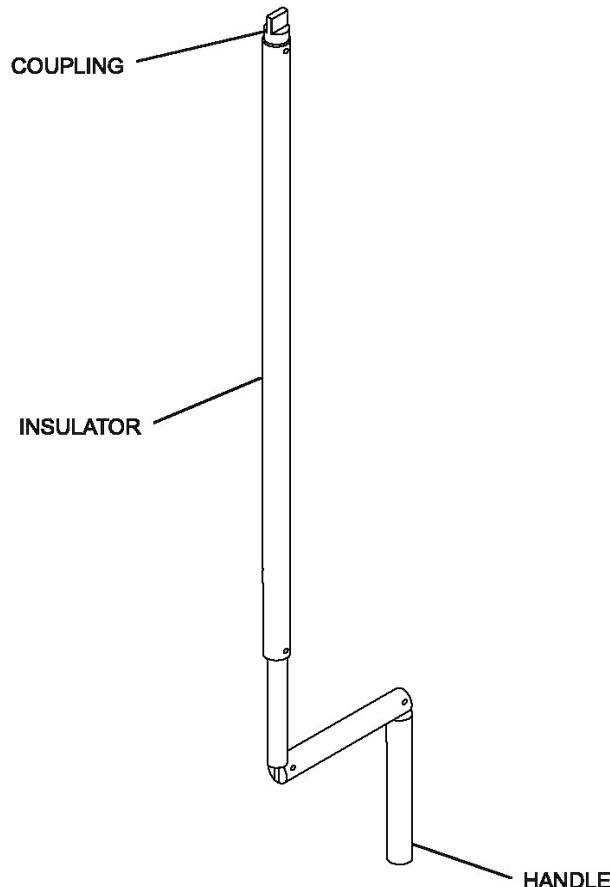
The hand crank is located in the A cab, behind the driver's seat.

In the absence of sufficient battery power (or a power loss), the hand crank is used to raise or lower the pantograph by hand from inside the car.

The insulator prevents injury in the event it contacts an electrified portion of the pantograph.

Rotation of the hand crank clockwise (CW) will raise the pantograph.

Rotation of the hand crank counterclockwise (CCW) will lower the pantograph.



**Figure 08-I-02.19 Hand Crank Assembly**

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**P2550**



RUNNING MAINTENANCE  
AND  
SERVICE MANUAL

VOLUME M-01  
PART II  
TROUBLESHOOTING  
SECTION 08 - PANTOGRAPH



## **SECTION 08**

### **PANTOGRAPH**

#### **PART II**

### **TROUBLESHOOTING**

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# SECTION 08

## PANTOGRAPH

### 08-II-01 INTRODUCTION

This Section of the Running Maintenance and Service Manual is divided into three Parts:

- Part I: Theory of Operation
- Part II: Troubleshooting
- Part III: Maintenance

Each Paragraph is numbered accordingly, to avoid that paragraphs of the same Section, pertaining to a different Part, have the same number.

#### Part I - Theory of Operation

Part I gives a thorough overview of the System structure and operation, by means of descriptions, figures, photos, schematics, block diagrams and flow charts, together with references to other documents or Sections when needed.

#### Part II - Troubleshooting

It gives the Maintenance Technicians a path to troubleshoot the System in every condition by means of the available tools:

- The PTU, equipped with the specific SW program
- The IDU
- The Fault Isolation Table

The Part III - Maintenance consists of:

- Preventive Maintenance
- Corrective Maintenance
- Consumable Materials
- Test Equipment, Tools, & Special Tools

**08-II-01.a LIST OF ABBREVIATIONS, ACRONYMS AND SYMBOLS**

The Abbreviations, Acronyms and Symbols commonly used throughout this manual are given below with their related meaning.

Abbreviation	Meaning
AB.....	AnsaldoBreda
HV .....	High Voltage
LRV .....	Light Rail Vehicle
LV .....	Low Voltage
MV .....	Medium Voltage
N .....	Newton
NC .....	Normally Closed
NO .....	Normally Open
PTU .....	Portable Test Unit
SGT.....	Schunk Graphite Technology
TBS .....	To Be Supplied
TCMS .....	Train Control and Monitoring System

**08-II-01.b LIST OF DEFINITIONS**

The Definitions commonly used throughout this manual are given below with their related meaning.

<b>Definition</b>	<b>Meaning</b>
'A' body section.....	The section of an articulated vehicle containing the pantograph
'B' body section.....	The section of an articulated vehicle not containing the pantograph
AW0.....	Empty car operating weight
AW1 .....	Full seated load plus AW0
AW2 .....	Standees at 4 persons per square meter plus AW1
AW3 .....	Standees at 6 persons per square meter plus AW1
AW4 .....	Standees at 8 persons per square meter plus AW1

**08-II-01.c LIST OF MEASUREMENT UNITS AND SYMBOLS**

The Measurement Units commonly used throughout this manual are given below with their related meaning.

<b>Definition</b>	<b>Meaning</b>
A.....	Ampere
ac .....	Alternate Current
dc .....	Direct Current
ft .....	Foot
Hz .....	Herz
in.....	Inch
kg .....	Kilogram - approx 2.205 pounds
km .....	Kilometer - approx 0.621 miles
Km/h.....	Kilometers per hour
kN .....	Kilo-Newton - approx 224.809 pound force
kVA.....	Kilo Volt Ampere
kW .....	Kilo Watt
lb.....	Pound
lb-ft .....	Pound force
m .....	Meter - approx 3.28 feet
mm .....	Millimeter - approx 0.0394 inches
mph .....	Miles per hour
ms .....	Milli second
Pa .....	Pascal
rpm .....	Revolution per Minute
V .....	Voltage
Vdc .....	Volts Direct Current
W.....	Watt

## **08-II-02 TROUBLESHOOTING**

The Pantograph is not interfaced by the TCMS (refer to Section 18).

Therefore, the IDU screen does not display any fault related to the Pantograph.

The only tool available to the Maintenance personnel for troubleshooting the Pantograph is the Fault Isolation/Repair Table (refer to Table 08-II-02.1).

### **08-II-02.01 Fault Insulation / Repair Tables**

**Table 08-II-02.1 Fault Isolation/Repair Table**

<b>DEFECT</b>	<b>PROBABLE CAUSE</b>	<b>CORRECTION</b>
1. Pantograph does not raise or lower.	1. No current supply from the vehicle. 3. Check up/down switch	1. Check supply battery. 2. Check electrical connections.
	2. The inner friction of the pantograph is too high.	1. Check pantograph for damage. 2. Check for damaged bearings.
	3. Broken or weak springs.	1. Replace springs.
2. Pantograph raises or lowers slowly.	1. The inner friction of the pantograph is too high.	1. Check pantograph for damage. 2. Check for damaged bearings.
	2. Friction in the motor flexible shaft is too high.	1. Check for proper routing of the flexible shaft and no sharp bends.
3. Frequent interruption of current transmittal (strong arcing).	1. Contact force is too low.	1. Check contact force.
	2. The inner friction of the pantograph is too high.	1. Check pantograph for damage. 2. Check for damaged bearings.
	3. Cracks or chips in contact strip	1. Replace contact strip.
	4. Pan head suspension works too slow.	1. Check for damaged bushings and flat springs.
	5. Carbon strips are not adjusted parallel.	1. Adjust contact strips so they are parallel.
	6. Pan guide not properly adjusted, restricting pan head rotation.	1. Adjust pan guide properly.

**Table 08-II-02.1 Fault Isolation/Repair Table**

<b>DEFECT</b>	<b>PROBABLE CAUSE</b>	<b>CORRECTION</b>
4. Uneven wear on contact strip.	1. Carbon strips are not adjusted parallel.	1. Adjust contact strips so they are parallel.
	2. Pan guide not properly adjusted, restricting pan head rotation.	1. Adjust pan guide properly.
5. Current flash over from base frame to vehicle roof.	1. Pantograph mounting insulators are dirty.	1. Clean insulators with mild non-abrasive detergent and rinse clean.
6. Current flash over from base frame to motor.	1. Motor mounting insulators are dirty.	1. Clean insulators with mild non-abrasive detergent and rinse clean.
7. Electrical lowering device does not switch off after raising or lowering the pantograph.	1. Electrical lowering device not properly adjusted.	1. Adjust using procedure detailed in OH #5-5.
	2. Defective electrical connections.	1. Check electrical connections and replace if necessary.
8. Electrical lowering device does not operate. Proper voltage is present but no amp draw.	1. Overheated motor.	1. Let cool. Check duty cycle.
9. Electrical lowering device does not operate. Proper voltage and amp draw present. Clutch slips.	1. Motor overloaded.	1. Check pantograph for damage or binding.
	2. Worn clutch.	1. Replace clutch.
10. Electrical lowering device stops in mid-stroke. Clutch slips.	1. Motor overloaded.	1. Check pantograph for damage or binding.
11. Electrical lowering device stops in mid-stroke. Clutch does not slip.	1. Blown fuse or tripped circuit breaker.	1. Replace fuse or reset circuit breaker.
	2. Motor thermal breaker activated from overheating.	1. Let cool. Check duty cycle.
12. Electrical lowering device stops in mid-stroke. Clutch does not slip. Amps present.	1. Motor stalled.	1. Voltage too low.
13. Pantograph cannot be raised or lowered with hand crank.	1. Flexible shaft not properly installed.	1. Check for proper connection, routing of the flexible shaft, and no sharp bends.

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**RUNNING MAINTENANCE  
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SERVICE MANUAL**

**VOLUME M-01-A  
PART III  
MAINTENANCE  
SECT 02 CAR BODY**





# **SECTION 08**

## **PANTOGRAPH**

### **PART III**

## **MAINTENANCE**

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# SECTION 08

## PANTOGRAPH

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# SECTION 08

## PANTOGRAPH

### 08-III-01 INTRODUCTION

The Pantograph Part III - Maintenance consists of:

- Preventive Maintenance
- Corrective Maintenance
- Consumable Materials
- Test Equipment & Special Tools

### **08-III-01.a List of Abbreviations, Acronyms & Symbols**

The Abbreviations, Acronyms and Symbols commonly used throughout this Section are given below with their relevant meaning.

<b>Abbreviation</b>	<b>Meaning</b>
AB	AnsaldoBreda
AC	Alternate Current
ASSY	Assembly
ELE	Electronic
H-CML	Heavy Consumable Material List
H-CMS	Heavy Corrective Maintenance Sheet
HV	High Voltage
IDU	Integrated Diagnostic Unit
IPC	Illustrated Parts Catalog
LRV	Light Railway Vehicle
LV	Low Voltage
MV	Medium Voltage
N	Newton
NC	Normally Closed
NO	Normally Open
PTU	Portable Test Unit
R-CML	Running Consumable Material List
R-CMS	Running Corrective Maintenance Sheet
RMSM	Running Maintenance & Service Manual
R-PMM	Running Preventive Maintenance Matrix
R-PMR	Running Preventive Maintenance Report
R-PMS	Running Preventive Maintenance Sheet
R-TESTL	Running Test Equipment, Tools & Special Tools List
SCPM	Safety Critical Preventive Maintenance
SGT	Schunk Graphite Technology
TBD	To Be Defined
TBS	To Be Supplied
TOC	Table Of Content
TCMS	Train Control and Monitoring System
TTEM	Tools & Test Equipment Manual
VAC	Voltage Alternate Current
VDC	Voltage Direct Current
W/	With
W/O	Without

### 08-III-01.b List of Definitions

The Definitions commonly used throughout this Section are given below with their relevant meaning.

Definition	Meaning
'A' body section	The section of an articulated vehicle containing the pantograph
'B' body section	The section of an articulated vehicle not containing the pantograph
AW0	Empty car operating weight
AW1	Full seated load plus AW0
AW2	Standees at 4 persons per square meter plus AW1
AW3	Standees at 6 persons per square meter plus AW1
AW4	Standees at 8 persons per square meter plus AW1
Front door	The door close to the Operator's Cab
Rear door	The door close to the Articulation Section
MC Handle	Master Controller Handle
"A" Cab (or Cab A)	Operator Cab in the A body section
"B" Cab (or Cab B)	Operator Cab in the B body section

### 08-III-01.c List of Measurement Units

The Measurement Units commonly used throughout this Section are given below with their relevant meaning.

<b>Definition</b>	<b>Meaning</b>
ft	Foot
gal	Gallon
in	Inch
kg	Kilogram - approx 2.205 pounds
km	Kilometer - approx 0.621 miles
lb	Pound
lb-ft	Pound force
m	Meter - approx 3.28 feet
mm	Millimeter - approx 0.0394 inches
mph	Miles per hour
Km/h	Kilometers per hour
s	Seconds
V	Volt
Vdc	Direct Voltage
Vac	Alternate Voltage
kVA	Kilo-Volt-Ampere
kW	Kilo-Watt
W	Watt
F	Farad
H	Henry
W	Ohm
°F	Fahrenheit
°C	Celsius
A	Ampere
Hz	Hertz
rpm	Revolution per Minute
N	Newton
Nm	Newton-Meter
mphs	Mile Per Hour Per Second
	(Acceleration)

## **08-III-01.d References**

Refer to Section 00 of this RMSM for details relevant to the following Topics:

<b>Topic</b>	<b>Paragraph</b>
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## 08-III-02 P2550 ANSALDOBREDA MAINTENANCE PLAN

The AB Preventive Maintenance Plan (PMP) has been designed in order to permit a 30-year Structural and Service Vehicle Life with the following basic assumptions:

- Yearly mileage: 120,000 Miles
- Motor and Trailer Truck removal: every 5 years. (600,000 Miles)

The AB Preventive Maintenance Plan (PMP) provides the Preventive Maintenance Tasks to be performed according the following Mileage Intervals:

<b>Running Maintenance</b>		<b>Heavy Maintenance</b>	
Daily			
10,000	Miles		
30,000	Miles	600,000	Miles
60,000	Miles	1,200,000	Miles
120,000	Miles	1,800,000	Miles

In accordance with the Preliminary Version of the AB Preventive Maintenance Plan, the Scheduled Maintenance Tasks for the entire Vehicle Life have been grouped into:

- Running Preventive Maintenance
- Heavy Preventive Maintenance

In accordance with the AB Corrective Maintenance Analysis, the Corrective Maintenance Tasks for the entire Vehicle Life have been grouped into:

- Running Corrective Maintenance
- Heavy Corrective Maintenance

## 08-III-03 RUNNING -PREVENTIVE MAINTENANCE

### 08-III-03.01 Running -Preventive Maintenance Matrixes (R-PMM)

The Pantograph Running -Preventive Maintenance Matrix (R-PMM) provides the Preventive Maintenance Plan of the Pantograph up to 120,000 Miles.

The Pantograph (R-PMM) is provided in two different arrangements as follows:

- **R-PMM Component Based**

It lists the Pantograph Running - Preventive Maintenance Tasks ordered by Subsystem /Assemblies / Component break down, followed by the PM Task Description and Scheduled Task Interval and linked to the relevant R-PM Sheet Code.

The R-PMM Component Based provides the Maintainer with the following data:

- SYSTEM/SUBSYSTEM /ASSEMBLY/UNIT/COMPONENT
- TASK
- SCPM
- INSPECTION INTERVAL
- SHEET CODE

- **R-PMM Mileage Based**

It lists the Pantograph Running - Preventive Maintenance Tasks ordered by Scheduled Maintenance Interval and broken down into the related Subsystem /Assemblies/Component followed by the PM Task Description and Person Hours and linked to the relevant R-PM Sheet Code.

The R-PMM Mileage Based provides the Maintainer with the following data:

- INSPECTION INTERVAL
- SYSTEM/SUBSYSTEM /ASSEMBLY/UNIT/COMPONENT
- TASK
- SCPM
- PERSON HOURS
- SHEET CODE

The data listed in this Matrix are the same of those listed in the R-PMM Component Based with the exception of the PERSON HOURS.

### **08-III-03.01.01 Definitions**

The following definitions are applicable to both types of R-PMM

#### **Tasks**

- Cleaning:** Methods and processes required (Step-By-Step Procedural Instructions) for cleaning specific parts or areas of the Vehicle.
- Inspection:** Preventive Maintenance procedures such as those required to ascertain the serviceability of a Part, Assembly, System or the specific interrelationship of Parts that perform a functional operation.
- Lubrication:** Provides component lubrication Instructions.
- Replacement** Provides the Components / Assemblies and Subassemblies removal & installation in a logical sequential order.  
Maintenance procedures identified in this topic include Components that are replaced within a 4 hours window.
- Service:** Operation performed to replenish Sand, Windshield Wiper Washer Fluid, HVAC Coolant, Gear and Compressor Oil, and Vehicle Lubrication.
- Test:** Procedures and Parameters to evaluate the operational efficiency and integrity of a System /Subsystem/Component and the interrelationship of Parts performing functional operations.

**NOTE:** The Safety Precautions to be followed to safely accomplish the Maintenance of the Pantograph are provided (in sheet format) at the beginning of each section containing the relevant R-PMS.

### **08-III-03.01.02 Inspection Intervals**

The Running - Preventive Maintenance Intervals for the P2550 LRV Fleet are scheduled as follows:

Daily	10,000 Miles	30,000 Miles	60,000 Miles	120,000 Miles
-------	--------------	--------------	--------------	---------------

The marker "●" in the INSPECTIONS INTERVAL column, indicates the periodicity of the corresponding Task.

### **08-III-03.01.03 Safety Critical Preventive Maintenance (SCPM) Tasks**

The marker "✓" in the SCPM column, indicates that the corresponding Task is a Safety Critical Preventive Maintenance (SCPM) Task, as per the results of the Safety Analyses performed, on Vehicle Subsystems, according to Vehicle Specification.

**08-III-03.01.04      Sheet Code**

The Sheet Code column, indicates the reference to Running -Preventive Maintenance Sheet where the Procedure to be performed is described and illustrated.

**THE SHEET CODE IS THE EXPLICIT LINK BETWEEN  
R-PM MATRIXES, R-PMR /JOB CARDS AND R-PM SHEETS**

Refer to Paragraph 08-III-03.03.01 for Running- Preventive Maintenance Sheet (R-PMS) Form for detailed explanation.

**08-III-03.01.05      Person Hours**

It indicates the time required to perform the corresponding Task with the basic assumption that the Vehicle is on an Inspection Pit or Stand Up Rail and the Consumables, Tools and Spare Parts needed to accomplish the Task are available at the Location of the Equipment to be maintained.

Refer to:

- Table 08-III-03.1 for Running - Preventive Maintenance Matrix (R-PMM)  
(Component Based)
- Table 08-III-03.2 for Running - Preventive Maintenance Matrix (R-PMM)  
(Mileage Based)

**08-III-03.01.06      Running Preventive Maintenance Matrix (Component Based)**
**Table 08-III-03.1    Running Preventive Maintenance Matrix (Component Based)**

SYSTEM 08		PANTOGRAPH						
SUBSYSTEM ASSY/UNIT/COMPONENT	TASK	S	INSPECTION INTERVAL MILES				SHEET CODE	
		C P M	Daily	10K	30K	60K	120K	
-PANTOGRAPH ASSY	INSPECTION		●					R-P-08-01-00-00/I-00
-PANTOGRAPH ASSY	INSPECTION			●				R-P-08-01-00-00/I-01
-PANTOGRAPH ASSY	SERVICE				●			R-P-08-01-00-00/S-00
-PANTOGRAPH ASSY	INSPECTION					●		R-P-08-01-00-00/I-02
-COLLECTOR HEAD	REPLACEMENT			●				R-P-08-02-00-00/R-00

**08-III-03.01.07      Running Preventive Maintenance Matrix (Mileage Based)**
**Table 08-III-03.2    Running Preventive Maintenance Matrix (Mileage Based)**

SYSTEM 08		PANTOGRAPH		
SUBSYSTEM	TASK	S C P M	PERSON HOURS	SHEET CODE
<b>10,000 MILES</b>				
-PANTOGRAPH ASSY	INSPECTION		0.25	R-P-08-01-00-00/I-00
<b>30,000 MILES</b>				
-PANTOGRAPH ASSY	INSPECTION		0.5	R-P-08-01-00-00/I-01
-COLLECTOR HEAD	REPLACEMENT		0.2	R-P-08-02-00-00/R-00
<b>60,000 MILES</b>				
-PANTOGRAPH ASSY	SERVICE		0.75	R-P-08-01-00-00/S-00
<b>120,000 MILES</b>				
-PANTOGRAPH ASSY	INSPECTION		1.25	R-P-08-01-00-00/I-02

## 08-III-03.02 Running -Preventive Maintenance Reports (R-PMR/Job Cards)

This paragraph describes the contents of the Pantograph Running -Preventive Maintenance Reports (R-PMR/Job Cards) for the Running - Preventive Maintenance Tasks.

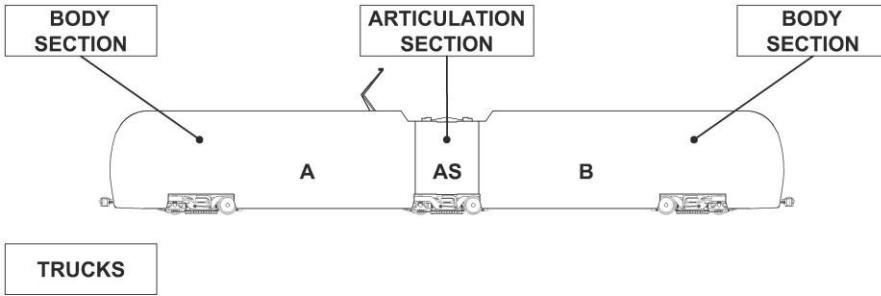
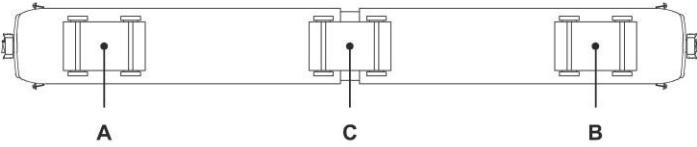
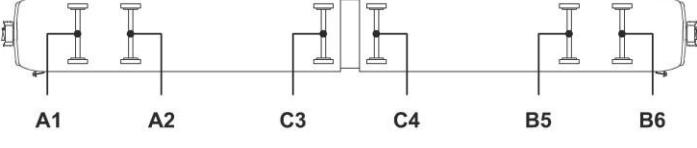
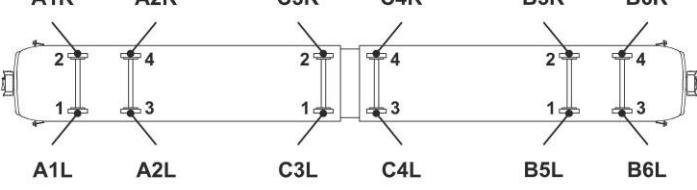
### 08-III-03.02.01 R-PMR/Job Card Form Content

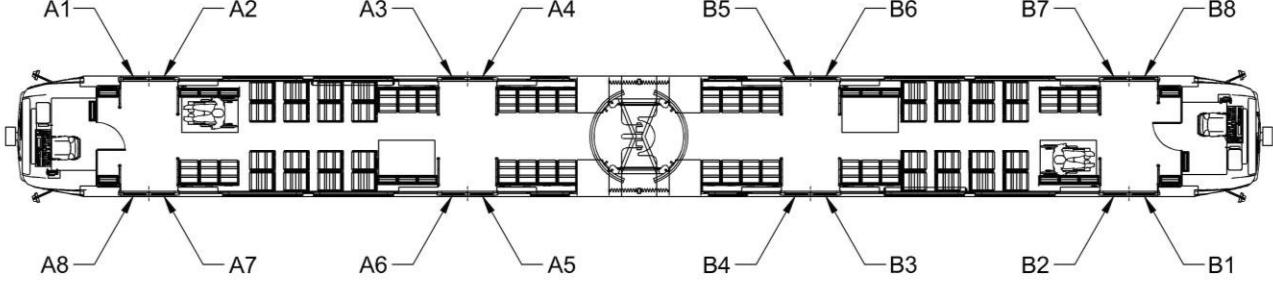
The R-PMR/JOB CARDS are broken down into two main topics:

Specific Data and R-PM Data

Refer to Figure 08-III-03.1 for R-PMR/JOB CARD Form example

<b>RUNNING PREVENTIVE MAINTENANCE REPORTS (R-PMR/JOB CARDS) FORM</b>		
<b>SPECIFIC DATA TO BE FILLED IN BY THE MAINTAINER</b>		
<b>ITEM #</b>	<b>TITLE</b>	<b>EXPLANATORY NOTE</b>
1	<b>VEHICLE #</b>	This field indicates the Vehicle Identification Number
2	<b>DATE</b>	This field indicates the Date on which the Vehicle entered the Maintenance Shop
3	<b>RUNNING HOURS</b>	This field indicates the Vehicle Running Hours at the above Date
4	<b>MILES</b>	This field indicates the Vehicle Running Miles at the above Date.
5	<b>EMPLOYEE # &amp; SIGNATURE</b>	This Field indicates the Employee # & Signature of the Maintainer(s) that perform the referred Task(s)
6	<b>STARTING DATE</b>	This field indicates the Starting Date of the referred Task(s).
7	<b>WORK HOURS</b>	This field indicates the Work duration to perform the referred Task(s).
8	<b>COMPLETION DATE</b>	This field indicates the Completion Date of the referred Task(s).
9	<b>DEFECT FOUND/COMMENTS</b>	This field indicates the result of the Task(s) execution and/ or note related to any items of the maintained Equipment requiring Corrective Maintenance
A	<b>P2550 RUNNING PREVENTIVE MAINTENANCE REPORT SYSTEM (Maintenance Interval) JOB CARD</b>	<p>This field provides R-PMR Title.</p> <p>The R-PM Maintenance Intervals are the following:</p> <p>Daily; 10,000 Miles; 30,000 Miles, 60,000 Miles, 120,000 Miles</p>
B	<b>WORK AREA</b>	<p>This column lists the On Vehicle Areas where the Equipment to be maintained is located</p> <p>The Work Areas are provided to optimize the jobs organization of the Preventive Maintenance tasks in order to:</p> <ul style="list-style-type: none"> <li>1- respect the Safety Precautions to be followed</li> <li>2- complete the preparation and the availability of the Consumables, Tools and Spare Parts, needed to perform the referred Task.</li> <li>3- respect the time (PERSON HOURS) established to perform the referred Task (with the basic assumption that the Vehicle is on an Inspection Pit or Stand Up Rail and the Consumables, Tools and Spare Parts are available at the location of the Equipment to be maintained.)</li> </ul> <p>The On Vehicle Work Areas are the following:</p> <p>Exterior - Interior - Roof - Truck - Undercar - Vehicle (Vehicle as a whole)</p>

<b>RUNNING PREVENTIVE MAINTENANCE REPORTS (R-PMR/JOB CARDS) FORM</b>		
<b>SPECIFIC DATA TO BE FILLED IN BY THE MAINTAINER</b>		
<b>ITEM #</b>	<b>TITLE</b>	<b>EXPLANATORY NOTE</b>
<b>C</b>	<b>ITEM</b>	This column lists the Subsystem/Assembly, Unit, Component to be maintained
<b>D</b>	<b>TASK</b>	<p>This column lists the R-PM tasks to be performed for each Assembly/Unit/Component (i.e., Cleaning, Inspection, Test)</p> <p>The R-PM Tasks are the following:</p> <ul style="list-style-type: none"> <li>- Cleaning - Inspection -Lubrication -</li> <li>- Replacement - Service- Test</li> </ul>
<b>E</b>	<b>LOCATION</b>	<p>This column lists the On Board Vehicle Location of all Equipment to be maintained according to the following Location identification Codes</p>    

<b>RUNNING PREVENTIVE MAINTENANCE REPORTS (R-PMR/JOB CARDS) FORM</b>		
<b>SPECIFIC DATA TO BE FILLED IN BY THE MAINTAINER</b>		
<b>ITEM #</b>	<b>TITLE</b>	
E (cont'd)	<b>LOCATION</b> (cont'd)	
<b>EXPLANATORY NOTE</b>		
 <p>CAR "A"</p> <p>CAR "B"</p>		
<b>Door Numbering</b>		
<b>ITEM #</b>	<b>TITLE</b>	<b>EXPLANATORY NOTE</b>
F	<b>PM SHEET CODE</b>	<p>This column lists the reference to Running-Preventive Maintenance Sheet where the Procedure to be performed is described and illustrated.</p> <p>Refer to Running-Preventive Maintenance Sheet (R-PMS) Form for detailed explanation.</p>
G	<b>SHEET ....OF.....</b>	This field indicates the progressive sheet page number of each R-PMR/JOB CARD

P2550 RUNNING PREVENTIVE MAINTENANCE REPORT PROPULSION 30,000 MILES JOB CARD						Metro
WORK AREA	ITEM	TASK	LOCATION		PM SHEET CODE	SHEET 1 OF 2
			BODY SECTION	TRUCK	AXLE	SIDE
ROOF	BRAKING RESISTOR	CLEANING	A			R-P-07-03-06-00/C-00
	BRAKING RESISTOR	CLEANING	B			R-P-07-03-06-00/C-00
TRUCK	GEARBOX	INSPECTION	A	A	A1	R-P-07-06-01-00/I-00
	GEARBOX	INSPECTION	A	A	A2	R-P-07-06-01-00/I-00
	GEARBOX	SERVICE	A	A	A1	R-P-07-06-01-00/S-00
	GEARBOX	SERVICE	A	A	A2	R-P-07-06-01-00/S-00
	GEARBOX	SERVICE	A	A	A1	R-P-07-06-01-00/S-01

P2550 RUNNING PREVENTIVE MAINTENANCE REPORT PROPULSION 30,000 MILES JOB CARD						Metro
VEHICLE#	DATE	/ /	RUNNING HOURS	MILES	DEFECT FOUND / COMMENTS	SHEET 2 OF 2
1					3 4	9
5					6	8
						FINAL VERSION APPROVAL DATE

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**Figure 08-III-03.1 R-PMR/Job Card Form -Example****08-III-03.02.02 R-PMR/Job Card Sequence**

The R-PMR/JOB CARDS provided in this Section are grouped according to the following sequence:

Daily      10,000 Miles      30,000 Miles      60,000 Miles      120,000 Miles

### 08-III-03.02.03 Running -Preventive Maintenance Cycle & R-PMR/Job Card Content

The Running -Preventive Maintenance Cycle and the relevant R-PMR/JOB CARD content are as follows:

MAINTENANCE INTERVAL	PMR /JOB CARD TITLE	PMR /Job Card CONTENT
DAILY	DAILY JOB CARD	<ul style="list-style-type: none"> <li>• List of Assemblies/Components and related Tasks to be performed <b>DAILY</b></li> </ul>
10,000 Miles	10,000 MILES JOB CARD	<ul style="list-style-type: none"> <li>• DAILY Job Card content</li> <li>+ List of Assemblies/Components and related Tasks to be performed at <b>10,000</b> Miles</li> </ul>
30,000 Miles	30,000 MILES JOB CARD	<ul style="list-style-type: none"> <li>• DAILY Job Card content</li> <li>+ 10,000 Job Card content</li> <li>+ List of Assemblies/Components and related Tasks to be performed at <b>30,000</b> Miles</li> </ul>
60,000 Miles	60,000 MILES JOB CARD	<ul style="list-style-type: none"> <li>• DAILY Job Card content</li> <li>+ 10,000 Job Card content</li> <li>+ 30,000 Job Card content</li> <li>+ List of Assemblies/Components and related Tasks to be performed at <b>60,000</b> Miles</li> </ul>
120,000 MILES	120,000 MILES JOB CARD	<ul style="list-style-type: none"> <li>• DAILY Job Card content</li> <li>+ 10,000 Job Card content</li> <li>+ 30,000 Job Card content</li> <li>+ 60,000 Job Card content</li> <li>+ List of Assemblies/Components and related Tasks to be performed at <b>120,000</b> Miles</li> </ul>

### 08-III-03.02.04 R-PMR/Job Card Data Presentation Sequence

The Subsystems / Assemblies / Units / Components listed in the ITEMS column of each R-PMR/JOB CARD are grouped by Work Area and Vehicle Systems' and sequenced, in alphabetical order, in conjunction with their On Vehicle Locations and Tasks to be performed.

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**08-III-03.02.05 Running Preventive Maintenance Reports R-PMR/Job Cards**

## **PANTOGRAPH**

### **Running - Preventive Maintenance Reports**

### **R-PMR/JOB CARDS**

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**PANTOGRAPH  
RUNNING PREVENTIVE MAINTENANCE REPORT  
10,000 MILES JOB CARD**

VEHICLE #		DATE		RUNNING HOURS		MILES		SHEET 1 OF 1
-----------	--	------	--	---------------	--	-------	--	--------------

WORK AREA	SYSTEM	ITEM	TASK	LOCATION				PM SHEET CODE
				BODY SECT	TRUCK	AXLE	SIDE	
ROOF	PANTOGRAPH	PANTOGRAPH ASSY	INSPECTION	A				R-P-08-01-00-00/I-00

**DEFECT FOUND / COMMENTS**

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EMPLOYEE # & SIGNATURE	STARTING DATE	WORK HOURS	COMPLETION DATE

**PANTOGRAPH**  
**RUNNING PREVENTIVE MAINTENANCE REPORT**  
**30,000 MILES JOB CARD**

VEHICLE #		DATE		RUNNING HOURS		MILES		SHEET 1 OF 1
-----------	--	------	--	---------------	--	-------	--	--------------

WORK AREA	SYSTEM	ITEM	TASK	LOCATION				PM SHEET CODE
				BODY SECT	TRUCK	AXLE	SIDE	
ROOF	PANTOGRAPH	COLLECTOR HEAD	REPLACEMENT	A				R-P-08-02-00-00/R-00
		PANTOGRAPH ASSY	INSPECTION	A				R-P-08-01-00-00/I-00
		PANTOGRAPH ASSY	INSPECTION	A				R-P-08-01-00-00/I-01

**DEFECT FOUND / COMMENTS**


EMPLOYEE # & SIGNATURE	STARTING DATE	WORK HOURS	COMPLETION DATE

**PANTOGRAPH -  
RUNNING PREVENTIVE MAINTENANCE REPORT  
- 60,000 MILES JOB CARD**

VEHICLE #		DATE		RUNNING HOURS		MILES		SHEET 1 OF 1
-----------	--	------	--	---------------	--	-------	--	--------------

WORK AREA	SYSTEM	ITEM	TASK	LOCATION				PM SHEET CODE
				BODY SECT	TRUCK	AXLE	SIDE	
ROOF	PANTOGRAPH	COLLECTOR HEAD	REPLACEMENT	A				R-P-08-02-00-00/R-00
		PANTOGRAPH ASSY	INSPECTION	A				R-P-08-01-00-00/I-00
		PANTOGRAPH ASSY	INSPECTION	A				R-P-08-01-00-00/I-01
		PANTOGRAPH ASSY	SERVICE	A				R-P-08-01-00-00/S-00

**DEFECT FOUND / COMMENTS**

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EMPLOYEE # & SIGNATURE	STARTING DATE	WORK HOURS	COMPLETION DATE

**PANTOGRAPH -  
RUNNING PREVENTIVE MAINTENANCE REPORT  
- 120,000 MILES JOB CARD**

VEHICLE #		DATE		RUNNING HOURS		MILES		SHEET 1 OF 1
-----------	--	------	--	---------------	--	-------	--	--------------

WORK AREA	SYSTEM	ITEM	TASK	LOCATION				PM SHEET CODE
				BODY SECT	TRUCK	AXLE	SIDE	
ROOF	PANTOGRAPH	COLLECTOR HEAD	REPLACEMENT	A				R-P-08-02-00-00/R-00
		PANTOGRAPH ASSY	INSPECTION	A				R-P-08-01-00-00/I-00
		PANTOGRAPH ASSY	INSPECTION	A				R-P-08-01-00-00/I-01
		PANTOGRAPH ASSY	INSPECTION	A				R-P-08-01-00-00/I-02
		PANTOGRAPH ASSY	SERVICE	A				R-P-08-01-00-00/S-00

**DEFECT FOUND / COMMENTS**

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EMPLOYEE # & SIGNATURE	STARTING DATE	WORK HOURS	COMPLETION DATE

### 08-III-03.03 Running -Preventive Maintenance Sheets (R-PMS)

Each R-PMS provides the following data consistent with Preventive Maintenance Plan (PMP), AB Design Documentation and Vehicle Systems Functional Tree:

- **R-PM Sheet Code**
- **SYSTEM, SUBSYSTEM /ASSEMBLY, UNIT, Component (Names)**
- **SYSTEM, SUBSYSTEM /ASSEMBLY, UNIT, Component (Location)**
- **Maintenance Interval (Miles)**
- **Maintenance Task,**
- **Man Hours**, needed to perform the Task
- **SPARE PARTS**, needed to perform the Task

Each R-PMS also provides:

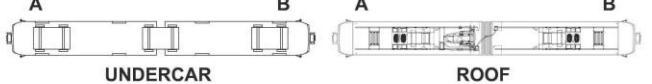
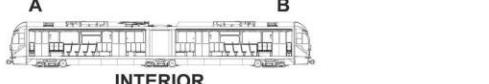
- **SAFETY PRECAUTIONS**, to be followed to safely accomplish the Task
- **TOOLS**, including Special Tools and Test Equipment, needed to accomplish the Task
- **CONSUMABLES**, required to accomplish the Task and consistent with those used by MTA
- **PROCEDURE**, consisting of **Preliminary Operations** and **Procedural Steps**, to be followed while performing Maintenance Tasks
- **Illustrations** and **Pictures** are inserted in the text to facilitate the understanding of the topics and/or to explain step-by-step procedure

#### 08-III-03.03.01      Running- Preventive Maintenance Sheet (R-PMS) Form

The R-PMS Form (refer to Figure 08-III-03.2) consists of several fields containing the following data/ information:

<b>RUNNING -PREVENTIVE MAINTENANCE SHEET (RPMS) Form</b>			
<b>ITEM #</b>	<b>TITLE</b>	<b>CONTENT</b>	<b>EXPLANATORY NOTES</b>
1	<b>Card code</b>	<b>Sheet code</b>	<p>The Sheet Code is an alphanumerical code that identifies each R-PM Sheet.</p> <p><b>THE SHEET CODE IS THE EXPLICIT LINK BETWEEN R-PM MATRIXES, R-PMR /JOB CARDS AND R-PM SHEETS</b></p> <p>The Sheet Code consists of letters R-P followed by an 11 digit code number as follows:</p> <p><b>R-P-nn-mm-zz-ww/Y-kk</b></p> <p><b>R = Running      P= Preventive</b></p> <p><b>nn</b>      may vary from 02 to 19, identifying the System/ Manual Section number.</p> <p><b>mm-zz-ww</b>    each one may vary from 00 to 99, according to AB System Functional Tree, allowing the identification of the Assembly/Unit/Component</p> <p><b>Y</b>      Maintenance Task Code. It may be one of the following:</p> <p><b>C=Cleaning      I=Inspection      L=Lubrication</b></p> <p><b>R=Replacement      S=Service      T=Test</b></p> <p><b>kk</b>      It may vary from 00 to 99.</p> <p>It is a progressive number allowing the explicit identification of RPMS when one of the following cases occur:</p> <ul style="list-style-type: none"> <li>1- same Maintenance Task pertaining to vehicle as a whole or to the same System/Subsystem/Assembly to be performed at same Maintenance Interval in different Vehicle Area (i.e Vehicle as a Whole DAILY Exterior /Interior INSPECTION)</li> <li>2- same Maintenance Task pertaining to the same Assembly/Unit/Component to be performed at different Maintenance Intervals and for this reason consisting of different Maintenance Procedure</li> </ul>
2	<b>System</b>	<b>System name</b>	This field indicates the System to which the Assembly/Unit/Component belongs.
3	<b>Subsystem/ Assembly</b>	<b>Subsystem/ Assembly name</b>	This field indicates the Subsystem/Assembly to which the Unit/Component belongs.
4	<b>Unit</b>	<b>Unit name</b>	This field indicates the Unit to which the Component belongs.
5	<b>Component</b>	<b>Component name</b>	This field indicates the Component the Maintenance Task is referring to
6	<b>Maintenance Task</b>	<b>Maintenance Task name</b>	This field indicates the Maintenance Task to be performed.
7	<b>Interval Miles</b>	<b>Number</b>	<p>This field indicates the maintenance Interval Miles.</p> <p>It may be DAILY, 10,000 Miles, 30,000 Miles, 60,000 Miles, 120,000 Miles</p>

<b>RUNNING -PREVENTIVE MAINTENANCE SHEET (RPMS) Form (cont'd)</b>			
<b>ITEM #</b>	<b>TITLE</b>	<b>CONTENT</b>	<b>EXPLANATORY NOTES</b>
8	<b>Man Hours</b>	<b>Number</b>	The Man Hour field indicates the time needed to perform the corresponding Maintenance Task, with the basic assumption that the Vehicle is staged on an Inspection Pit/Jacking tracks with the required Consumables, Tools And Materials Available.
9	<b>Sheet</b>	<b>Pages numbering</b>	This field indicates the progressive R-PMS sheet page number.
10	<b>LOCATION</b>	<b>Illustration</b>	<p>This field indicates the On Board Location of the Equipment to be maintained</p> <p>The following Graphic Symbols are used</p> <p>for: Assembly/Unit/Component </p> <p>for System/Subsystem/Vehicle as a Whole </p>
11	<b>R</b>	<b>Letter</b>	This field indicates that the Sheet pertains to Running Maintenance
12	<b>P</b>	<b>Letter</b>	This field indicates that the Sheet pertains to Preventive Maintenance
13	<b>nn</b>	<b>Number</b>	<p>This field indicates the System/Manual Section number to which the Sheet pertains.</p> <p>It may vary from 01 to 19</p>
14	<b>rr</b>	<b>Number</b>	This field indicates the Sheet Revision number
15	<b>Page ##</b>	<b>Page ##</b>	This field indicates the RMSM Section Page number
16	<b>-#</b>	<b>Number</b>	This field indicates the RMSM Section Revision number
17	<b>SAFETY PRECAUTIONS</b>	<b>Text</b>	This field presents the General and/or specific Safety Precautions to be followed to safely accomplish the relevant Maintenance Tasks.
18	<b>TOOLS</b>	<b>Text</b>	<p>This field lists the description and the P/N of the Standard tools, Special Tools and Test Equipment needed to accomplish the Maintenance Task.</p> <p>Refer to the TTE Manual for the TE and Special Tools detailed descriptions and tools maintenance.</p>
19	<b>CONSUMABLES</b>	<b>Text</b>	<p>This field lists the Consumables Materials (consistent with those used by MTA with the related P/N.) needed to accomplish the Maintenance Task.</p> <p>Cleaning agents are included</p>
20	<b>SPARE PARTS</b>	<b>Text</b>	<p>This field lists the Description and PN of Spare Parts (consistent with Illustrated Parts Catalog) needed to accomplish the Maintenance Task.</p>
21	<b>PROCEDURE</b>	<b>Text</b>	<p>The Procedure field provides Preliminary Operations and Procedural step by step Instructions to be followed while performing the Maintenance Task.</p> <p>Illustrations and Pictures are inserted in the text to facilitate the understanding of the topics and/or to explain step-by-step procedure.</p>

		LACMTA P2550 LRV Running Maintenance and Servicing Manual - Section 01	
<b>P2550 PREVENTIVE MAINTENANCE SHEET</b>			
System: <b>R-P-nn-mm-zz-ww/Y-kk</b> Subsystem/Assy: Component: Maintenance Task:		Card Code: <b>x/z</b> Sheet: Man Hours: Interval/Miles:	
<b>LOCATION:</b>			
 <b>RH</b> <b>A</b> <b>EXTERIOR</b> <b>LH</b>  <b>UNDERCAR</b>  <b>ROOF</b>  <b>INTERIOR</b>			
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	 <b>M<sub>Metro</sub></b> Page 011 Draft		

**Figure 08-III-03.2 R-PMS Form  
(Sheet 1 of 2)**

LACMTA P2550 LRV Running Maintenance and Servicing Manual - Section 01		 <b>AnsaldoBreda</b>				
<b>P2550 PREVENTIVE MAINTENANCE SHEET</b>						
Card Code: <b>R-P-nn-mm-zz-ww/Y-kk</b>						
System: _____		Sheet: <b>x/z</b>				
Subsystem/Assy: _____		Unit: _____				
Component: _____		Man Hours: _____				
Maintenance Task: _____		Interval/Miles: _____				
<b>SAFETY PRECAUTIONS:</b>						
17						
18						
19						
20						
21						
<b>TOOLS:</b>						
<b>CONSUMABLES:</b>						
<b>SPARE PARTS:</b>						
<b>PROCEDURE:</b> <b>PRELIMINARY OPERATIONS</b>						
Page 01-2 Draft						
<table border="1" style="margin-left: auto; margin-right: 0; border-collapse: collapse;"> <tr> <td style="padding: 2px;">R</td> <td style="padding: 2px;">P</td> <td style="padding: 2px;">nn</td> <td style="padding: 2px;">rr</td> </tr> </table>			R	P	nn	rr
R	P	nn	rr			

**Figure 08-III-03.2 R-PMS Form  
(Sheet 2 of 2)**

## 08-III-03.02 How to Use the R-PM Sheets and R-PMR /Job Cards

To optimize the job organization, proceed as follows:

### 1. At Scheduled Preventive Maintenance Interval Expiration Date

- a) Use the relevant (Maintenance Interval) R-PMR/JOB CARD where the Subsystems/Assemblies/Units/Components, listed in the ITEMS column, are grouped by Work Area and Vehicle System and sequenced, in alphabetical order, in conjunction with their On Vehicle Location and Task to be performed.
- b) Select the Work Area and the System
- c) Select the first Equipment listed in the ITEMS column and the Sheet Code listed in conjunction with the Task to be performed and gather the relevant Sheet
- d) Read carefully the Sheet to fully understand the provided Data/Instructions.
- e) Carefully read:
  - The Safety Precautions to perform the Task safely
  - The Preliminary Operations to set the Vehicle in safety conditions according to MTA Maintenance Shop Regulations
  - The Tools, Consumables and Spare Parts listed in each Sheet which are needed to accomplish the Task, in order to have all of them available next to the location of the Equipment to be maintained before starting the activities
- f) Fill the R-PMR/JOB CARD with the data required by the Maintainer at the start of the Maintenance Activities

### 2. Task Execution

- a) Follow carefully the prescribed Safety Precautions and Maintenance Procedural Steps provided in the R-PM Sheet.
- b) Perform the Maintenance Task Procedure on the first Equipment (listed in the ITEMS column of the relevant R-PMR /JOB CARD) at its On Vehicle LOCATION, as indicated in the LOCATION column of the R-PMR /JOB CARD.
- c) After completing the Maintenance Task for the first Equipment then highlight (with a flag) its LOCATION field on the R-PMR / JOB CARD.
- d) Note Equipment Defect Found and / or your Comments on the End Page of the R-PMR / JOB CARD
- e) Proceed to perform the same Task on the second (same) Equipment listed in the R-PMR / JOB CARD at its On Vehicle LOCATION, (different from the previous one) as indicated in the LOCATION column of the R-PMR /JOB CARD.
- f) Proceed as above to perform the same Task on every Equipment (to which the same Sheet Code refers) listed in the ITEMS column of the relevant (Maintenance Interval) R-PMR /JOB CARD.
- g) During Task execution, note any Areas / Items of the Assembly / Unit/ Component under Preventive Maintenance Process requiring Corrective Maintenance.
- h) Gather as much information about the Equipment as is practical to increase your Equipment knowledge (i.e.; knowledge about the malfunction in terms of correctly operating and incorrectly operating equipment processes).

### 3. At every Task Completion

- a) Follow carefully the prescribed Safety Precautions before restoring Electrical Power to Vehicle.
- b) Check the correct operation and/or functions of the Subsystem to which the maintained Equipment pertains.
- c) Perform this check on the IDU "A" as follows:

**NOTE:** Through the IDU you can check if all Systems are exchanging data through the MVB or LonWorks Bus and the Trainlines Status.

The IDU Display also shows in real time the Status of all Vehicle Systems.

Reading the IDU Fault List it is possible to immediately detect a fault  
Using the IDU in the Operating Mode the Fault Indications are generic,

, Using the IDU in Maintenance Mode the same Fault has a detailed description.

For more in depth troubleshooting use the PTU connected to the relevant system that requires further troubleshooting.

1. On IDU "A" access to the Maintenance Menu first and then to the "Faults" Screen by selecting, in sequence, the relevant icons.
2. Check, On IDU "A" through the list of the Current Active Faults shown in the "Faults" Screen, for "Fault" Codes related to the Subsystem to which the maintained Equipment pertains.  
Refer to Section 18 of RMSM for Fault Signals Details.
3. As per "Fault" Codes check results proceed as follows:

➤ **No Faults are listed in the "Faults" Screen**

- a) Key OFF the Vehicle.
- b) Record Service and Test results on the Defect Report Card for administrative and maintenance planning.
- c) Fill the R-PMR /JOB CARD with the data required from the Maintainer at the completion of the Maintenance Activities and include your comments.

➤ **Fault Codes are listed in the “Faults” Screen**

- a) Investigate/troubleshoot the Equipment previously maintained first and then the System/Subsystem/Assembly/Unit for Fault Probable Causes.
- b) Gather as much information about the failure symptoms as is practical.
- c) Refer to Section 18 of RMSM for Fault Signals Details.
- d) Try to identify the malfunction in terms of correctly operating and incorrectly operating equipment processes.
- e) Identify which equipment signals or parameters will best help you to localize the failure.
- f) Identify the source of the problem.
- g) Repair or replace the defective component.
- h) Verify that the repair is effective in eliminating all of the failure symptoms.
- i) Evaluate whether or not the defective component was the root cause of the failure.
- j) Once the Fault Codes are not found in the “Faults” Screen perform steps from 3-a through 3-c (previous subparagraph **“No Faults are listed in the “Faults” Screen”**).

#### **08-III-03.03.03      Running- Preventive Maintenance Sheet (R-PMS) List**

The Pantograph Running- Preventive Maintenance Sheets (R-PMS) List is provided in the following pages.

The R-PM Sheets are listed by Subsystem / Assembly / Unit / Component and sequenced by Maintenance Interval in conjunction with their Sheet Codes and Tasks (including SCPM flag) to be performed.

**Table 08-III-03.3    Running Preventive Maintenance Sheets List**

<b>SYSTEM      08</b>		<b>PANTOGRAPH</b>			
<b>SUBSYSTEM/ ASSY</b>	<b>ASSY /UNIT/ COMPONENT</b>	<b>SCPM</b>	<b>TASK</b>	<b>MAINTEN. INTERVAL (MILES)</b>	<b>SHEET CODE</b>
PANTOGRAPH ASSY	SAFETY PIN		SAFETY PRECAUTIONS		R-C-08-00-00-00/SP-00
PANTOGRAPH	PANTOGRAPH ASSY		INSPECTION	10,000	R-P-08-01-00-00/I-00
PANTOGRAPH	PANTOGRAPH ASSY		INSPECTION	30,000	R-P-08-01-00-00/I-01
PANTOGRAPH	PANTOGRAPH ASSY		SERVICE	60,000	R-P-08-01-00-00/S-00
PANTOGRAPH	PANTOGRAPH ASSY		INSPECTION	120,000	R-P-08-01-00-00/I-02
COLLECTOR HEAD	COLLECTOR HEAD		REPLACEMENT	30,000	R-P-08-02-00-00/R-00

08-III-03.03.04

**Running- Preventive Maintenance Sheets (R-PMS)**

## PANTOGRAPH

### **Running - Preventive Maintenance Sheets**

### **R-PMS**

**INTENTIONALLY LEFT BLANK**

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-00-00-00/SP-00**

System:

**PANTOGRAPH**

Sheet:

**1/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

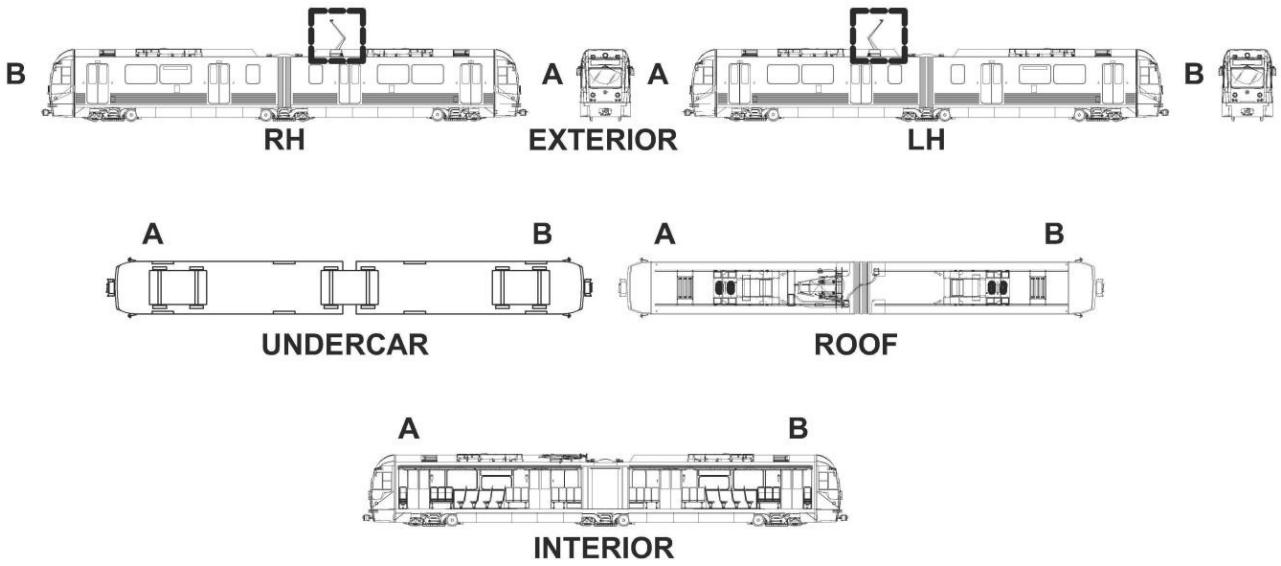
**SAFETY PIN**

Man Hours:

Maintenance Task:

**SAFETY PRECAUTIONS**

Interval/Miles:

**LOCATION:**


## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-00-00-00/SP-00**

System:	<b>PANTOGRAPH</b>	Sheet:
Subsystem/Assy:	<b>PANTOGRAPH ASSY</b>	<b>2/4</b>
Component:	<b>SAFETY PIN</b>	Man Hours:
Maintenance Task:	<b>SAFETY PRECAUTIONS</b>	Interval/Miles:

### PROCEDURE:

**WARNING:** BLUE FLAG THE VEHICLE IN ACCORDANCE WITH ALL LACMTA BLUE FLAG POLICIES, RULES, & PROCEDURES IN ORDER TO WARN THAT MAINTENANCE PERSONNEL ARE WORKING ON, UNDER, OR NEAR ROLLING EQUIPMENT.

**DANGER OF PERSONAL INJURY EXISTS DUE TO ELECTRICAL POWER (750 V). ENSURE PANTOGRAPH IS LOWERED, AND CATENARY POWER IS REMOVED AND ISOLATED PER LACMTA SAFETY RULES AND PROCEDURES.**

**IF POSSIBLE, WORK SHOULD BE DONE IN AN AREA WITHOUT OVERHEAD CATENARY.**

**DANGER OF PERSONAL INJURY EXISTS DUE TO THE WORKING ON ROOF. FOLLOW SAFETY PROCEDURES FOR ACCESSING ROOF. ALWAYS WEAR A SAFETY HARNESS WHEN ACCESSING THE ROOF.**

**DANGER OF PERSONAL INJURY EXISTS DUE TO THE UNEXPECTED RAISING OR LOWERING OF THE PANTOGRAPH. A WARNING TAG SHOULD BE PLACED ON PANTOGRAPH CONTROL SWITCHES TO ALERT PERSONNEL THAT PANTOGRAPH MAINTENANCE IS IN-PROGRESS.**

**DANGER OF PERSONAL INJURY EXISTS DUE TO SHEAR PIN BREAKING AND ALLOWING SUDDEN COLLAPSE OF PANTOGRAPH.**

**THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.**

**USE EXTREME CARE WHEN REMOVING THE SAFETY PIN. THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.**

**REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.**

### USE OF SAFETY PIN.

THIS IS A STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.

### PRELIMINARY OPERATIONS

1. Lock-out and tag-out the Overhead Catenary, 750Vdc Power, per LACMTA Safety Rules and Procedures.

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-00-00-00/SP-00**

System:

Sheet:

**PANTOGRAPH**
**3/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

**SAFETY PIN**

Man Hours:

Maintenance Task:

**SAFETY PRECAUTIONS**

Interval/Miles:

### PROCEDURE (CONT'D):

2. Set the Master Controller Handle to FSB position.
3. Make sure that all Parking Brakes are applied (by checking on the IDU "Parking Brake A and B Not Released" and on Indicator Panel "A" "Park / Friction Brake" ON).
4. Lower the Pantograph.
5. Turn the Transfer Switch to OFF.
6. Set the Pantograph Control Motor Switch (5F02 CB LV Locker "A" Section) to OFF.
7. Attach a tag with the person's name who removed power.

**NOTE** The tag must indicate the name of the person who removed Power.

That person knows why the Power was removed and when it safe to restore it. Only the individual whose name appears on the tag or a person with his approval should remove the tag and restore Power.

### SAFETY PIN INSTALLATION

1. Access Vehicle Roof according to MTA procedures.
  2. Remove Cotter Pin.
  3. Remove Yellow Safety Pin (2) from storage location on bracket (3).
  4. Install Yellow Safety Pin (2) in Safety System Linkage beside Shear Pin (4).
- NOTE:** Yellow safety pin (2) goes through the aligned holes of lever (5) and spindle lashing (6) next to shear pin (4).
5. Install Cotter Pin (1) on Yellow Safety Pin (2).
  6. Perform required maintenance task or tasks.
  7. Do not remove Yellow Safety Pin (2) until all maintenance tasks are completed.

**CAUTION:** DO NOT LEAVE THE SAFETY PIN INSTALLED WHEN MAINTENANCE TASKS ARE COMPLETED. IF THE SAFETY PIN IS INSTALLED WHILE THE PANTOGRAPH IS IN OPERATION, IT WILL PREVENT THE SHEAR PIN FROM PROTECTING AGAINST EXCESSIVE CONTACT FORCE THAT COULD DAMAGE THE CATENARY OR THE PANTOGRAPH.

### SAFETY PIN REMOVAL

1. Working outside the envelope of Pantograph Assembly, reach underneath Base Frame and check fit of Yellow Safety Pin (2) in hole.
  - a. If Yellow Safety Pin (2) is tight, replace Shear Pin (4) before doing any other maintenance.
  - b. If Yellow Safety Pin (2) is loose, remove Cotter Pin (1) and remove Yellow Safety Pin(2) from Lever (5) and Spindle Lashing (6).
2. Install Yellow Safety Pin (2) in Storage Bracket (3) and secure it with Cotter Pin (1).

### FINAL OPERATIONS

1. Leave the Roof according to MTA Safety Rules.
2. Restore power to Overhead Catenary or relocate the Vehicle to an area where there is an Overhead Catenary with Power available.
3. Restore Power to Vehicle.

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-00-00-00/SP-00**

System:

**PANTOGRAPH**

Sheet:

**4/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

**SAFETY PIN**

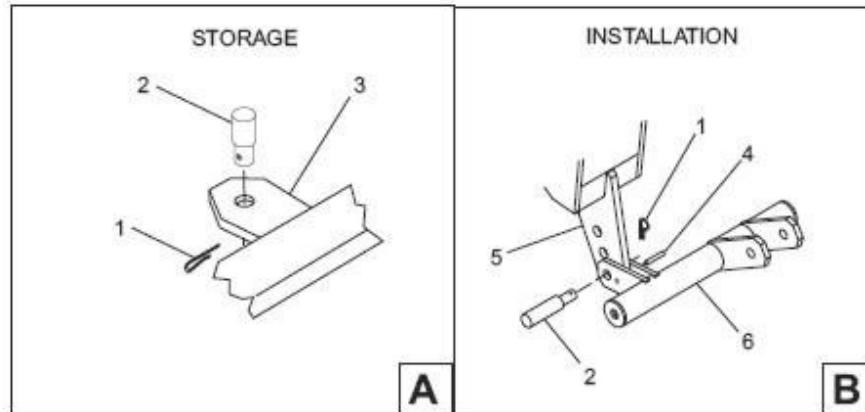
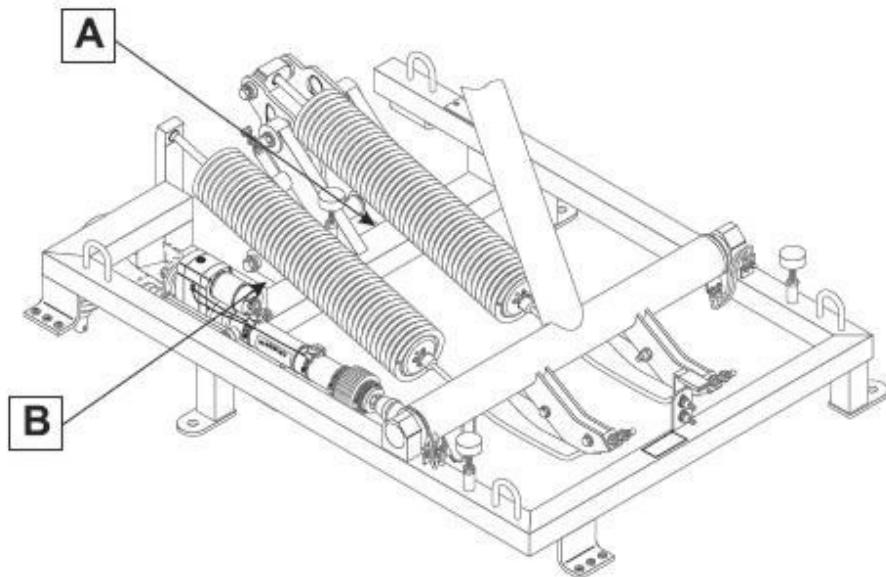
Man Hours:

Maintenance Task:

**SAFETY PRECAUTIONS**

Interval/Miles:

### PROCEDURE (CONT'D):



**FIGURE 1 - YELLOW SAFETY PIN**

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-00**

System:

**PANTOGRAPH**

Sheet:

**1/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

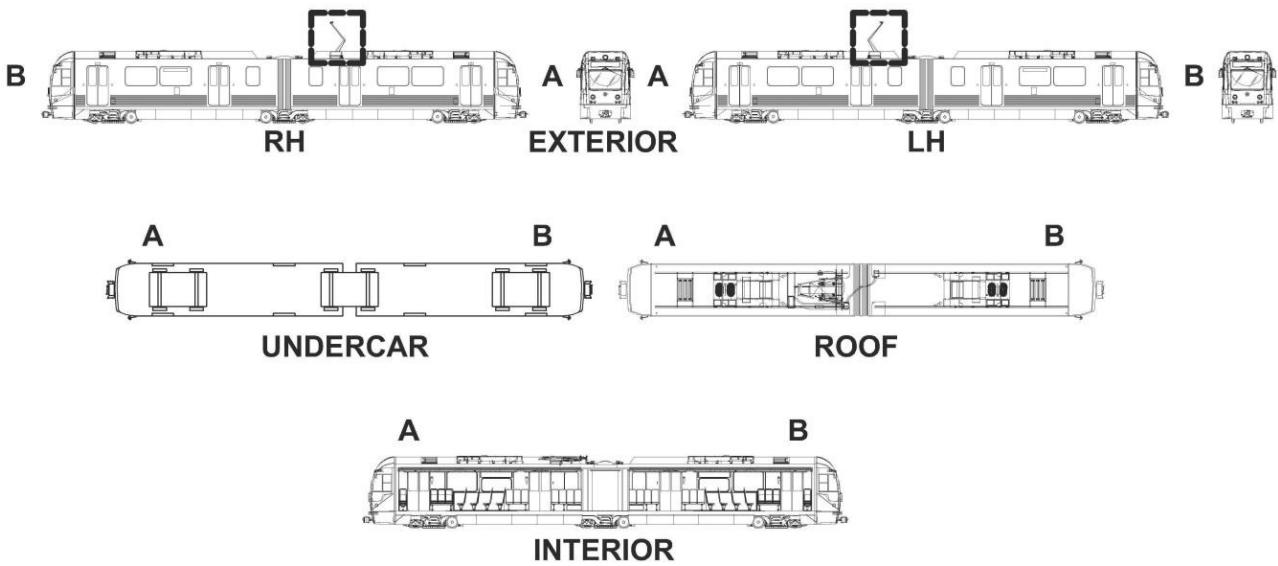
Man Hours:

**1**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**10,000**
**LOCATION:**


## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-00**

System:

**PANTOGRAPH**

Sheet:

**2/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**10,000****SAFETY PRECAUTIONS:**

**WARNING: SHEET R-P-08-00-00-00/SP-00 PROVIDES STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.**

**USE EXTREME CARE WHEN REMOVING THE SAFETY PIN.**

**THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.**

**REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.**

**TOOLS:**

LACMTA Maintenance Shop Standard Tools Kit

**CONSUMABLES:**

Carbon Remover, M3      PN      161689

CRC 2000 Contact Cleaner

Grease Shell Alvania 2      PN      149973

**SPARE PARTS:**

Carbon Contact Strip      PN      SK806

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-00**

System:

**PANTOGRAPH**

Sheet:

**3/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**10,000**

### PROCEDURE:

#### PRELIMINARY OPERATIONS

1. Set the Vehicle in safety condition in accordance with LACMTA Maintenance Shop Regulations.
2. Follow the Safety Precautions according to Sheet R-P-08-00-00-00/SP-00.

#### INSPECTION

This inspection consists of the following activities:

1. Carbon Contact Strip Check.
2. Visual Inspection.
3. Operational Check.

##### 1 Carbon Contact Strip Check

To perform Carbon Contact Strip check, proceed as follows (Refer to Fig 1).

**NOTE:** Carbon Contact Strips should be checked at every Vehicle Inspection for damage and/or wear.

Damage and abnormal wear can be detected in their early stages.

Even gradual wear is normal since the Contact Strips are in constant contact with the Overhead Wire.

Normal wear will occur if the Overhead Wire System is in good condition, wire stagger is correct, and the two Contact Strips are parallel.

Excessive Contact Force will cause rapid premature wear. Carbon Strips have a wear line at the **1/8 inch (3 mm)** dimension to facilitate the inspection.

Both Contact Strips need to be replaced at the same time.

**CAUTION:** REPLACING ONLY ONE STRIP WILL CAUSE UNEVEN CARBON HEIGHT RESULTING IN POOR CONTACT TO THE WIRE, RAPID CARBON WEAR, AND POSSIBLE ARCING.

1. Access Vehicle Roof according to MTA procedures.
2. Check the thickness of both Carbon Strips against the wear indicator line.

**CAUTION:** THE MINIMUM ALLOWABLE THICKNESS OF CARBON STRIP IS **1/8 INCH (3 mm)** MEASURED AT ANY POINT ON CARBON STRIP. A CARBON THICKNESS BELOW **1/8 INCH (3 mm)** WILL RISK CONTACT BETWEEN THE CATENARY WIRE AND THE METAL CARRIER CONTACT BETWEEN THE CATENARY WIRE AND ANY METAL OBJECT CAN DAMAGE OR CAUSE RAPID WEAR TO THE WIRE.

**NOTE:** Carbon strip condemning limit is 1/8 inch (3 mm) or greater.

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-00**

System:

**PANTOGRAPH**

Sheet:

**4/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**10,000****PROCEDURE (CONT'D):****INSPECTION (CONT'D)**

**CAUTION:** IF CARBON STRIP IS WITHIN SPECIFICATION ON ONE OF THE CARBON CARRIERS AND THE MATCHING ONE (ON THE OTHER CARBON CARRIER) IS WORN BEYOND SPECIFICATION, THEN BOTH CARBON STRIPS MUST BE REPLACED TOGETHER. REPLACING ONLY ONE CARBON STRIP CREATES AN UNEVEN CARBON HEIGHT CONDITION, RESULTING IN POOR CONTACT WITH THE CATENARY WIRE, RAPID CARBON WEAR, AND POSSIBLE ARCING.

3. Inspect Carbon Strips for large chips or severe cracks that extend through the entire width of the carbon.

**NOTE:** Small chips are normal. Replace Carbon Strips if large chips or severe cracks are detected, even if strip thickness is within specification.

4. Inspect End Horns for wear (See **NOTE** below ) or damage.

**NOTE:** Under normal wear conditions, the End Horns require replacement every two to three sets of Carbon Strips.

**2 Visual Inspection (refer to Fig 2)**

- a) Inspect the Pantograph items for breaks, deformation, corrosion and loose connections.
- b) Inspect Shunt Cables for burn, breaks and loose connection.
- c) Inspect Electrical Lowering Device for burn, breaks, deformation and loose connection.
- d) Check for missing attaching parts.
- e) Note any areas requiring Corrective Maintenance.
- f) Pull down on Pan Head by hand and check for rough operation.
- g) Rotate and pivot the Pan Head by hand and check for rough operation.
- h) Note any areas requiring Corrective Maintenance.
- i) Inspect Electrical Connections for tightness.
- j) Remove Yellow Safety Pin according to Safety Precautions above.

**3. Operational Check**

- a) Restore Power to Catenary.
- b) Set the Transfer Switch (located on the Operator's Console) to "ON".
- c) Raise and lower the Pantograph several times by operating Pantograph Switch to "UP" and "DOWN" positions and check for improper operation.

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-00**

System:

**PANTOGRAPH**

Sheet:

**5/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1**

Maintenance Task:

**INSPECTION**

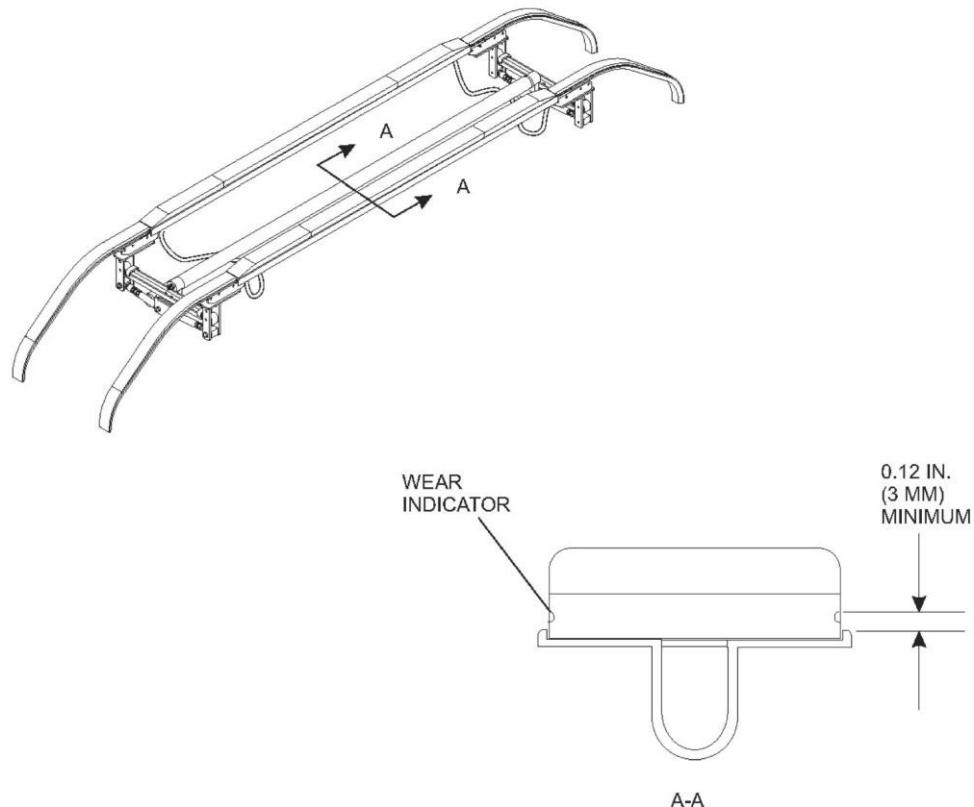
Interval/Miles:

**10,000**
**PROCEDURE (CONT'D):**
**INSPECTION (CONT'D)**
**FINAL OPERATIONS**

Record Inspection Results on the Defect Report Card for administrative and maintenance planning.

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the maintained Equipment pertains.

Refer to **HOW TO USE THE R-PM SHEETS** (para 08-III-03-03-02 of this Section) and follow the prescriptions provided at Step 3 "**At every Task Completion.**"



**FIGURE 1 - CARBON CONTACT STRIP CHECK**

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-00**

System:

**PANTOGRAPH**

Sheet:

**6/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1**

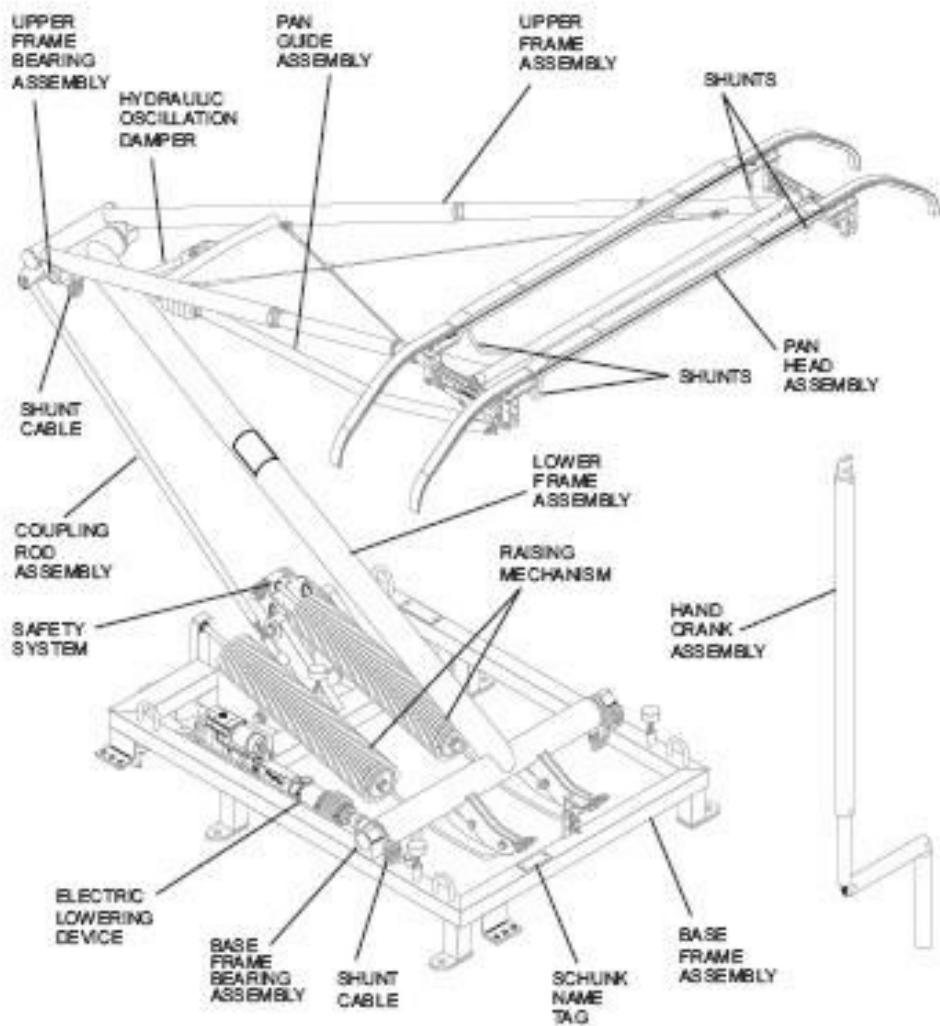
Maintenance Task:

**INSPECTION**

Interval/Miles:

**10,000**

### PROCEDURE (CONT'D):



**FIGURE 2 - PANTOGRAPH ASSEMBLY MAIN COMPONENT**

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-01**

System:

**PANTOGRAPH**

Sheet:

**1/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

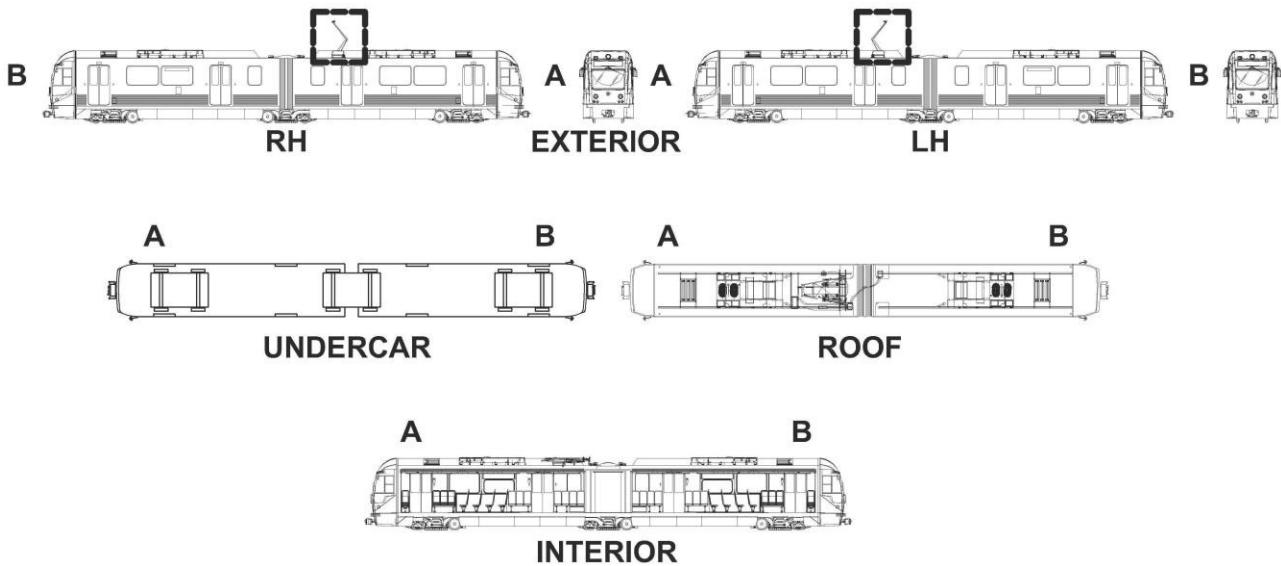
Man Hours:

**0.5**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**30,000**
**LOCATION:**


## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-01**

System:

**PANTOGRAPH**

Sheet:

**2/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**0.5**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**30,000**

### **SAFETY PRECAUTIONS:**

**WARNING: SHEET R-P-08-00-00-00/SP-00 PROVIDES STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.**

**USE EXTREME CARE WHEN REMOVING THE SAFETY PIN.**

**THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.**

**REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.**

### **TOOLS:**

LACMTA Maintenance Shop Standard Tools Kit.

### **CONSUMABLES:**

Carbon Remover, M3                    PN 161689 or Soy Foam Degreaser

CRC 2000 Contact Cleaner

### **SPARE PARTS:**

N/A

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-01**

System:

**PANTOGRAPH**

Sheet:

**3/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**0.5**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**30,000**

### PROCEDURE

#### PRELIMINARY OPERATIONS

1. Set the Vehicle in safety condition in accordance with LACMTA Maintenance Shop Regulations.
2. Follow the Safety Precautions according to Sheet R-P-08-00-00-00/SP-00.
3. Access Vehicle Roof according to MTA procedures.

#### INSPECTION

This inspection consists of the following activities (see Figure 1):

##### 1. BOLTS AND NUTS CHECK

- a. Inspect attaching Hardware for looseness or damage.  
Pay particular attention to the Attaching Parts of Shunt Cables and Carbon Strips.

##### 2. SPRINGS AND HYDRAULIC DAMPER INSPECTION

- a. Inspect Raising Springs for cracks, corrosion, distortion or other damage.
- b. Inspect Cables for breaks, corrosion, or loose / missing hardware.
- c. Inspect Hydraulic Oscillation Damper for fluid leakage and damage.

##### 3. INSULATOR CLEANING

- a. Check all Insulators for damage or buildup of dirt.
- b. Clean dirty Insulators with a grease detergent (as Soy Foam Cleaner).

This will avoid possibility of a High Voltage electrical leakage pathway being created around the Insulators.

#### FINAL OPERATIONS

Record Inspection Results on the Defect Report Card for administrative and maintenance planning

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the maintained Equipment pertains.

Refer to **HOW TO USE THE R-PM SHEETS** (para 08-III-03-03-02 of this Section) and follow the prescriptions provided at Step 3 “**At every Task Completion.**”

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-01**

System:

**PANTOGRAPH**

Sheet:

**4/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**0.5**

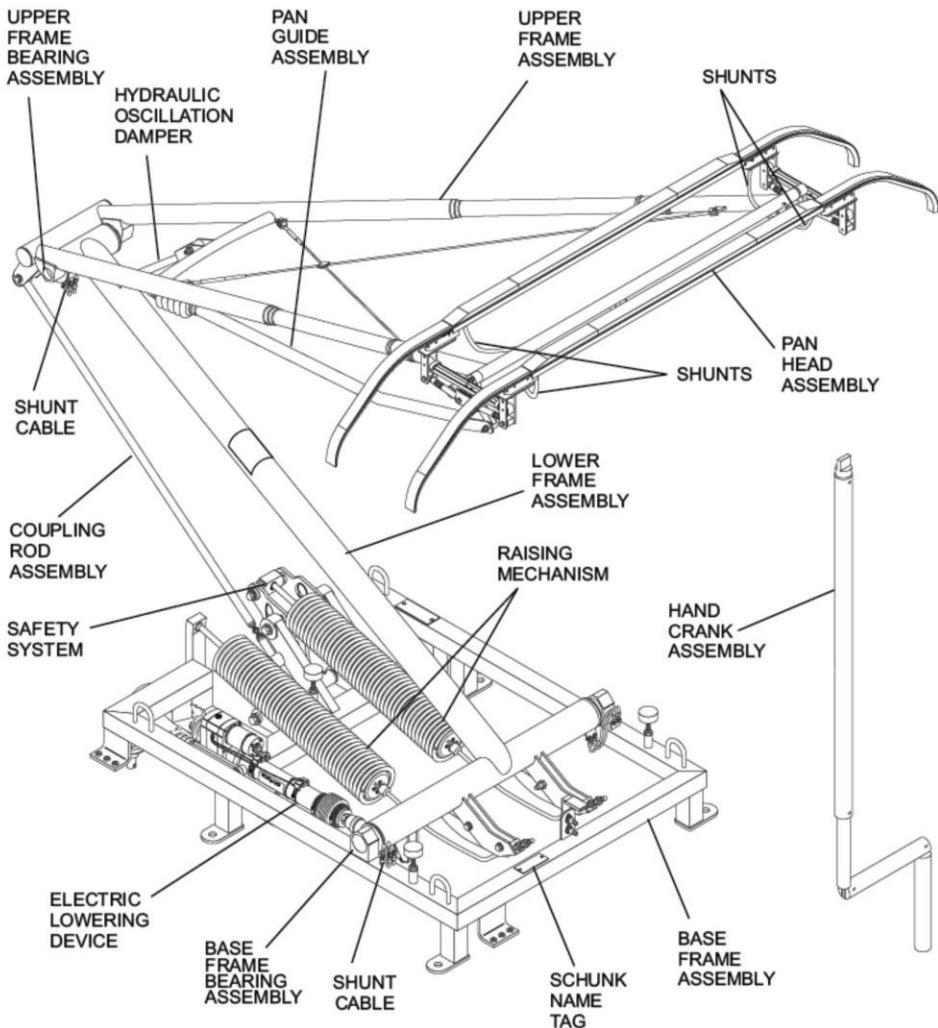
Maintenance Task:

**INSPECTION**

Interval/Miles:

**30,000**

### PROCEDURE (CONT'D):



**FIGURE 1 - PANTOGRAPH ASSEMBLY MAIN COMPONENT**

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/S-00**

System:

**PANTOGRAPH**

Sheet:

**1/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

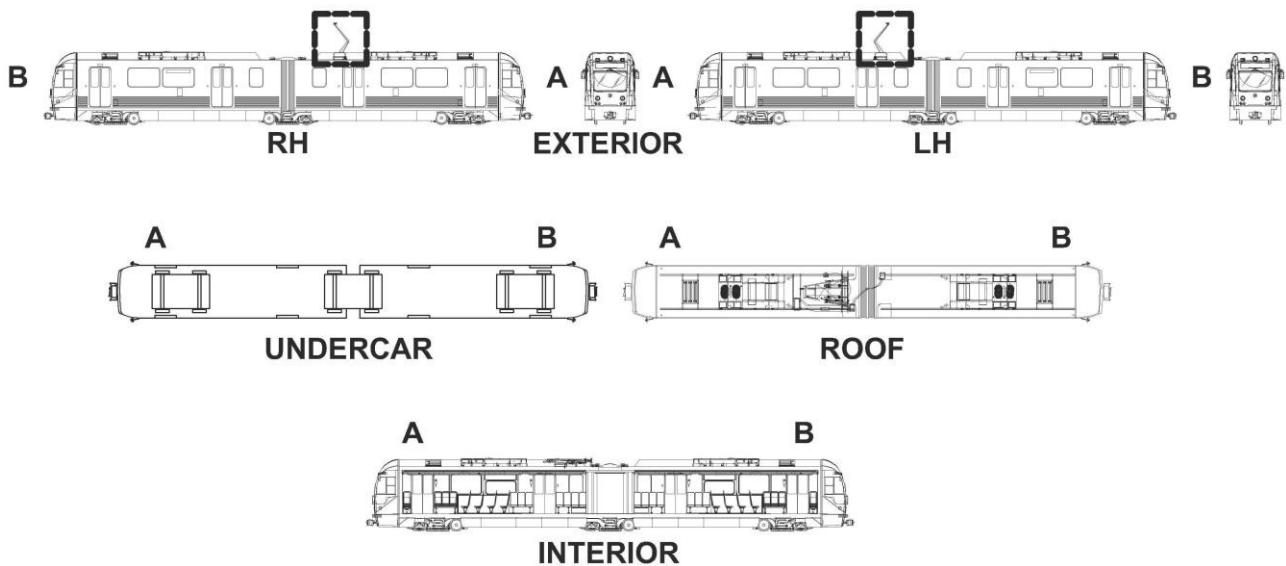
Man Hours:

**0.75**

Maintenance Task:

**SERVICE**

Interval/Miles:

**60,000**
**LOCATION:**


## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/S-00**

System:

**PANTOGRAPH**

Sheet:

**2/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**0.75**

Maintenance Task:

**SERVICE**

Interval/Miles:

**60,000**

### **SAFETY PRECAUTIONS:**

**WARNING: SHEET R-P-08-00-00-00/SP-00 PROVIDES STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.**

**USE EXTREME CARE WHEN REMOVING THE SAFETY PIN.**

**THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.**

**REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.**

### **TOOLS:**

CONTACT PRESSURE GAUGE KM 11

SPRING SCALE

SPANNER WRENCH - PN 351-05990

### **CONSUMABLES:**

NOALOX Electrical Contact Grease or equivalent

Soy Foam

Wypalls

### **SPARE PARTS:**

N/A

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/S-00**

System:

**PANTOGRAPH**

Sheet:

**3/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**0.75**

Maintenance Task:

**SERVICE**

Interval/Miles:

**60,000**

### PROCEDURE:

#### PRELIMINARY OPERATIONS

1. Set the Vehicle in safety condition in accordance with LACMTA Maintenance Shop Regulations.
2. Follow the Safety Precautions according to Sheet R-P-08-00-00-00/SP-00.

#### SERVICE

##### 1. INSULATOR CLEANING

- a. Clean all Insulators with Soy Foam and Wypalls.
- b. Brush using a soft brush.
- c. Use approved solvents for stubborn deposits.

##### 2. INSPECT BALL BEARINGS

- a. Inspect Ball Bearings for excessive weeping or leaking seals.
- b. Inspect Bushings for wear, damage, or corrosion.

##### 3. INSPECT CONNECTIONS

- a. Inspect all Shunts for signs of damage, fraying, loose connections and overheating.
- b. Replace as necessary and use NOALOX on terminal lugs.

##### 4. CHECK CONTACT FORCE

**NOTE:** Before checking or adjusting the Contact Force, disconnect one end of the Hydraulic Oscillation Damper. In dynamic motion, the Hydraulic Oscillation Damper causes an increase in Contact Force. Contact force is a static measurement taken through a continuous motion.

- a. Using KM 11 Gauge or Spring Scale, check and record Contact Force through its entire range. Readings should be nominally **20.9 lbs. (93 N)**. ( $\pm 10\%$ ).
- b. If the Nominal Value or tolerance is out of range, adjust Contact Force.

##### 5. ADJUST CONTACT FORCE

**NOTE:** Adjustments to Coupling Rod directly affect Contact Force. Coupling Rod should generally not require adjustment once it is set.

**NOTE:** Before checking or adjusting the Contact Force, disconnect one end of the Hydraulic Oscillation Damper. In dynamic motion, the Hydraulic Oscillation Damper causes an increase in Contact Force. Contact Force is a static measurement taken through a continuous motion.

- a. Loosen M10 jam nuts (2 and 3).
- b. Adjust Coupling Rod Turnbuckle (4) so that Upper Frame (5) contacts two Bumpers (6) and Lower Frame (7) contacts Bumper (8) simultaneously. It may be necessary to adjust bumpers. Tighten M10 jam nuts (1 and 2).

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/S-00**

System:	<b>PANTOGRAPH</b>	Sheet:	<b>4/6</b>
Subsystem/Assy:	<b>PANTOGRAPH ASSY</b>	Unit:	
Component:		Man Hours:	<b>0.75</b>
Maintenance Task:	<b>SERVICE</b>	Interval/Miles:	<b>60,000</b>

**PROCEDURE (CONT'D):****5. ADJUST CONTACT FORCE (CONT'D)**

**NOTE** Base Frame (9), Lower Frame (7), and Upper Frame (5) should be fairly level to each other.

- c. Using KM 11 Gauge or Spring Scale, check and record Contact Force through its entire range. Nominal Contact Force should be **20.9 lbs.** (93 N). (  $\pm 10\%$  )
- d. If Values are out of tolerance in lower range, loosen two M10 jam nuts (10) and turn M10 Adjustment Bolts (11) clockwise to increase or counterclockwise to decrease Contact Force. Make sure to adjust M10 Bolts (11) equally. Tighten M10 Jam Nuts (10) when complete.
- e. If Values remain out of tolerance after completing step d, adjust length. If necessary, adjust two Raising Springs (12) to achieve Nominal Contact Force as follows:
  1. Loosen M16 jam nut on two threaded rods (13).

**WARNING DANGER OF PERSONAL INJURY EXISTS DUE TO SPRINGS.  
AS SPRINGS CONTRACT, FINGERS CAN GET CAUGHT IN COILS.  
USE SPANNER WRENCH PART NUMBER 351-05990, OR  
EQUIVALENT, INSERTED IN END CAP TO PREVENT RAISING  
SPRINGS FROM ROTATING.**

**CAUTION:** DO NOT USE AN AIR IMPACT GUN TO LOOSEN OR TIGHTEN BOLTS. USE SPANNER WRENCH P/N 351-05990, OR EQUIVALENT, TO PREVENT THE RAISING SPRINGS FROM ROTATING.

- 2. Using a wrench, turn both Threaded Rods (13) clockwise to increase Contact Force or counterclockwise to decrease Contact Force. Springs should be adjusted to equal lengths..

**NOTE:** One complete turn of one threaded rod will change the Contact Force by **1 Ft-Lb (5 Nm)**.

- 3. When proper Nominal Contact Force is achieved, tighten M16 Jam Nuts on threaded rods (13).
- 4. Reconnect end of Hydraulic Oscillation Damper (1) to pantograph.
- f. Using KM 11 Gauge or Spring Scale, check and record Contact Force through its entire range. Repeat steps d and/or e again as required.

**FINAL OPERATIONS**

Record Inspection Results on the Defect Report Card for administrative and maintenance planning.

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the maintained Equipment pertains.

Refer to **HOW TO USE THE R-PM SHEETS** (para 08-III-03-03-02 of this Section) and follow the prescriptions provided at Step 3 "**At every Task Completion.**"

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/S-00**

System:

**PANTOGRAPH**

Sheet:

**5/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**0.75**

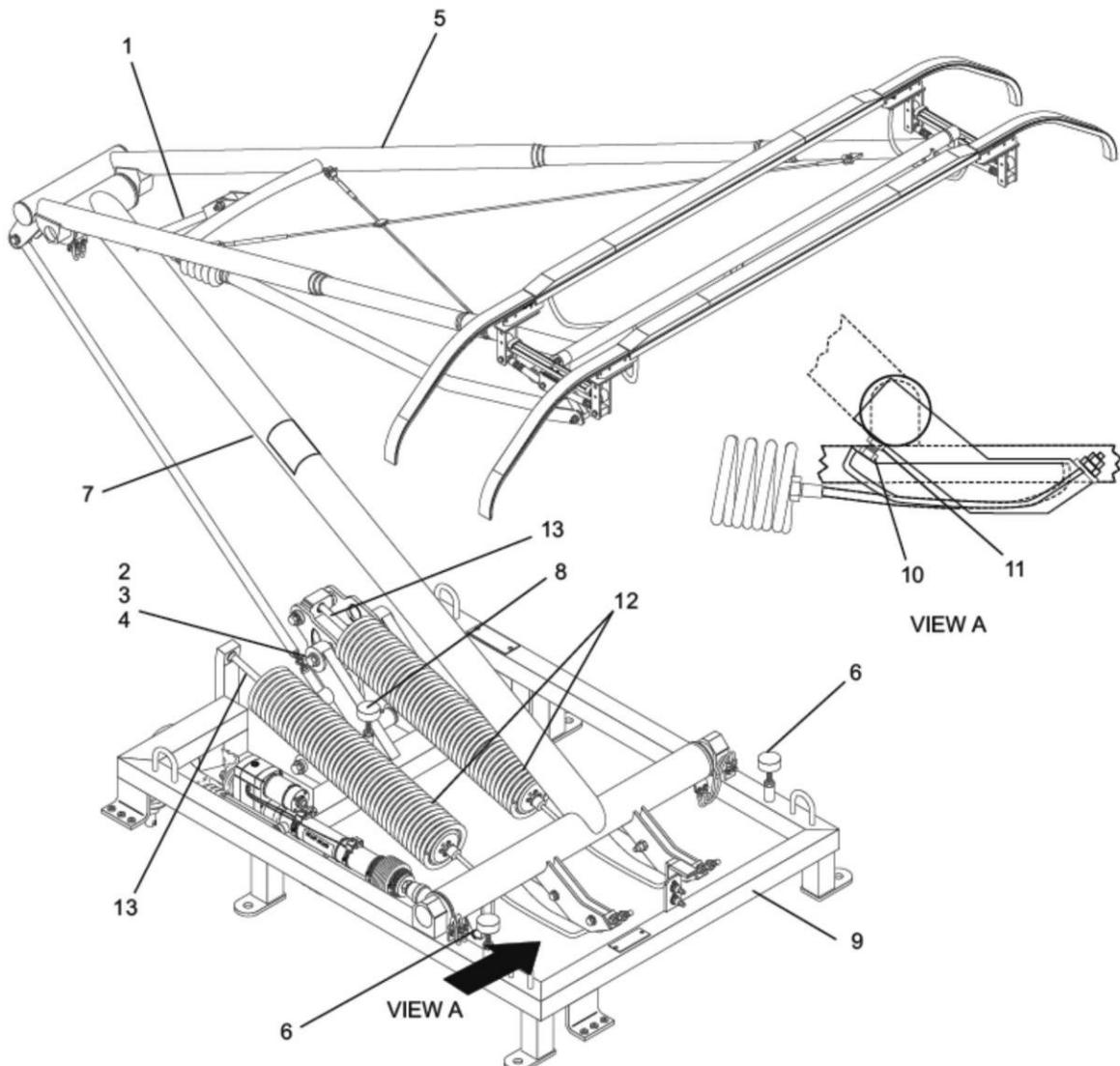
Maintenance Task:

**SERVICE**

Interval/Miles:

**60,000**

### PROCEDURE (CONT'D):



**FIGURE 1 - CONTACT FORCE ADJUSTMENT**

**P2550 PREVENTIVE MAINTENANCE SHEET**

Card Code:

**R-P-08-01-00-00/S-00**

System:

**PANTOGRAPH**

Sheet:

**6/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**0.75**

Maintenance Task:

**SERVICE**

Interval/Miles:

**60,000****INTENTIONALLY****LEFT BLANK**

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-02**

System:

**PANTOGRAPH**

Sheet:

**1/8**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

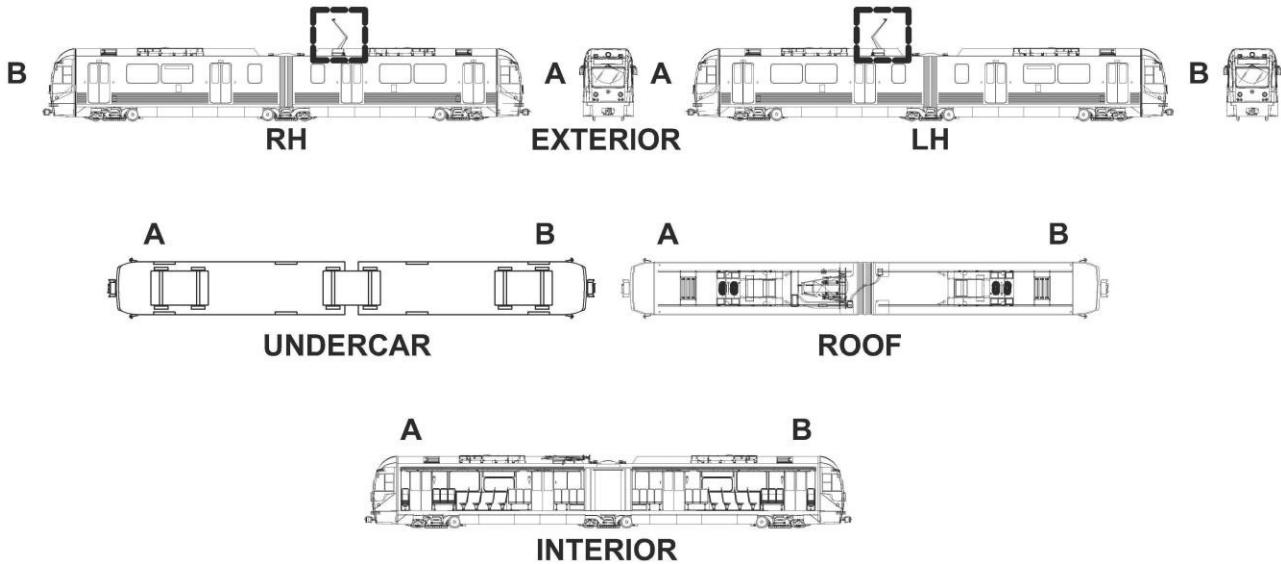
Man Hours:

**1.25**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**120,000**
**LOCATION:**


## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-02**

System:

**PANTOGRAPH**

Sheet:

**2/8**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1.25**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**120,000****SAFETY PRECAUTIONS:**

**WARNING: SHEET R-P-08-00-00-00/SP-00 PROVIDES STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.**

**USE EXTREME CARE WHEN REMOVING THE SAFETY PIN.**

**THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.**

**REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.**

**TOOLS:**

LACMTA Maintenance Shop Standard Tools Kit

MULTIMETER (FLUKE 87 V/E)

**CONSUMABLES:**

NOALOX Electrical Contact Grease or equivalent used by MTA

**SPARE PARTS:**

P/N	351-06066-39 - SHUNT CABLES,	11	INCH LONG
P/N	351-05640-28 - SHUNT CABLES,	9 5/16	INCH LONG

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-02**

System:

**PANTOGRAPH**

Sheet:

**3/8**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1.25**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**120,000**

### PROCEDURE:

#### INSPECTION

##### PRELIMINARY OPERATIONS

1. Set the Vehicle in safety condition in accordance with LACMTA Maintenance Shop Regulations.
  2. Follow the Safety Precautions according to Sheet R-P-08-00-00-00/SP-00.
  3. Access Vehicle Roof according to MTA procedures.
- 1. CHECK ELECTRICAL LOWERING DEVICE PROXIMITY SWITCHES.**

The Proximity Switches are Limit Switches that tell the Vehicle Control System to turn off the Motor when the Pantograph reaches its working height and when it reaches the down (rest) position.

Switch S3 determines the working height position.

Switch S4 determines the rest position.

Verify the operation by raising and lowering the Pantograph electrically. Adjust as follows if needed:

**CAUTION:** IF ELECTRICAL LOWERING DEVICE WAS REPLACED, S3 AND S4 MUST BE ADJUSTED PER NOTE BELOW.  
 IF S3 AND S4 ARE NOT ADJUSTED CORRECTLY, THE MOTOR CAN NOT SHUT OFF AND/OR THE INTERNAL CLUTCH CAN SLIP AND DAMAGE ELECTRICAL LOWERING DEVICE.  
 DISCONNECT POWER SOURCE IMMEDIATELY IF THIS HAPPENS AND CHECK ADJUSTMENTS.

**NOTE:** Normally Closed Switch S3 and S4 can be monitored with a Multimeter with Power off (see Figure 1 for Switches Diagram).

The Pantograph is raised with the Hand Crank until the Internal Stop is hit and then backed off 2 to 3 turns of the Hand Crank.

The position of Switch S3 is adjusted to open at this point.

The Pantograph is lowered with the Hand Crank until the Internal Stop is hit and then backed off 2 to 3 turns of the hand crank.

The position of Switch S4 is adjusted to open at this point.

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-02**

System:

**PANTOGRAPH**

Sheet:

**4/8**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1.25**

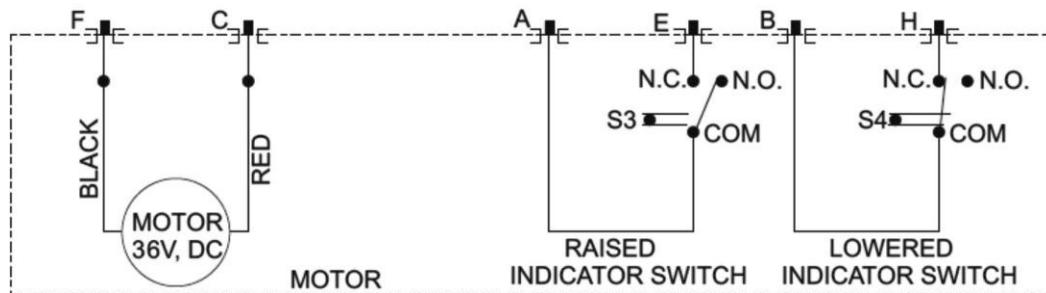
Maintenance Task:

**INSPECTION**

Interval/Miles:

**120,000**

### PROCEDURE (CONT'D):



- PIN NUMBER OF PLUG  
 CIRCUIT DIAGRAM SHOWS PAN HEAD LIFTED  
 RED 36VDC: PANTOGRAPH RAISES  
 PEAK CURRENT 12A  
 RUNNING CURRENT 6A-8A

**FIGURE 1 - WIRING DIAGRAM**

- a. Loosen Clamp (1, Figure 2).
- b. Raise the Pantograph electrically. Motor should turn off at desired height due to actuation of proximity switch S3 (2).
- c. If needed, adjust the position of Switch S3 by sliding the Switch.
- d. Tighten Clamp (1).
- e. Recheck function by lowering and raising Pantograph electrically.
- f. Loosen clamp (3).
- g. Lower Pantograph electrically. Motor should turn off at rest position due to actuation of proximity Switch S4 (4).
- h. If needed, adjust the position of Switch S4 by sliding the Switch.
- j. Tighten Clamp (4).
- k. Recheck function by raising and lowering Pantograph electrically.

### 2. CHECK SHUNTS CABLES

- a. Perform visual inspection for breaks, corrosion, or loose connections. Replace missing attaching parts.
- b. Replace Shunt Cables as necessary using electrical contact grease on Cable Connections.

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-02**

System:

**PANTOGRAPH**

Sheet:

**5/8**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1.25**

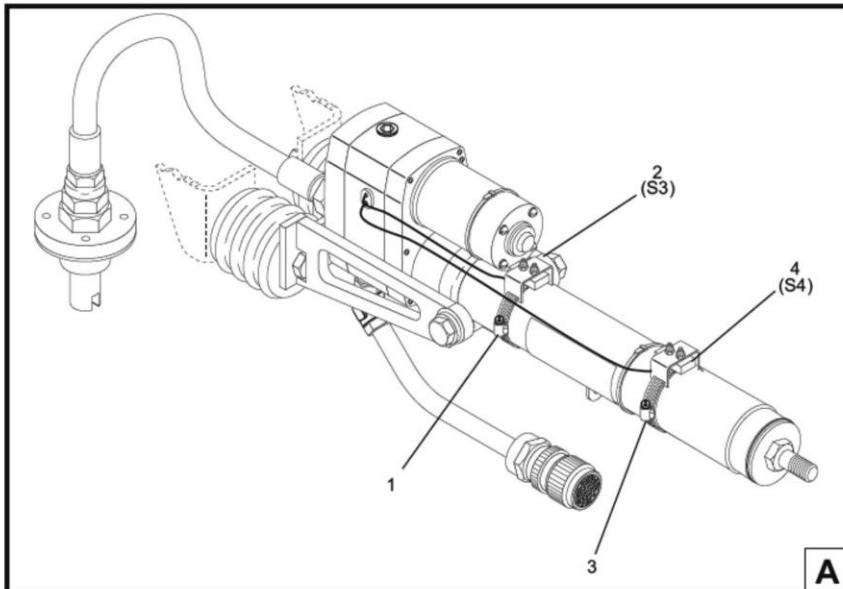
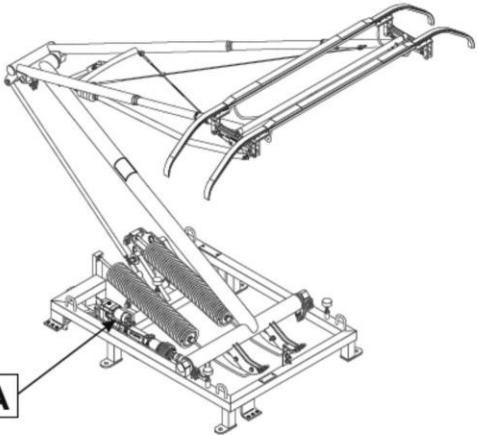
Maintenance Task:

**INSPECTION**

Interval/Miles:

**120,000**

### PROCEDURE (CONT'D):



**FIGURE 2 - MICROSWITCH ADJUSTMENT**

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-02**

System:

**PANTOGRAPH**

Sheet:

**6/8**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1.25**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**120,000**

### **PROCEDURE (CONT'D):**

#### **3. REPLACE SHUNTS CABLES**

**CAUTION:** APPLY NOALOX ELECTRICAL CONTACT GREASE ON MATING SURFACES OF CURRENT CONNECTIONS FOR PROPER ELECTRICAL CONTACT.

##### **a. Pan Head Shunt Cables Replacing**

1. Locate Shunt Cable (1, Figure 3) to be replaced. Remove M8 Bolt (2), Spring Washer (3), and Self-Locking Nut (4) securing Shunt Cable (1) to Current Connection on Upper Frame (5).
2. Remove M8 Self-Locking Nut (6) and Flat Washer (7) securing opposite end of Shunt Cable to Carbon Holder (8).
3. Remove and discard Shunt Cable (1).
4. Align new Shunt Cable (1) with Current Connection on Upper Frame (5) and secure with M8 Bolt (2), Spring Washer (3), and Self-Locking Nut (4). Tighten Self-Locking Nut (4).
5. Install opposite end of Shunt Cable (1) on Carbon Holder (8) and secure in place with M8 Bolt (2), Spring Washer (3), and Self-Locking Nut (4). Tighten Self-Locking Nut (4).

##### **b. Upper Frame Shunt Cables Replacing**

1. Locate Shunt Cable (9, Figure 3) to be replaced. Remove M8 Bolt (10), Spring Washer (11), and Self-Locking Nut (12) securing Shunt Cable (9) to Current Connection on Lower Frame (13).
2. Remove M8 Bolt (14), Spring Washer (15), and Self-Locking Nut (16) securing Shunt Cable (9) to Current Connection Bracket on Upper Frame (17).
3. Remove and discard Shunt Cable (9).
4. Align new Shunt Cable (9) with Current Connection on Upper Frame (17) and secure with M8 Bolt (14), Spring Washer (15), and Self-Locking Nut (16). Tighten Self-Locking Nut (16).
5. Align opposite end of Shunt Cable (9) with Current Connection on Lower Frame (13) and secure with M8 Bolt (10), Spring Washer (11), and Self-Locking Nut (12). Tighten Self-Locking Nut (12).

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-02**

System:

**PANTOGRAPH**

Sheet:

**7/8**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1.25**

Maintenance Task:

**INSPECTION**

Interval/Miles:

**120,000**

### PROCEDURE (CONT'D):

#### c. Base Frame Shunt Cables Replacing

1. Locate Shunt Cable (18, Figure 3) to be replaced. Remove M8 Bolt (19), Spring Washer (20), and Self-Locking Nut (21) securing Shunt Cable (18) to Current Connection on Base Frame (22).
2. Remove M8 Bolt (23), Spring Washer (24), and Self-Locking Nut (25) securing Shunt Cable (18) to Current Connection on Lower Frame (13).
3. Remove and discard Shunt Cable (18).
4. Align new Shunt Cable (18) with Current Connection on Lower Frame (13) and secure with M8 Bolt (23), Spring Washer (24), and Self-Locking Nut (25). Tighten Self-Locking Nut (25).
5. Align opposite end of Shunt Cable (18) with Current Connection on Base Frame (22) and secure with M8 Bolt (19), Spring Washer (20), and Self-Locking Nut (21). Tighten Self-Locking Nut (21).

### FINAL OPERATIONS

Record Inspection Results on the Defect Report Card for administrative and maintenance planning

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the maintained Equipment pertains.

Refer to **HOW TO USE THE R-PM SHEETS** (para 08-III-03-03-02 of this Section) and follow the prescriptions provided at Step 3 “**At every Task Completion.**”

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-01-00-00/I-02**

System:

**PANTOGRAPH**

Sheet:

**8/8**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

Man Hours:

**1.25**

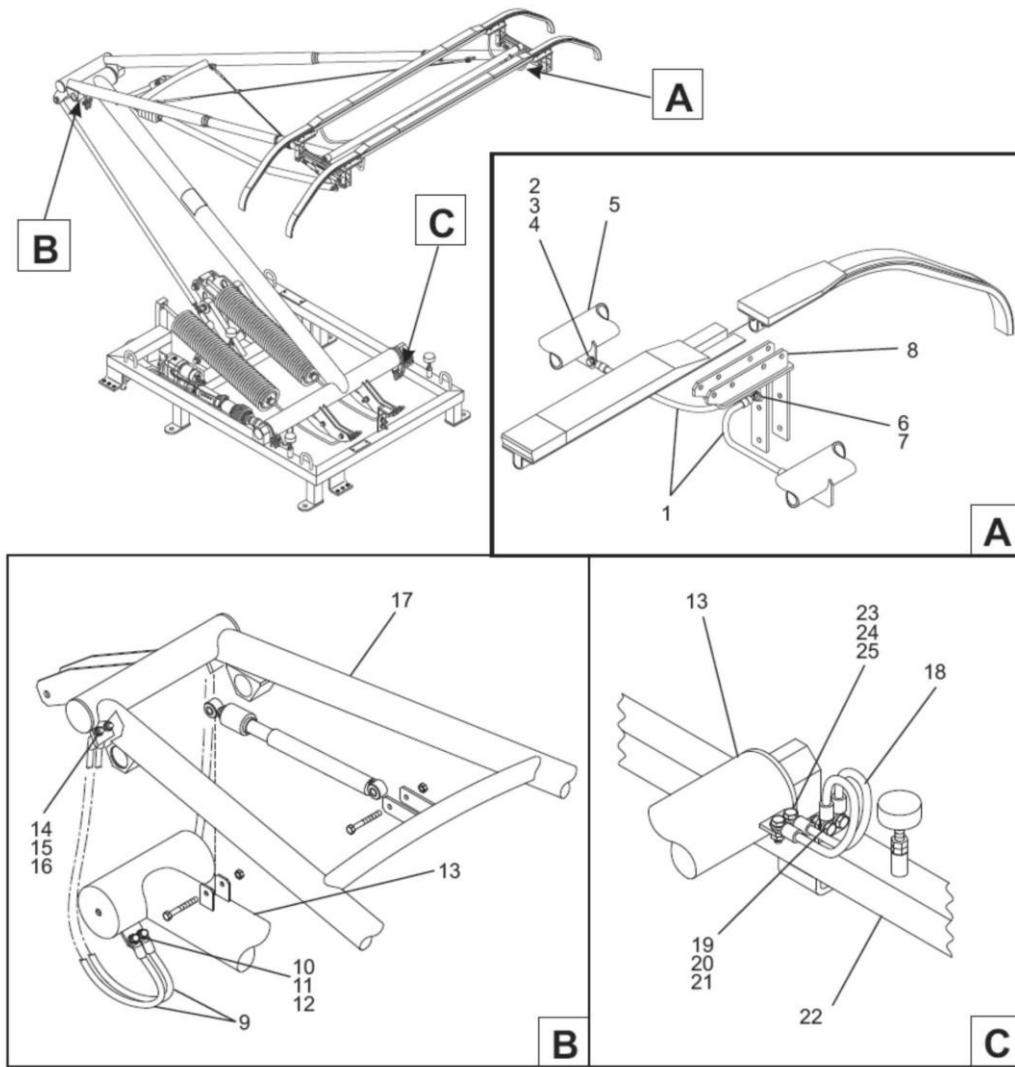
Maintenance Task:

**INSPECTION**

Interval/Miles:

**120,000**

### PROCEDURE (CONT'D):



**FIGURE 3- SHUNT CABLES REPLACEMENT**

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**1/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**COLLECTOR HEAD**

Component:

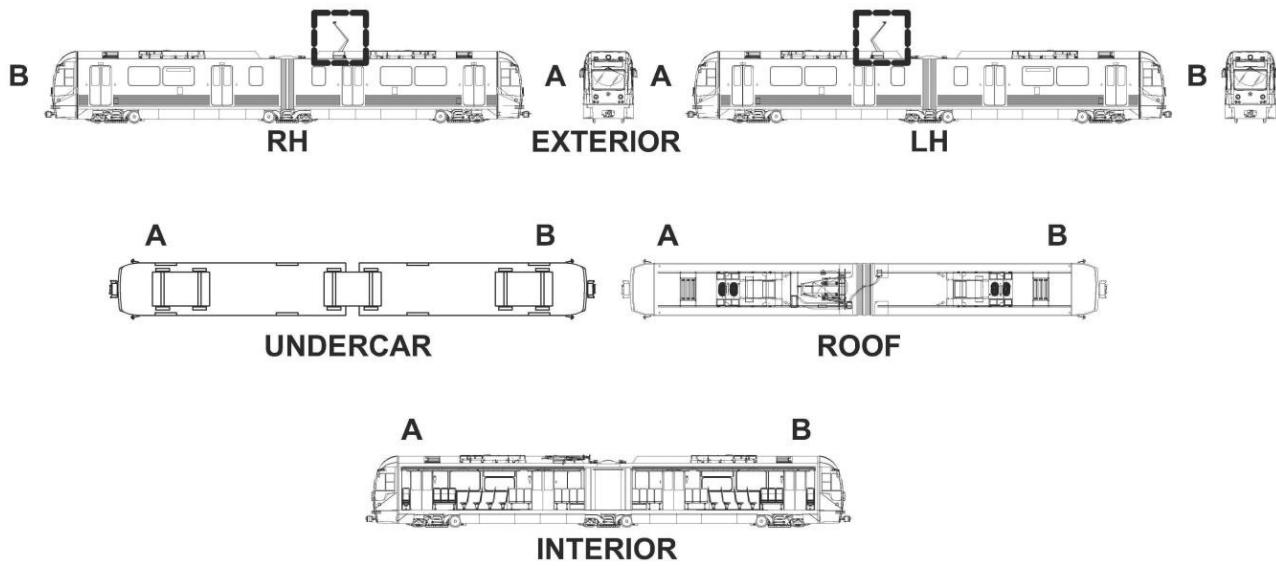
Man Hours:

**0.2**

Maintenance Task:

**REPLACEMENT**

Interval/Miles:

**30,000****LOCATION:**

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**2/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**COLLECTOR HEAD**

Component:

Man Hours:

**0.2**

Maintenance Task:

**REPLACEMENT**

Interval/Miles:

**30,000****SAFETY PRECAUTIONS:**

**WARNING: SHEET R-P-08-00-00-00/SP-00 PROVIDES STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.**

**USE EXTREME CARE WHEN REMOVING THE SAFETY PIN.**

**THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.**

**REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.**

**TOOLS:**

LACMTA Maintenance Shop Standard Tools Kit

**CONSUMABLES:**

Carbon Remover, M3      PN      161689

Grease Shell Alvania 2      PN      149973

NOALOX Electrical Contact Grease or equivalent used by MTA

**SPARE PARTS:**Carbon Contact Strip      P/N      SK806  
End Horn      P/N      312891102

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**3/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**COLLECTOR HEAD**

Component:

Man Hours:

**0.2**

Maintenance Task:

**REPLACEMENT**

Interval/Miles:

**30,000**

### PROCEDURE:

#### PRELIMINARY OPERATIONS

1. Set the Vehicle in safety condition in accordance with LACMTA Maintenance Shop Regulations.
2. Follow the Safety Precautions according to Sheet R-P-08-00-00-00/SP-00.
3. Access Vehicle Roof according to MTA procedures.

**CAUTION:** USE A LIGHT COAT OF DOW CORNING G-N METAL ASSEMBLY PASTE ON ALL THREADS TO REDUCE THE RISK OF SEIZING. THIS WILL ALSO HELP PREVENT STAINLESS STEEL FASTENERS THAT ARE THREADED INTO CARBON STEEL FROM RUSTING FAST.  
DO NOT USE AN IMPACT WRENCH ON ANY FASTENERS. STAINLESS STEEL FASTENERS TEND TO SEIZE WHILE BEING ASSEMBLED, ESPECIALLY IF AN IMPACT WRENCH IS USED.

**CAUTION:** IF CARBON STRIP IS WITHIN SPECIFICATION ON ONE OF THE CARBON CARRIERS AND THE MATCHING ONE (ON THE OTHER CARBON CARRIER) IS WORN BEYOND SPECIFICATION, THEN BOTH CARBON STRIPS MUST BE REPLACED TOGETHER. REPLACING ONLY ONE CARBON STRIP CREATES AN UNEVEN CARBON HEIGHT CONDITION, RESULTING IN POOR CONTACT WITH THE CATENARY WIRE, RAPID CARBON WEAR, AND POSSIBLE ARCING.

#### REPLACEMENT

##### 1. CARBON STRIP (Refer to Figure 1)

- a. Remove four M6 bolts (1, Figure 1) and Self Locking Nuts (2) from Carbon Holder (3) at both ends of Carbon Strip (4).
- b. Carefully remove both End Horns (5) from Carbon Holder (3) and Carbon Strip (4).
- c. Remove Carbon Strip (4).
- d. Apply NOALOX electrical contact grease on contact surfaces of both End Horns (5), both Carbon Holders (3), and Carbon Strip (4).
- e. Install new Carbon Strip (4) in Carbon Holders (3).
- f. Install both End Horns (5) on Carbon Holder (3) and Carbon Strip (4).
- g. Install four M6 bolts (1) and Self Locking Nuts (2).
- h. Tighten Bolts (1) and Self Locking Nuts (2).

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**4/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**COLLECTOR HEAD**

Component:

Man Hours:

**0.2**

Maintenance Task:

**REPLACEMENT**

Interval/Miles:

**30,000**

### **PROCEDURE (CONT'D):**

#### **REPLACEMENT (CONT'D)**

**2. END HORN** (Refer to Figure 1)

**NOTE:** Under normal wear conditions, End Horns require replacement every 2 to 3 sets of Carbon Strips.

- a. Remove four M6 bolts (1, Figure 1) and Self Locking Nuts (2) from Carbon Holder (3).
- b. Carefully remove End Horn (5) from Carbon Holder (3) and Carbon Strip (4).
- c. Discard End Horn (5).
- d. Apply NOALOX electrical contact grease on contact surfaces of new End Horn (5), Carbon Holder (3), and Carbon Strip (4).
- e. Install new End Horn (5) on Carbon Holder (3) and Carbon Strip (4).
- f. Install four M6 bolts (1) and Self Locking Nuts (2).
- g. Tighten Bolts (1) and Self Locking Nuts (2).
- h. Repeat as required for other End Horn.
- i. Perform the following Adjustments and Checks according to Sheet R-C-08-01-00-00/R-00
  - Contact Force
  - Turning Capacity of the Pan Head
  - Parallelism of Carbon Strips

### **FINAL OPERATIONS**

Record Inspection Results on the Defect Report Card for administrative and maintenance planning

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the maintained Equipment pertains.

Refer to **HOW TO USE THE R-PM SHEETS** (para 08-III-03-03-02 of this Section) and follow the prescriptions provided at Step 3 "**At every Task Completion.**"

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-P-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**5/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**COLLECTOR HEAD**

Component:

Man Hours:

**0.2**

Maintenance Task:

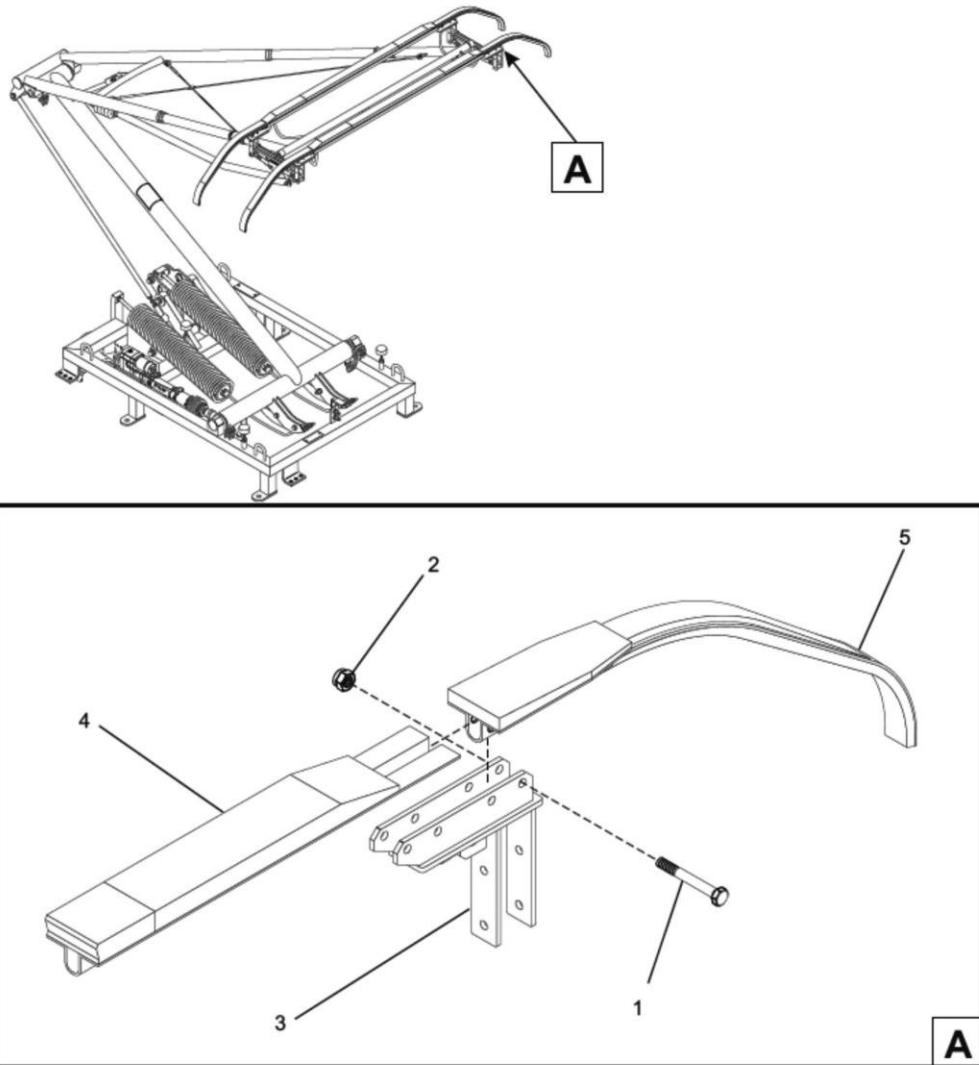
**REPLACEMENT**

Interval/Miles:

**30,000**

### PROCEDURE (CONT'D):

#### REPLACEMENT (CONT'D)



**FIGURE 1 - CARBON STRIP & END HORN REPLACEMENT**

**P2550 PREVENTIVE MAINTENANCE SHEET**

Card Code:

**R-P-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**6/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**COLLECTOR HEAD**

Component:

Man Hours:

**0.2**

Maintenance Task:

**REPLACEMENT**

Interval/Miles:

**30,000****INTENTIONALLY LEFT  
BLANK**

## 08-III-04 RUNNING -CORRECTIVE MAINTENANCE

### 08-III-04.01 Running -Corrective Maintenance Sheets (R-CMS)

Each R-CMS provides the following data consistent with Corrective Maintenance Analysis (CMA), AB Design Documentation and Vehicle Systems Functional Tree:

- **R-CM Sheet Code**
- **SYSTEM, SUBSYSTEM /ASSEMBLY, UNIT, Component** (Names)
- **SYSTEM, SUBSYSTEM /ASSEMBLY, UNIT, Component** (Location)
- **Maintenance Task,**

The following definitions are applicable to the R-CM Tasks

<b>Inspection:</b>	Maintenance procedures such as those required to ascertain the serviceability of a Part, Assembly, System or the specific interrelationship of Parts that perform a functional operation.
<b>Leveling:</b>	Procedure to adjust the distance between the Vehicle Floor to the Top Of Rail and the designated Vehicle Height
<b>Replacement:</b>	Provides the Components / Assemblies and Subassemblies removal & installation in a logical sequential order.
<b>Re-Profiling:</b>	Provides the procedure to maintain the safe and proper "wheel Profile"
<b>Repair:</b>	Provides detailed procedures for the repair of a specific Equipment / Component
<b>Service:</b>	Operation performed to replenish Sand, Windshield Wiper Washer Fluid, HVAC Coolant, Gear and Compressor Oil, and Vehicle Lubrication

- **Man Hours**, needed to perform the Task
- **SPARE PARTS**, needed to perform the Task

Each R-CMS also provides:

- **SAFETY PRECAUTIONS**, to be followed to safely accomplish the Task
- **TOOLS**, including Special Tools and Test Equipment, needed to accomplish the Task
- **CONSUMABLES**, required to accomplish the Task and consistent with those used by MTA
- **PROCEDURE**, consisting of Preliminary Operations and Procedural Steps, to be followed while performing Maintenance Tasks
- **Illustrations and Pictures** are inserted in the text to facilitate the understanding of the topics and/or to explain step-by-step procedure

Each R-CM Sheet refers to one Task and consists of several pages where Safety Precautions and Maintenance Instructions to perform safely the Task are provided by Procedural Steps in conjunction with Illustrations and Pictures.

**NOTE:** The Safety Precautions to be followed to safely accomplish the Maintenance of the Pantograph are provided (in sheet format) at the beginning of each section containing the relevant R-CMS.

## 08-III-04.01.01      Running- Corrective Maintenance Sheet (R-CMS) Form

The R-CMS Form (refer to Figure 08-III-04.1) consists of several fields containing the following data/ information:

<b>RUNNING -CORRECTIVE MAINTENANCE SHEET (R-CMS) Form</b>			
<b>ITEM #</b>	<b>TITLE</b>	<b>CONTENT</b>	<b>EXPLANATORY NOTES</b>
1	<b>Card code</b>	<b>Sheet code</b>	<p>The Sheet Code is an alphanumerical code that identifies each R-CM Sheet.</p> <p><b>THE SHEET CODE IS EXPLICIT</b></p> <p>The Sheet Code consists of letters <b>R-C</b> followed by an 11 digit code number as follows:</p> <p><b>R-C-nn-mm-zz-ww/Y-kk</b></p> <p><b>R = Running                    C = Corrective</b></p> <p><b>nn</b> may vary from 02 to 19, identifying the System/ Manual Section number.</p> <p><b>mm-zz-ww</b> each one may vary from 00 to 99, according to AB System Functional Tree, allowing the identification of the Assembly/Unit/Component</p> <p><b>Y</b> Maintenance Task Code. It may be one of the following:</p> <p><b>I = Inspection                LL =Leveling</b></p> <p><b>R = Replacement            RP= Re-Profilng</b></p> <p><b>RR = Repair                    S = Service</b></p> <p><b>SP = Safety Precautions</b></p> <p><b>kk</b> It may vary from 00 to 99. It is a progressive number allowing the explicit identification of R-CMS</p> <p><b>NOTE:</b> The code R-C-nn-00-00-00-R-kk identifies a Typical Replacement Procedure The Typical Replacement Procedure is provided for the following items: Board, Circuit Breaker, Diode, Indicator Lamp, Main Contactor, Switch &amp; Relays..</p>
2	<b>System</b>	<b>System name</b>	This field indicates the System to which the Assembly/Unit/Component belongs.
3	<b>Subsystem/ Assembly</b>	<b>Subsystem/ Assembly name</b>	This field indicates the Subsystem/Assembly to which the Unit/Component belongs.
4	<b>Unit</b>	<b>Unit name</b>	This field indicates the Unit to which the Component belongs.
5	<b>Component</b>	<b>Component name</b>	This field indicates the Component the Maintenance Task is referring to
6	<b>Maintenance Task</b>	<b>Maintenance Task name</b>	This field indicates the Maintenance Task to be performed.
7	<b>Man Hours</b>	<b>Number</b>	The Man Hour field indicates the time needed to perform the corresponding Maintenance Task. with the basic assumption that the Vehicle is staged on an Inspection Pit/Jacking tracks with the required Consumables, Tools and Materials available.

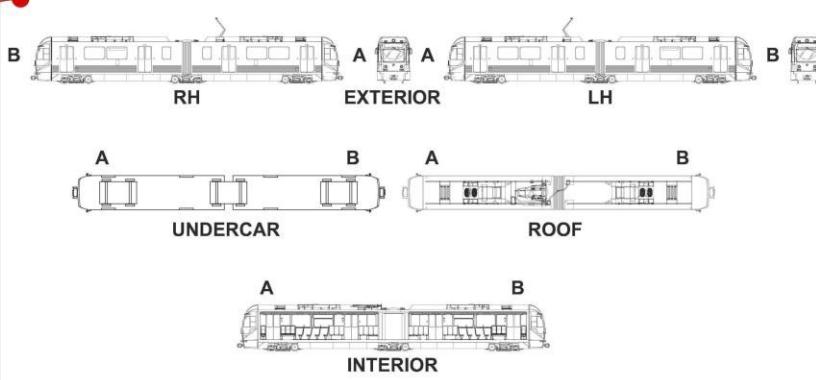
<b>RUNNING -CORRECTIVE MAINTENANCE SHEET (R-CMS) Form (cont'd)</b>			
<b>ITEM #</b>	<b>TITLE</b>	<b>CONTENT</b>	<b>EXPLANATORY NOTES</b>
8	Sheet	Pages numbering	This field indicates the progressive R-CMS sheet page number.
9	LOCATION	Illustration	This field indicates the On Board Location of the Equipment to be maintained The following Graphic Symbols are used for: Assembly/Unit/Component  for System/Subsystem/Vehicle as a Whole 
10	R	Letter	This field indicates that the Sheet pertains to Running Maintenance
11	C	Letter	This field indicates that the Sheet pertains to Corrective Maintenance
12	nn	Number	This field indicates the System/Manual Section number to which the Sheet pertains. It may vary from 01 to 19
13	rr	Number	This field indicates the Sheet Revision number
14	Page ##	Page ##	This field indicates the RMSM Section Page number
15	-#	Number	This field indicates the RMSM Section Revision number
16	SAFETY PRECAUTIONS	Text	This field presents the General and/or specific Safety Precautions to be followed to safely accomplish the relevant Maintenance Tasks.
17	TOOLS	Text	This field lists the description and the P/N of the Standard tools, Special Tools and Test Equipment needed to accomplish the Maintenance Task. Refer to the TTE Manual for the TE and Special Tools detailed descriptions and tools maintenance.
18	CONSUMABLES	Text	This field lists the Consumables Materials (consistent with those used by MTA with the related P/N.) needed to accomplish the Maintenance Task. Cleaning agents are included
19	SPARE PARTS	Text	This field lists the Description and PN of Spare Parts (consistent with Illustrated Parts Catalog) needed to accomplish the Maintenance Task.
20	PROCEDURE	Text	The Procedure field provides Preliminary Operations and Procedural step by step Instructions to be followed while performing the Maintenance Task. Illustrations and Pictures are inserted in the text to facilitate the understanding of the topics and/or to explain step-by-step procedure.

LACMTA P2550 LRV  
Running Maintenance and Servicing Manual - Section 01

**P2550 CORRECTIVE MAINTENANCE SHEET**

System:	Sheet:	Card Code:
Subsystem/Assy:	Unit:	x/z
Component:	Man Hours:	
Maintenance Task:		
<b>LOCATION:</b>		

**R-C-nn-mm-zz-ww/Y-kk**



**10**      **11**      **12**      **13**      **14**      **15**

**M**<sub>Metro</sub>

**1**      **2**      **3**      **4**      **5**      **6**      **7**      **8**      **9**

**Page 011 Draft**

**Figure 08-III-04.1 R-CMS Form  
(Sheet 1 of 2)**

LACMTA P2550 LRV Running Maintenance and Servicing Manual - Section 01		 <b>AnsaldoBreda</b>				
<b>P2550 CORRECTIVE MAINTENANCE SHEET</b>						
Card Code: <b>R-C-nn-mm-zz-ww/Y-kk</b>						
System:	Sheet:	<b>x/z</b>				
Subsystem/Assy:	Unit:					
Component:	Man Hours:					
Maintenance Task:						
<b>SAFETY PRECAUTIONS:</b>						
16						
<b>TOOLS:</b>						
17						
<b>CONSUMABLES:</b>						
18						
<b>SPARE PARTS:</b>						
19						
<b>PROCEDURE:</b>						
PRELIMINARY OPERATIONS						
20						
Page 01-2 Draft						
						
<table border="1" style="margin-left: auto; margin-right: 0; border-collapse: collapse;"> <tr> <td style="width: 10px; height: 10px;"></td> </tr> </table>						

**Figure 08-III-04.1 R-CMS Form  
(Sheet 2 of 2)**

## 08-III-04.01.02 How to Use the R-CM Sheets

To optimize the job organization it is suggested to proceed as follows:

### 1. Before Task Execution

- a) Carefully read the sheets to ensure that you fully understand all safety precautions, preliminary conditions required, warnings, notes & procedures that will be followed
- b) Particularly read
  - The Safety Precautions to perform safely the Task
  - The Preliminary Operations to set the Vehicle in safety conditions according to MTA Maintenance Shop Regulations
  - The Tools, Consumables and Spare Parts listed in each Sheet that are needed to accomplish the Task and to have all of them available next the location of the Equipment to be maintained before starting the activities

### 2. During Task Execution

- a) Follow accurately the prescribed Safety Precautions and Maintenance Procedural Steps.
- b) Note any Areas/Items of the Assembly/Unit/Component under Corrective Maintenance Process requiring further Corrective Maintenance.
- c) Gather as much information about the Equipment as is practical.  
(i e knowledge about the malfunction in terms of correctly operating and incorrectly operating equipment processes) to increase your equipment knowledge.

### 3. At every Task Completion

- a) Carefully follow the prescribed Safety Precautions before restoring the Electrical Power to Vehicle.
- b) Check the correct operation and/or functions of the Subsystem to which the maintained Equipment pertains.
- c) It is suggested to perform this check on the IDU "A" as follows:

**NOTE:** Through the IDU you can check if all Systems are exchanging data by MVB or LonWorks Bus and the Trainlines Status.

The IDU Display also shows in real time the Status of all Vehicle Systems.

Reading the IDU Fault List it is possible to immediately detect a fault

Using the IDU in the Operating Mode the Fault Indications are generic,

Using the IDU in Maintenance Mode the same Fault has a detailed description.

For more in depth troubleshooting use the PTU connected to the relevant system that requires further troubleshooting.

1. On IDU "A" access to the Maintenance Menu first and then to the "Faults" Screen by selecting, in sequence, the relevant icons.
2. Check, On IDU "A" through the list of the Current Active Faults shown in the "Faults" Screen, for Fault Codes related to the Subsystem to which the maintained Equipment pertains.  
Refer to Section 18 of RMSM for Fault Signals Details.
3. As per "Fault" Codes check results proceed as follows:

➤ **No Faults are listed in the "Faults" Screen**

- a) Key OFF the Vehicle
- b) Record Service and Test results on the Defect Report Card for administrative and maintenance planning.

➤ **Fault Codes are listed in the "Faults" Screen**

- a) Investigate/troubleshoot the Equipment previously maintained first and then the System/Subsystem/Assembly/Unit for Fault Probable Causes.
- b) Gather as much information about the failure symptoms as is practical.  
Refer to Section 18 of RMSM for Fault Signals Details.
- c) Try to identify the malfunction in terms of correctly operating and incorrectly operating equipment processes.
- d) Identify which equipment signals or parameters will best help you to localize the failure.
- e) Identify the source of the problem.
- f) Repair or replace the defective component.
- g) Verify that the repair is effective in eliminating all of the failure symptoms.
- h) Evaluate whether or not the defective component was the root cause of the failure.
- i) Once the Fault Codes are not found in the "Faults" Screen perform steps from 3-a through 3-b (previous subparagraph **"No Faults are listed in the "Faults" Screen"**).

**08-III-04.01.03      Running- Corrective Maintenance Sheet (R-CMS) List**

The Pantograph Running- Corrective Maintenance Sheets (R-CMS) List is provided in the following.

Table 08-III-04.1

The R-CM Sheets are listed by Subsystem / Assembly / Unit / Component and sequenced by Sheet Codes and Tasks to be performed.

**Table 08-III-04.1    Running Corrective Maintenance Sheets List**

<b>SYSTEM      08</b>		<b>PANTOGRAPH</b>		
<b>SUBSYSTEM / ASSY</b>	<b>UNIT</b>	<b>COMPONENT</b>	<b>TASK</b>	<b>SHEET CODE</b>
PANTOGRAPH ASSY		SAFETY PIN	SAFETY PRECAUTIONS	R-C-08-00-00-00/SP-00
PANTOGRAPH ELECTRIC PLANT		CIRCUIT BREAKER TYPE S280	REPLACEMENT (TYPICAL)	R-C-08-00-00-00/R-00
PANTOGRAPH ELECTRIC PLANT		MAIN CONTACTOR	REPLACEMENT (TYPICAL)	R-C-08-00-00-00/R-01
PANTOGRAPH ELECTRIC PLANT		SWITCH	REPLACEMENT (TYPICAL)	R-C-08-00-00-00/R-02
PANTOGRAPH ELECTRIC PLANT		DIODE	REPLACEMENT (TYPICAL)	R-C-08-00-00-00/R-03
PANTOGRAPH ASSY			REPLACEMENT	R-C-08-01-00-00/R-00
PANTOGRAPH ASSY	COLLECTOR HEAD		REPLACEMENT	R-C-08-02-00-00/R-00
PANTOGRAPH ASSY	MOTOR (04M01)		REPLACEMENT	R-C-08-03-00-00/R-00
PANTOGRAPH ASSY	PROXIMITY MICROSWITCHES (S03-S04)		REPLACEMENT	R-C-08-04-00-00/R-00
PANTOGRAPH ASSY		BEARINGS	REPLACEMENT	R-C-08-08-00-00/R-00

08-III-04.01.04      **Running- Corrective Maintenance Sheets (R-CMS)**

## **PANTOGRAPH**

### **Running - Corrective Maintenance Sheets**

#### **R-CMS**

**INTENTIONALLY LEFT BLANK**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/SP-00**

System:

**PANTOGRAPH**

Sheet:

**1/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

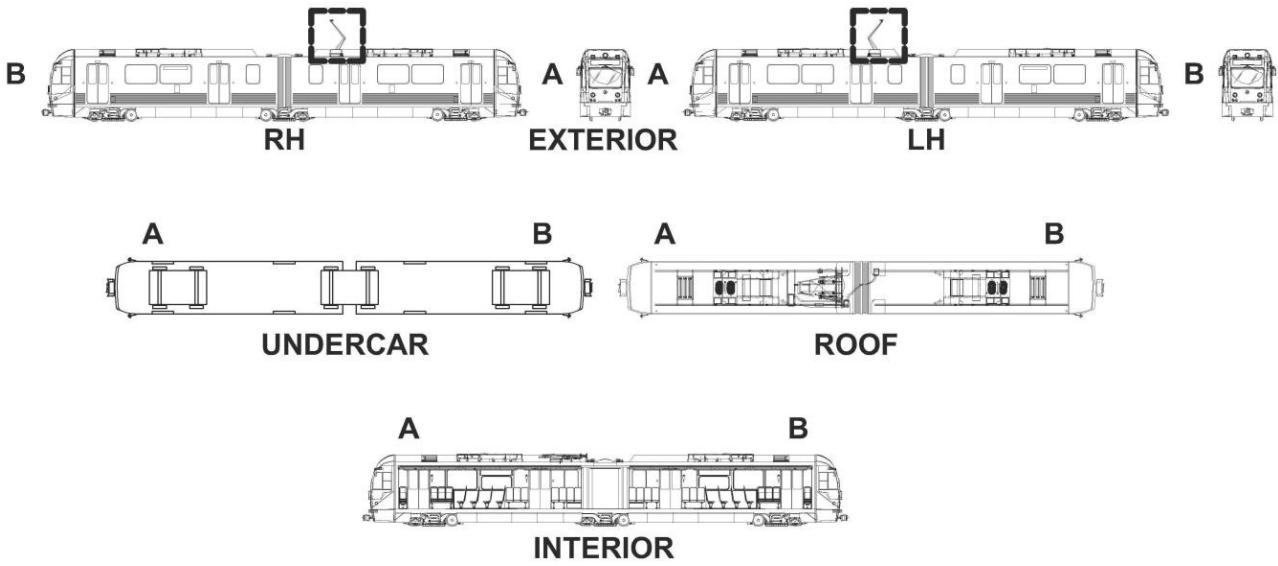
**SAFETY PIN**

Man Hours:

Maintenance Task:

**SAFETY PRECAUTIONS**

Interval/Miles:

**LOCATION:**


## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/SP-00**

System: <b>PANTOGRAPH</b>	Sheet: <b>2/4</b>
Subsystem/Assy: <b>PANTOGRAPH ASSY</b>	Unit:
Component: <b>SAFETY PIN</b>	Man Hours:
Maintenance Task: <b>SAFETY PRECAUTIONS</b>	Interval/Miles:

### PROCEDURE:

**WARNING: BLUE FLAG THE VEHICLE IN ACCORDANCE WITH ALL LACMTA BLUE FLAG POLICIES, RULES, & PROCEDURES IN ORDER TO WARN THAT MAINTENANCE PERSONNEL ARE WORKING ON, UNDER, OR NEAR ROLLING EQUIPMENT.**

**DANGER OF PERSONAL INJURY EXISTS DUE TO ELECTRICAL POWER (750 V). ENSURE PANTOGRAPH IS LOWERED, AND CATENARY POWER IS REMOVED AND ISOLATED PER LACMTA SAFETY RULES AND PROCEDURES.**

**IF POSSIBLE, WORK SHOULD BE DONE IN AN AREA WITHOUT OVERHEAD CATENARY.**

**DANGER OF PERSONAL INJURY EXISTS DUE TO THE WORKING ON ROOF. FOLLOW SAFETY PROCEDURES FOR ACCESSING ROOF. ALWAYS WEAR A SAFETY HARNESS WHEN ACCESSING THE ROOF.**

**DANGER OF PERSONAL INJURY EXISTS DUE TO THE UNEXPECTED RAISING OR LOWERING OF THE PANTOGRAPH. A WARNING TAG SHOULD BE PLACED ON PANTOGRAPH CONTROL SWITCHES TO ALERT PERSONNEL THAT PANTOGRAPH MAINTENANCE IS IN-PROGRESS.**

**DANGER OF PERSONAL INJURY EXISTS DUE TO SHEAR PIN BREAKING AND ALLOWING SUDDEN COLLAPSE OF PANTOGRAPH.**

**THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.**

**USE EXTREME CARE WHEN REMOVING THE SAFETY PIN. THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.**

**REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.**

### USE OF SAFETY PIN.

THIS IS A STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.

### PRELIMINARY OPERATIONS

1. Lock-out and tag-out the Overhead Catenary, 750Vdc Power, per LACMTA Safety Rules and Procedures.

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/SP-00**

System:

Sheet:

**PANTOGRAPH**
**3/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

**SAFETY PIN**

Man Hours:

Maintenance Task:

**SAFETY PRECAUTIONS**

Interval/Miles:

### PROCEDURE (CONT'D):

2. Set the Master Controller Handle to FSB position.
3. Make sure that all Parking Brakes are applied (by checking on the IDU "Parking Brake A and B Not Released" and on Indicator Panel "A" "Park / Friction Brake" ON).
4. Lower the Pantograph.
5. Turn the Transfer Switch to OFF.
6. Set the Pantograph Control Motor Switch (5F02 CB LV Locker "A" Section) to OFF.
7. Attach a tag with the person's name who removed power.

**NOTE** The tag must indicate the name of the person who removed Power.

That person knows why the Power was removed and when it safe to restore it. Only the individual whose name appears on the tag or a person with his approval should remove the tag and restore Power.

### SAFETY PIN INSTALLATION

1. Access Vehicle Roof according to MTA procedures.
  2. Remove Cotter Pin.
  3. Remove Yellow Safety Pin (2) from storage location on bracket (3).
  4. Install Yellow Safety Pin (2) in Safety System Linkage beside Shear Pin (4).
- NOTE:** Yellow safety pin (2) goes through the aligned holes of lever (5) and spindle lashing (6) next to shear pin (4).
5. Install Cotter Pin (1) on Yellow Safety Pin (2).
  6. Perform required maintenance task or tasks.
  7. Do not remove Yellow Safety Pin (2) until all maintenance tasks are completed.

**CAUTION:** DO NOT LEAVE THE SAFETY PIN INSTALLED WHEN MAINTENANCE TASKS ARE COMPLETED.

IF THE SAFETY PIN IS INSTALLED WHILE THE PANTOGRAPH IS IN OPERATION, IT WILL PREVENT THE SHEAR PIN FROM PROTECTING AGAINST EXCESSIVE CONTACT FORCE THAT COULD DAMAGE THE CATENARY OR THE PANTOGRAPH.

### SAFETY PIN REMOVAL

1. Working outside the envelope of Pantograph Assembly, reach underneath Base Frame and check fit of Yellow Safety Pin (2) in hole.
  - a. If Yellow Safety Pin (2) is tight, replace Shear Pin (4) before doing any other maintenance.
  - b. If Yellow Safety Pin (2) is loose, remove Cotter Pin (1) and remove Yellow Safety Pin(2) from Lever (5) and Spindle Lashing (6).
2. Install Yellow Safety Pin (2) in Storage Bracket (3) and secure it with Cotter Pin (1)

### FINAL OPERATIONS

- 1 Leave the Roof according to MTA Safety Rules
- 2 Restore power to Overhead Catenary or relocate the Vehicle to an area where there is an Overhead Catenary with Power available.
- 3 Restore Power to Vehicle.

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/SP-00**

System:

**PANTOGRAPH**

Sheet:

**4/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

**SAFETY PIN**

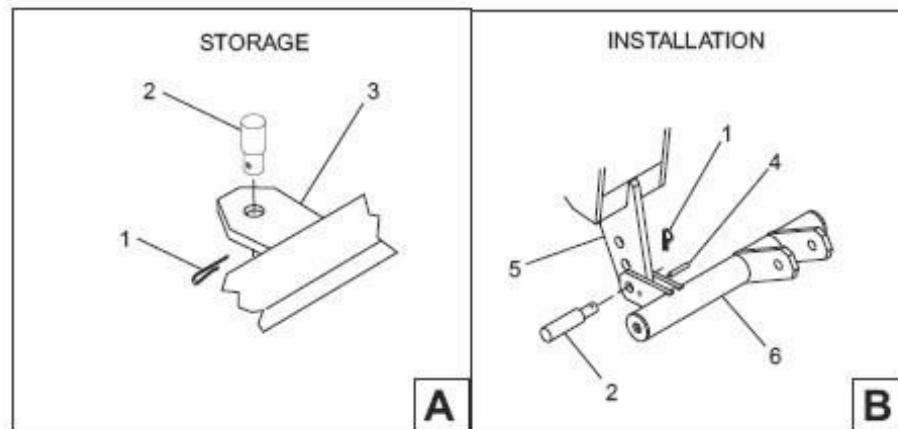
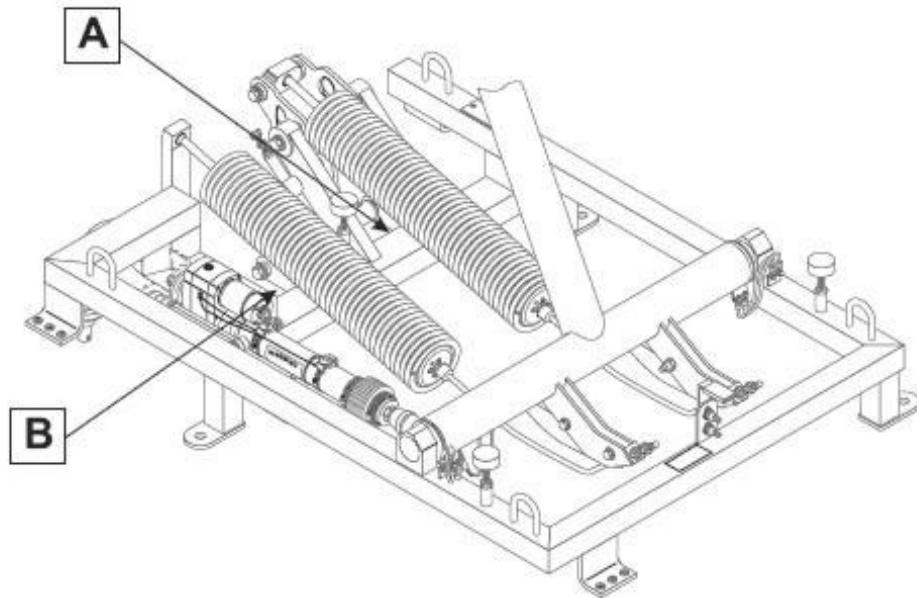
Man Hours:

Maintenance Task:

**SAFETY PRECAUTIONS**

Interval/Miles:

### PROCEDURE (CONT'D):



**FIGURE 1 - YELLOW SAFETY PIN**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**1/10**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**CIRCUIT BREAKER TYPE S280**

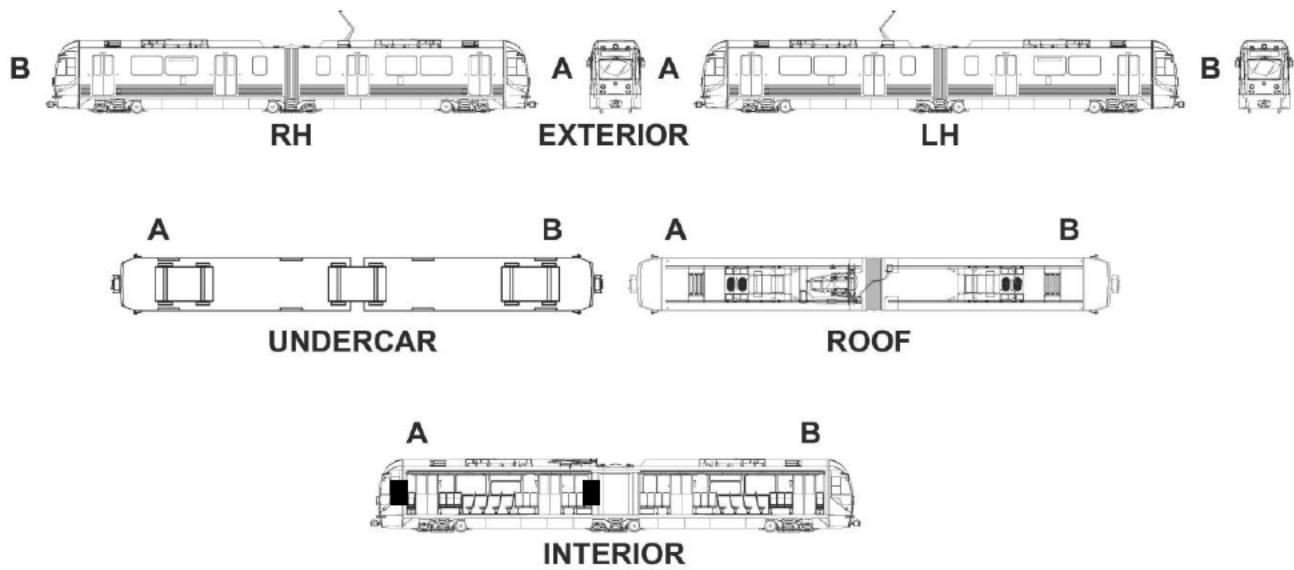
Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### LOCATION:



### APPLICABILITY:

This Replacement procedure is applicable to the following Items:

**TABLE 1 CIRCUIT BREAKERS IDENTIFICATION & LOCATIONS**

LABEL	DESCRIPTION	TYPE	P/N	CAR	LOCATION	FUNCTIONAL DIAGRAMS	
						SCHEMATICS	SHEET#
5F01	PANTOGRAPH UP\DOWN C.B.	S281 C 6A	211EK22984B01	A	LV LOCKER	LV	49
5F02	PANTOGRAPH CONTROL MOTOR SWITCH	S281 C 20A	211EK22984B05	A	CAB. CB PANEL	LV	50
5F03	PANTOGRAPH UP\DOWN CONTAC SWITCH	S281 C 6A	211EK22984B01	A	LV LOCKER	LV	49

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**2/10**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**CIRCUIT BREAKER TYPE S280**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### **SAFETY PRECAUTIONS:**

LACMTA Maintenance Shop Safety Rules & Regulations

**CAUTION :**SWITCH OFF THE 3F01 CB (BATTERY BOX) BEFORE STARTING TO PERFORM THE REPLACEMENT OF ANY CB LISTED IN THE PREVIOUS TABLE 1.

### **TOOLS:**

LACMTA Standard Tools Kit

### **CONSUMABLES:**

CRC 2000 Contact Cleaner

### **SPARE PARTS:**

Refer to Table 1 Circuit Breakers Identification & Locations

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**3/10**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**CIRCUIT BREAKER TYPE S280**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### PROCEDURE:

#### PRELIMINARY OPERATIONS

Set the Vehicle in safety conditions in accordance with LACMTA Maintenance Shop Regulations:

1. Place the Vehicle in the Maintenance Shop.
2. Set the Master Controller Handle to FSB position.
3. Make sure that all Parking Brakes are applied (by checking on the IDU "Parking Brake A and B Not Released" and on Indicator Panel "A" "Park / Friction Brake" ON).
4. Remove Electrical Power from Vehicle by lowering the Pantograph.
5. Turn the Transfer Switch to OFF.
6. Attach a tag with the person's name who removed power.

**NOTE** The tag must indicate the name of the person who removed Power.

That person knows why the Power was removed and when it safe to restore it.

Only the individual whose name appears on the tag or a person with his approval should remove the tag and restore Power.

**CAUTION** :SWITCH OFF THE 3F01 CB (BATTERY BOX) BEFORE STARTING TO PERFORM THE REPLACEMENT OF ANY CB LISTED IN THE PREVIOUS TABLE 1.

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**4/10**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**CIRCUIT BREAKER TYPE S280**

Man Hours:

**0.5**

Maintenance Task:

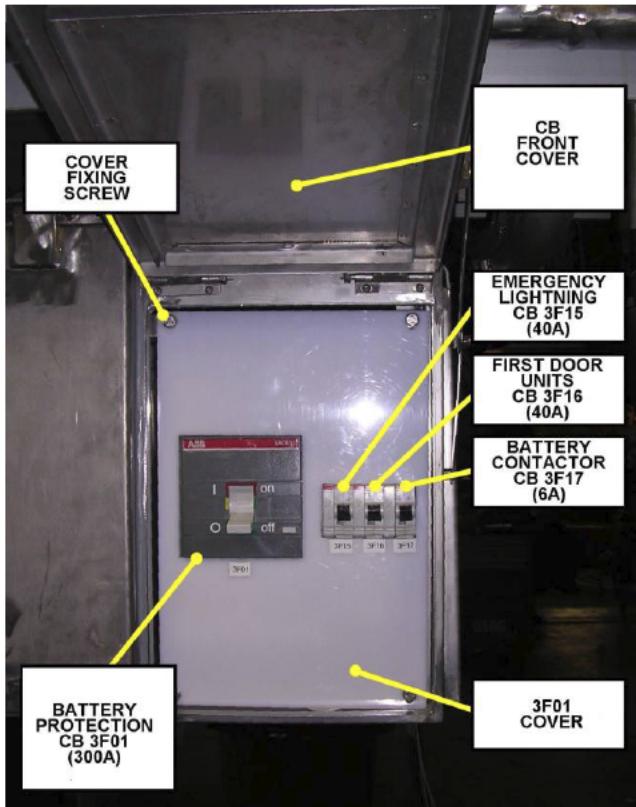
**REPLACEMENT (TYPICAL)**

### PROCEDURE (CONT'D): (Refer to Figures 1 through 7)

#### REMOVAL

To perform the Task proceed as follows:

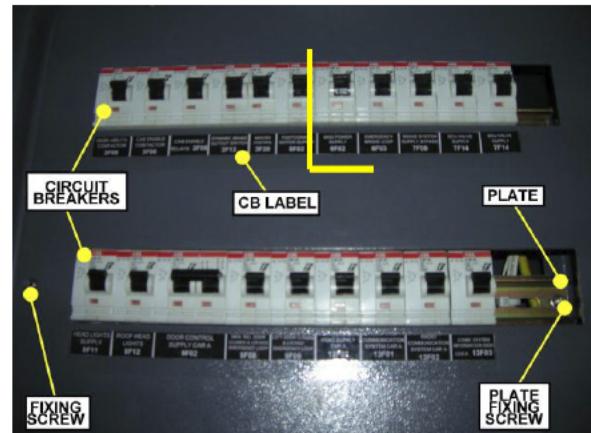
1. Locate the Circuit Breaker to be replaced according to the Label identification and the Location provided in the previous Table 1.



**FIG 1 BATTERY BOX LV CB 3F01 LOCATION**



**FIG 2 "A" LV LOCKER CB PANEL**



**FIG 3 CAB LV CB PANEL**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**5/10**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

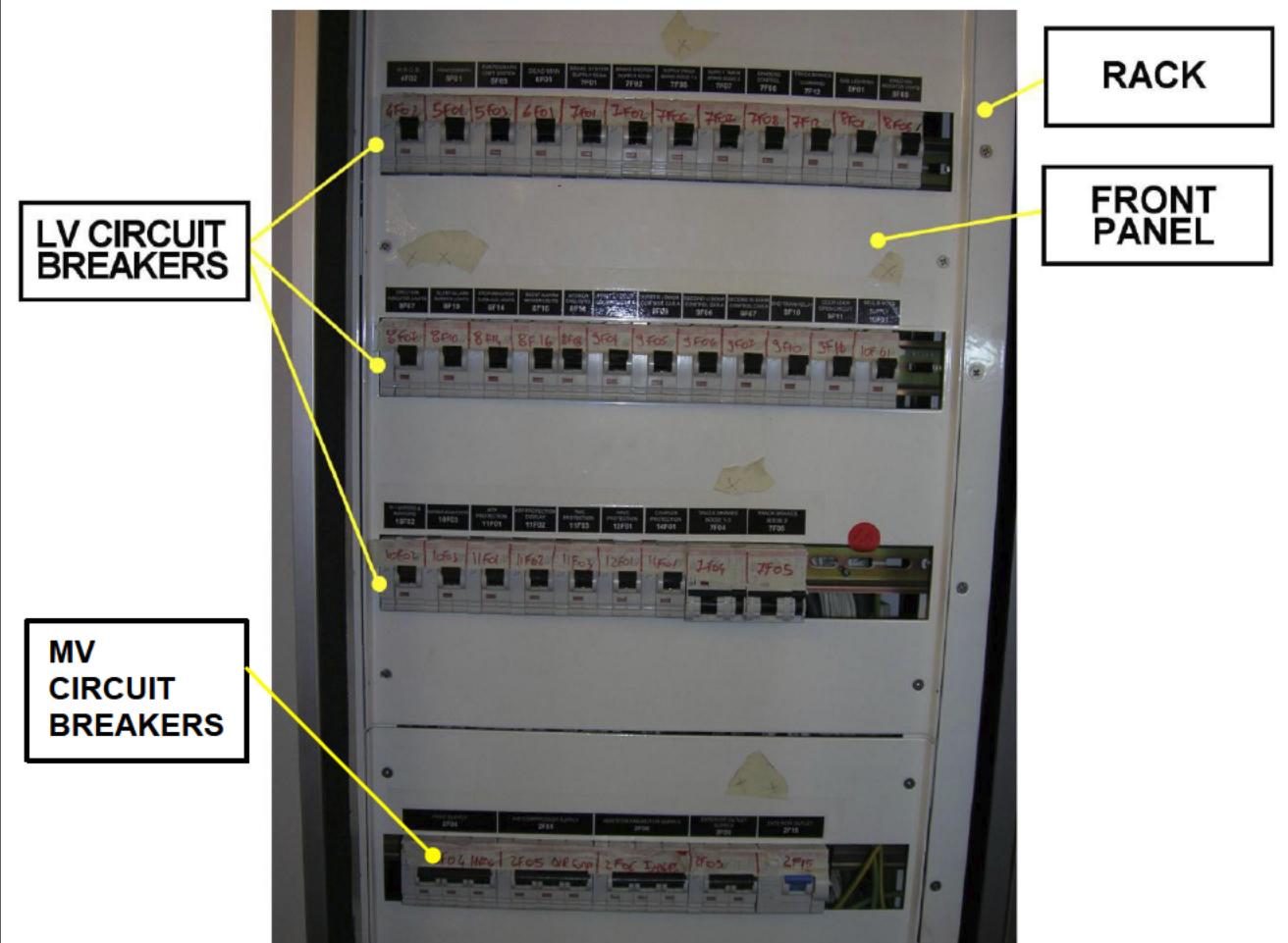
Component:

**CIRCUIT BREAKER TYPE S280**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)****PROCEDURE (CONT'D):****FIG 4 CAB****LV LOCKER LV & MV CB RACK RACKS**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**6/10**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**CIRCUIT BREAKER TYPE S280**

Man Hours:

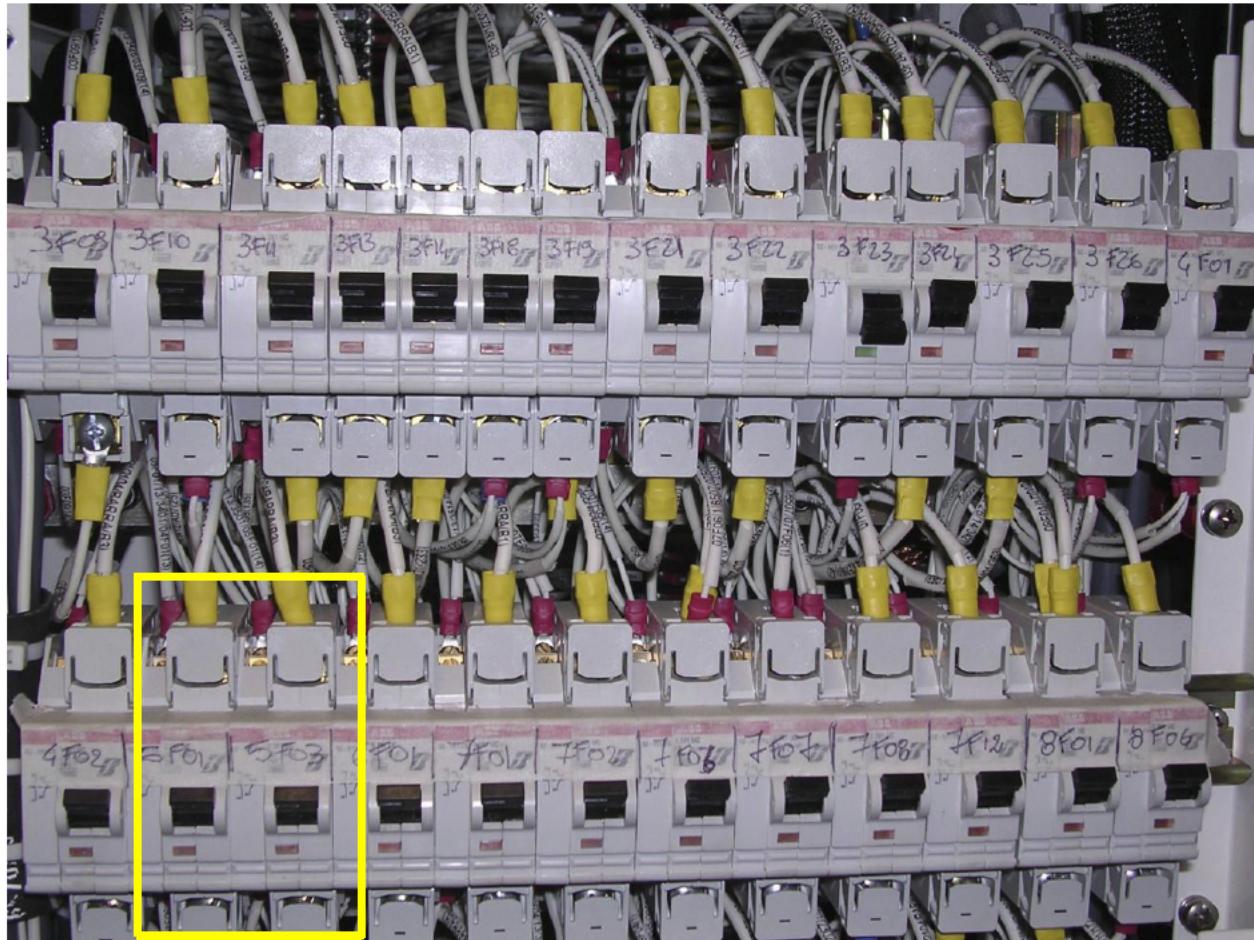
**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### PROCEDURE (CONT'D):

2. Remove the Circuit Breaker Front Panel by loosening the relevant Fixing Screws.  
Retain them for later use.



**FIG 5 LV CB CONNECTIONS (TYPICAL)**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**7/10**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**CIRCUIT BREAKER TYPE S280**

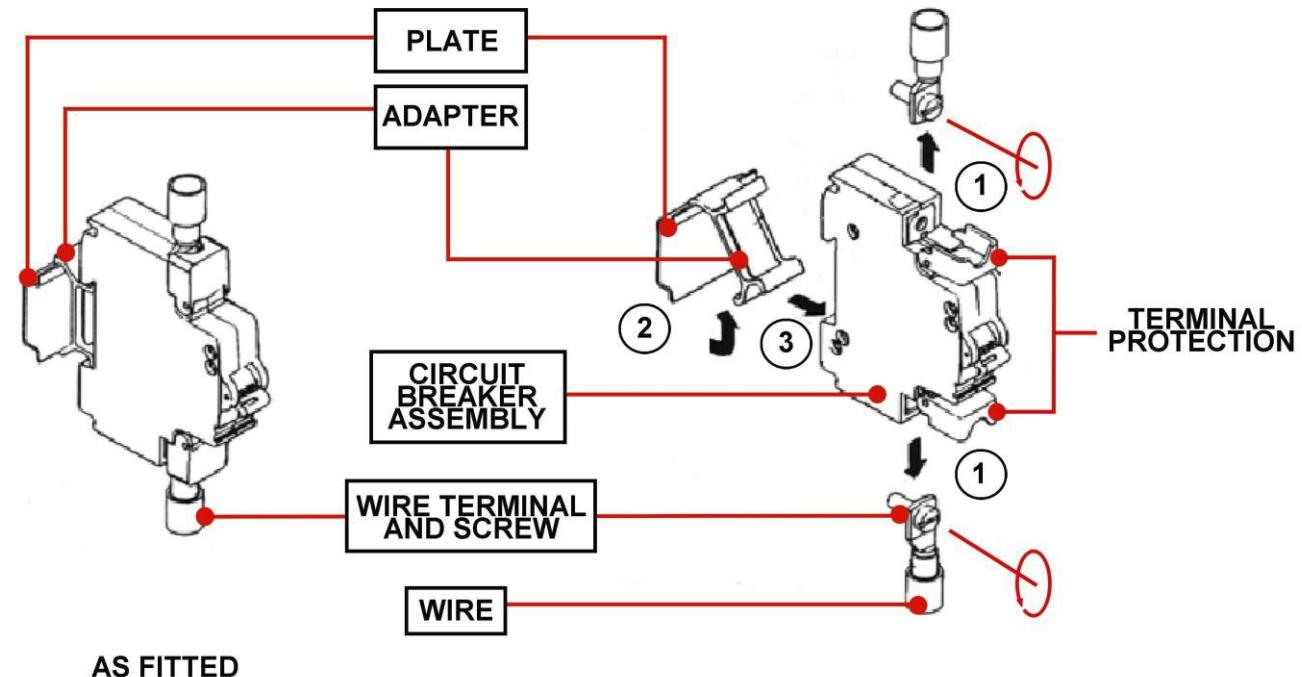
Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)****PROCEDURE(CONT'D):**

3. Remove and discard the Circuit Breaker according to the Instructions provided in the following Figure 6



**FIGURE 6 -CIRCUIT BREAKER REMOVAL**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**8/10**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**CIRCUIT BREAKER TYPE S280**

Man Hours:

**0.5**

Maintenance Task:

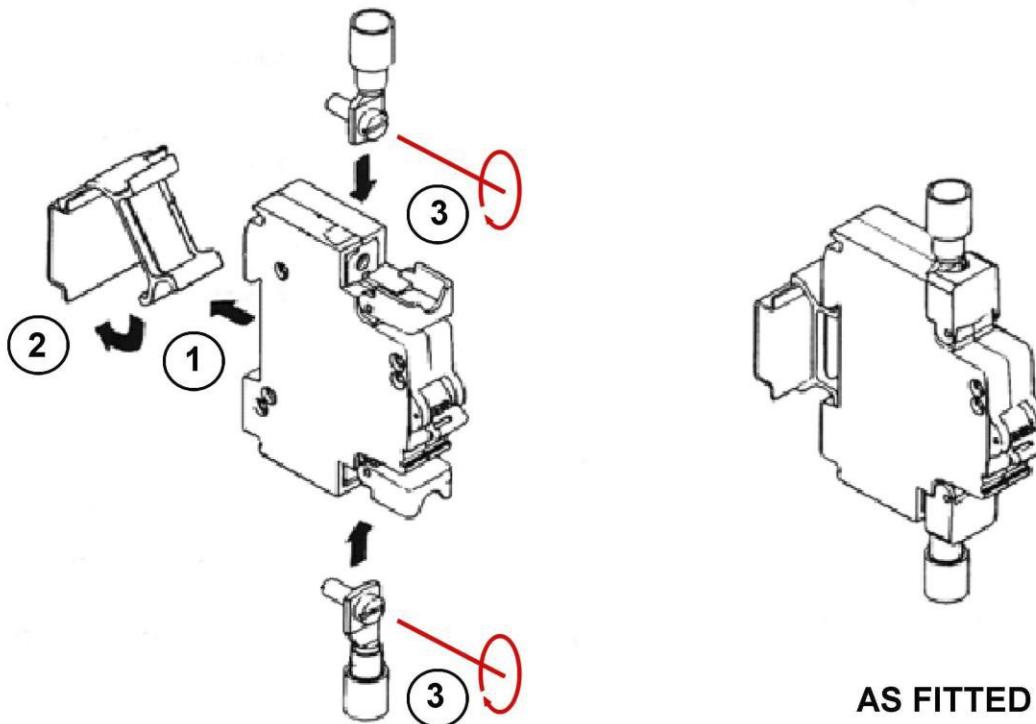
**REPLACEMENT (TYPICAL)**

### **PROCEDURE (CONT'D):**

#### **INSTALLATION**

To perform the Task proceed as follows:

1. Clean the Circuit Breaker Seat using recommended Cleaner / Agent and lint-free rags.
2. Check CB Plate for installation / missing / loosen Hardware. Torque, as per check result, at **15.2 ft-lb.**
3. Check Wires and Wire Terminals for signs of overheating.
4. Install the "new" Circuit Breaker according to the instructions provided in the following figure 7.



**FIGURE 7 -CIRCUIT BREAKER INSTALLATION**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**9/10**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**CIRCUIT BREAKER TYPE S280**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### PROCEDURE (CONT'D):

5. Torque the Wires Terminals Screws according to the following Torque Values:

#### MAIN CONTACTS    AUX CONTACTS

<b>SCREW</b>	<b>M5</b>	<b>M3</b>
<b>TORQUE</b>	<b>5 ft-*lb</b>	<b>4 ft-*lb</b>

6. Install the Circuit Breakers Front Panel and secure it by installing and tightening the relevant Fixing Screws.  
 7. Switch on the "new" installed CB.  
 8. Restore Electrical Power.

### FINAL OPERATIONS

Record Task Results on the Defect Report Card for administrative and maintenance planning.

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the replaced Equipment pertains.

Refer to **HOW TO USE THE R-CM SHEETS** (para 08-III-04-01-02 of this Section) and follow the prescriptions provided at Step 3 "**At every Task Completion.**"

**P2550 CORRECTIVE MAINTENANCE SHEET**

Card Code:

**R-C-08-00-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**10/10**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**CIRCUIT BREAKER TYPE S280**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)****INTENTIONALLY  
LEFT BLANK**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-01**

System:

**PANTOGRAPH**

Sheet:

**1/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**MAIN CONTACTOR**

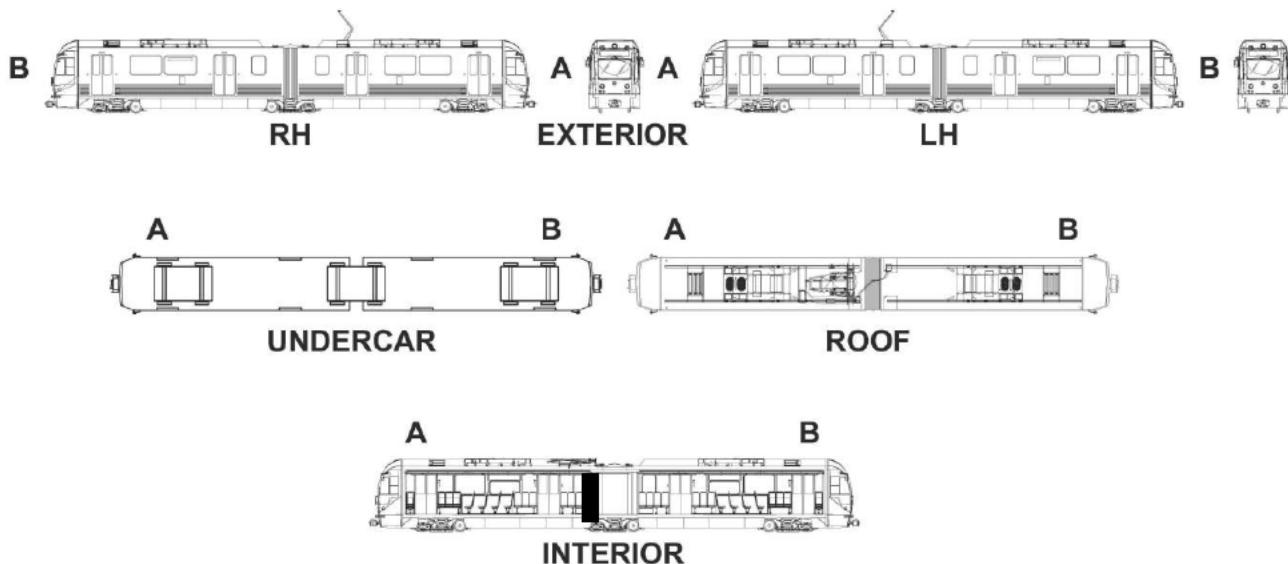
Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### LOCATION:



### APPLICABILITY

This Replacement procedure is applicable to the following Items:

**TABLE 1 CONTACTORS IDENTIFICATION & LOCATIONS**

LABEL	DESCRIPTION	TYPE	P/N	CAR	LOCATION	FUNCTIONAL DIAGRAMS	
						SCHEMATICS	SHEET#
5K01	PANTOGRAPH UP CONTACTOR	ICM211AA	211VK01555B02	A	LV LOCKER	LV	49
5K02	PANTOGRAPH DOWN CONTACTOR	ICM211AA	211VK01555B02	A	LV LOCKER	LV	49

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-01**

System:

**PANTOGRAPH**

Sheet:

**2/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**MAIN CONTACTOR**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### **SAFETY PRECAUTIONS:**

LACMTA Maintenance Shop Safety Rules & Regulations

**CAUTION :**SWITCH OFF THE 3F01 CB (BATTERY BOX) BEFORE STARTING TO PERFORM THE REPLACEMENT OF ANY CONTACTOR LISTED IN THE PREVIOUS TABLE 1

### **TOOLS:**

LACMTA Standard Tools Kit

### **CONSUMABLES:**

CRC 2000 Contact Cleaner

### **SPARE PARTS:**

Refer to Table 1 Contactors Identification & Locations

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-01**

System:

**PANTOGRAPH**

Sheet:

**3/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**MAIN CONTACTOR**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### PROCEDURE:

#### PRELIMINARY OPERATIONS

Set the Vehicle in safety conditions in accordance with LACMTA Maintenance Shop Regulations:

1. Place the Vehicle in the Maintenance Shop.
2. Set the Master Controller Handle to FSB position.
3. Make sure that all Parking Brakes are applied (by checking on the IDU "Parking Brake A and B Not Released" and on Indicator Panel "A" "Park / Friction Brake" ON).
4. Remove Electrical Power from Vehicle by lowering the Pantograph.
5. Turn the Transfer Switch to OFF.
6. Set the Pantograph Control Motor Switch (5F02 CB LV Locker "A" Section) to OFF.
7. Attach a tag with the person's name who removed power.

**NOTE** The tag must indicate the name of the person who removed Power.

That person knows why the Power was removed and when it safe to restore it.

Only the individual whose name appears on the tag or a person with his approval should remove the tag and restore Power.

**CAUTION** :SWITCH OFF THE 3F01 CB (BATTERY BOX) BEFORE STARTING TO PERFORM THE REPLACEMENT OF ANY CONTACTOR LISTED IN THE PREVIOUS TABLE 1.

### REMOVAL

To perform the Task proceed as follows:

1. Gain access to the Contactor to be replaced by opening the "A" LV Locker Door.

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-01**

System:

**PANTOGRAPH**

Sheet:

**4/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**MAIN CONTACTOR**

Man Hours:

**0.5**

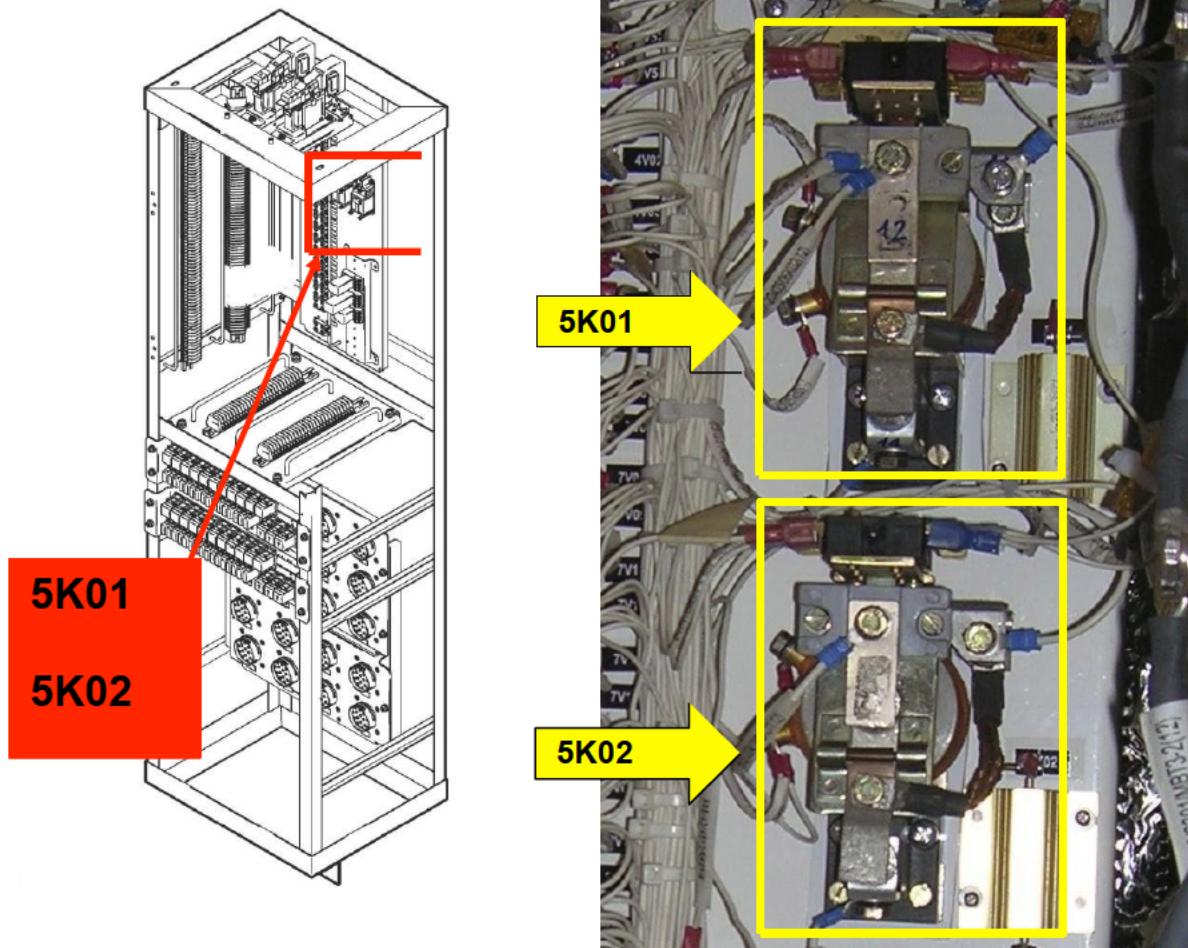
Maintenance Task:

**REPLACEMENT (TYPICAL)**

### PROCEDURE (CONT'D):

#### REMOVAL

2. Locate the Contactor to be replaced



**FIG 1 "A" LV LOCKER  
5K01-5K02 CONTACTORS LOCATION**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-01**

System:

**PANTOGRAPH**

Sheet:

**5/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**MAIN CONTACTOR**

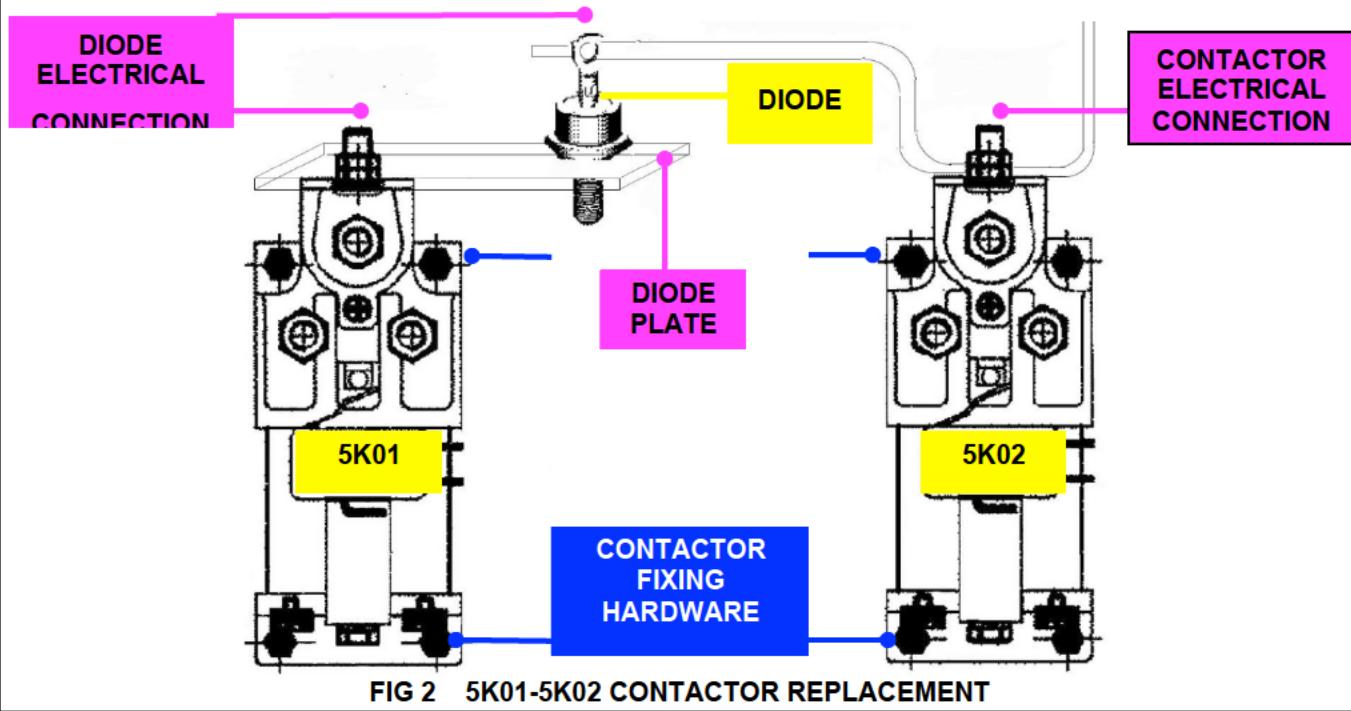
Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)****PROCEDURE: (CONT'D):**

4. To remove the 5K01 Contactor proceed as follows:
  - a. Disconnect the Electrical Connections from Diode and from the Contactor, paying attention to not damage the Plate supporting the Diode and the Diode itself.( do not remove the Diode from its Plate).
  - b. Retain the Electrical Connections Fixing Hardware for later use.
  - c. Loose and remove the Contactor Fixing Self Locking Nuts & Washers.
  - d. Retain them for later use.
  - e. Remove the 5K01Contactor.
5. To remove the 5K02 Contactor proceed as follows:
  - a. Disconnect the Diode and the Contactor Electrical Connections.
  - b. Retain the Electrical Connections Fixing Hardware for later use.
  - c. Loose and remove the Contactor Fixing Self Locking Nuts & Washers.
  - d. Retain them for later use.
  - e. Remove the 5K02 Contactor.



## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-01**

System:

**PANTOGRAPH**

Sheet:

**6/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**MAIN CONTACTOR**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)****PROCEDURE (CONT'D):****INSTALLATION**

1. To install the 5K01 Contactor proceed as follows
  - a. Clean the Contactor Seat using recommended Cleaner / Agent and lint-free rags.
  - b. Check Diode Plate , Wires and Wire Terminals for signs of overheating.
  - c. Install the Contactor in its position.
  - d. Install the Contactor attaching Washers and Self Locking Nuts. Torque to **4 ft-\*lb**.
  - e. Connect the Electrical Connections to Diode and to the Contactor .Refer to the Functional Schematic Sheet listed in the previous Table 1 for complete Wiring Details.
  - f. Torque the Diode Plate and Wires Screw Terminals to **4 ft-\*lb**.
  - g. Leave the Task area by closing and locking the Lv Locker Door.
  - h. Restore Electrical Power.
  
2. To install the 5K02 Contactor proceed as follows
  - a. Clean the Contactor Seat using recommended Cleaner / Agent and lint-free rags.
  - b. Check Wires and Wire Terminals for signs of overheating.
  - c. Install the Contactor in its position.
  - d. Install the Contactor attaching Washers and Self Locking Nuts. Torque to 4 ft-\*lb
  - e. Connect the Electrical Connections to Diode and to the Contactor .Refer to the Functional Schematic Sheet listed in the previous Table 1 for complete Wiring Details.
  - f. Torque the Wires Screw Terminals to **4 ft-\*lb**.
  - g. Leave the Task area by closing and locking the Lv Locker Door.
  - h. Restore Electrical Power.

**FINAL OPERATIONS**

Record Task Results on the Defect Report Card for administrative and maintenance planning.

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the replaced Equipment pertains.

Refer to **HOW TO USE THE R-CM SHEETS** (para 08-III-04-01-02 of this Section) and follow the prescriptions provided at Step 3 "**At every Task Completion.**"

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-02**

System:

**PANTOGRAPH**

Sheet:

**1/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**SWITCH**

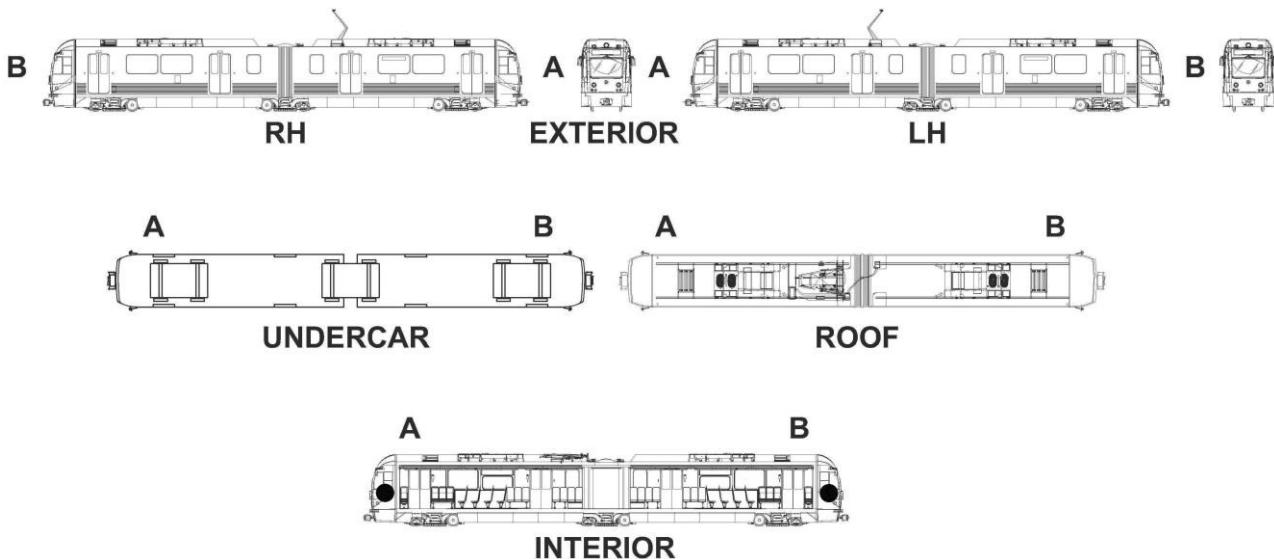
Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### LOCATION:



### APPLICABILITY:

This Replacement procedure is applicable to the following Items:

**TABLE 1 SWITCHES IDENTIFICATION & LOCATIONS**

LABEL	DESCRIPTION	TYPE	P/N	CAR	LOCATION	FUNCTIONAL DIAGRAMS	
						SCHEMATICS	SHEET#
5S01	PANTOGRAPH UP \ DOWN SELECTOR			A - B	CONSOLE	LV	49

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-02**

System:

**PANTOGRAPH**

Sheet:

**2/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**SWITCH**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### **SAFETY PRECAUTIONS:**

LACMTA Maintenance Shop Safety Rules & Regulations

**CAUTION :** SWITCH OFF THE 3F01 CB (BATTERY BOX) BEFORE STARTING TO PERFORM THE REPLACEMENT OF ANY SWITCH LISTED IN THE PREVIOUS TABLE 1.

### **TOOLS:**

LACMTA Maintenance Shop Standard Tools Kit

MULTIMETER (FLUKE 87 V/E) PN 4EB19

### **CONSUMABLES:**

CRC 2000 Contact Cleaner

### **SPARE PARTS:**

Refer to Table 1 Switches Identification & Locations

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-02**

System:

**PANTOGRAPH**

Sheet:

**3/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**SWITCH**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### PROCEDURE:


**FIG 1 CONSOLE**

**5S01**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-02**

System:

**PANTOGRAPH**

Sheet:

**4/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**SWITCH**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT (TYPICAL)**

### **PROCEDURE (CONT'D):**

#### **PRELIMINARY OPERATIONS**

1. Set the Vehicle in safety conditions in accordance with LACMTA Maintenance Shop Regulations:

#### **REPLACEMENT**

To perform the Switch Replacement proceed as follows:

##### **1. Removal**

- a) Gain access to the rear of the Operator Console Panel Assy by unscrewing and removing the relevant attaching hardware (Screws and Washers).
 

**NOTE:** It is advised to retain the attaching Hardware for later use.
- b) On the rear of the Operator Console Panel, locate the Switch Body to be replaced and its Electrical Connections.
- c) Note the Switch Body Wiring Identification Codes.
- d) Disconnect the Switch Body electrical Connections.
- e) Disengage the Switch Assy from its seat.
- f) Remove the Switch Assy by pushing it from the rear toward the front of the Operator Console Panel.

##### **2. Installation**

- a) Install and engage on its seat the Switch Assy to be installed.
- b) Connect the Switch Body Electrical Connections according to the previously noted Wiring Identification Codes (Refer to Figure 2 for Switch Body Wiring Scheme or to LV Functional Schematic, Sheet 49 for complete Wiring Scheme).
- c) Position the Operator Console Panel Assy.
- d) Install and tighten the Operator Console Panel Assy attaching Hardware.
- e) Key on the Vehicle and check that the "new" Switch work properly.

#### **FINAL OPERATIONS**

Record Task Results on the Defect Report Card for administrative and maintenance planning.

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the replaced Equipment pertains.

Refer to **HOW TO USE THE R-CM SHEETS** (para 08-III-04-01-02 of this Section) and follow the prescriptions provided at Step 3 "**At every Task Completion.**"

**P2550 CORRECTIVE MAINTENANCE SHEET**

Card Code:

**R-C-08-00-00-00/R-02**

System:

**PANTOGRAPH**

Sheet:

**5/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

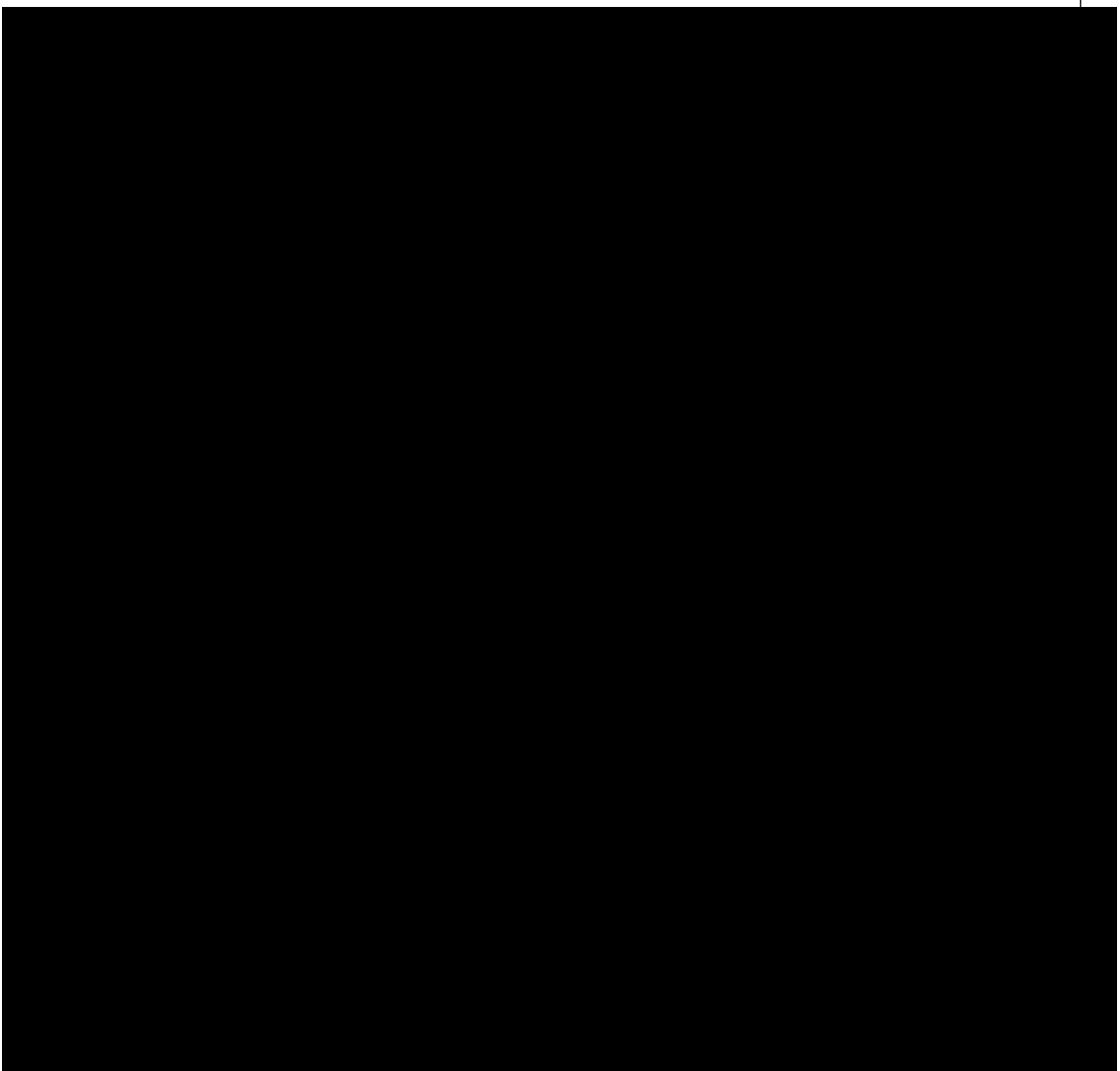
Component:

**SWITCH**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT(TYPICAL)****PROCEDURE (CONT'D):**

**P2550 CORRECTIVE MAINTENANCE SHEET**

Card Code:

**R-C-08-00-00-00/R-02**

System:

**PANTOGRAPH**

Sheet:

**6/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

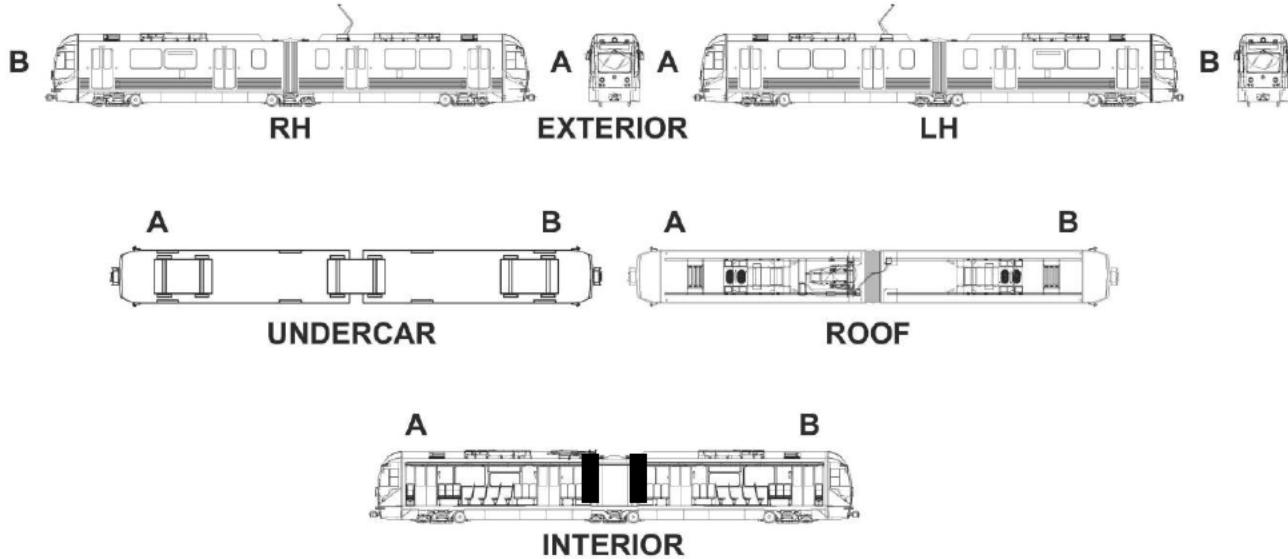
**SWITCH**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT(TYPICAL)****INTENTIONALLY  
LEFT BLANK**

<b>P2550 CORRECTIVE MAINTENANCE SHEET</b>							
Card Code: <b>R-C-08-00-00-00/R-03</b>							
System: <b>PANTOGRAPH</b>				Sheet: <b>1/6</b>			
Subsystem/Assy: <b>PANTOGRAPH ELECTRIC PLANT</b>				Unit:			
Component: <b>DIODE</b>				Man Hours: <b>0.5</b>			
Maintenance Task: <b>REPLACEMENT(TYPICAL)</b>							
<b>LOCATION:</b>							
							
<b>APPLICABILITY:</b>							
This Replacement procedure is applicable to the following Items:							
<b>TABLE 1 DIODES IDENTIFICATION &amp; LOCATIONS</b>							

LABEL	DESCRIPTION	TYPE	P/N	CAR	LOCATION	FUNCTIONAL DIAGRAMS	
						SCHEMATICS	SHEET
5V02	PANTOGRAPH CIRCUIT DIODE	ABB DACOM	211VV01044B	A	LV LOCKER	LV	49
5V03	PANTOGRAPH CIRCUIT DIODE	ABB DACOM	211VV01044B	A - B	LV LOCKER	LV	49
5V04	PANTOGRAPH CIRCUIT DIODE	IXYS RECTIFIER DIODE	DSA 17-16A	A	LV LOCKER	LV	49

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-03**

System:

**PANTOGRAPH**

Sheet:

**2/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**DIODE**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT(TYPICAL)****SAFETY PRECAUTIONS:**

LACMTA Maintenance Shop Safety Rules &amp; Regulations

**CAUTION :**SWITCH OFF THE 3F01 CB (BATTERY BOX) BEFORE STARTING TO PERFORM THE REPLACEMENT OF ANY DIODE LISTED IN THE PREVIOUS TABLE 1.

**TOOLS:**

LACMTA Maintenance Shop Standard Tools Kit

MULTIMETER (FLUKE 87 V/E) PN 4EB19

SOLDERING STATION

**CONSUMABLES:**

CRC 2000 Contact Cleaner

**SPARE PARTS:**

Refer to Table 1 Diodes Identification &amp; Locations

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-03**

System:

**PANTOGRAPH**

Sheet:

**3/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**DIODE**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT(TYPICAL)**

### PROCEDURE:

#### PRELIMINARY OPERATIONS

Set the Vehicle in safety conditions in accordance with LACMTA Maintenance Shop Regulations:

1. Place the Vehicle in the Maintenance Shop.
2. Set the Master Controller Handle to FSB position.
3. Make sure that all Parking Brakes are applied (by checking on the IDU "Parking Brake A and B Not Released" and on Indicator Panel "A" "Park / Friction Brake" ON).
4. Remove Electrical Power from Vehicle by lowering the Pantograph.
5. Turn the Transfer Switch to OFF.
6. Set the Pantograph Control Motor Switch (5F02 CB LV Locker "A" Section) to OFF.
7. Attach a tag with the person's name who removed power.

**NOTE** The tag must indicate the name of the person who removed Power.

That person knows why the Power was removed and when it safe to restore it.

Only the individual whose name appears on the tag or a person with his approval should remove the tag and restore Power.

**CAUTION** :SWITCH OFF THE 3F01 CB (BATTERY BOX) BEFORE STARTING TO PERFORM THE REPLACEMENT OF ANY DIODE LISTED IN THE PREVIOUS TABLE 1.

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-03**

System:

**PANTOGRAPH**

Sheet:

**4/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**DIODE**

Man Hours:

**0.5**

Maintenance Task:

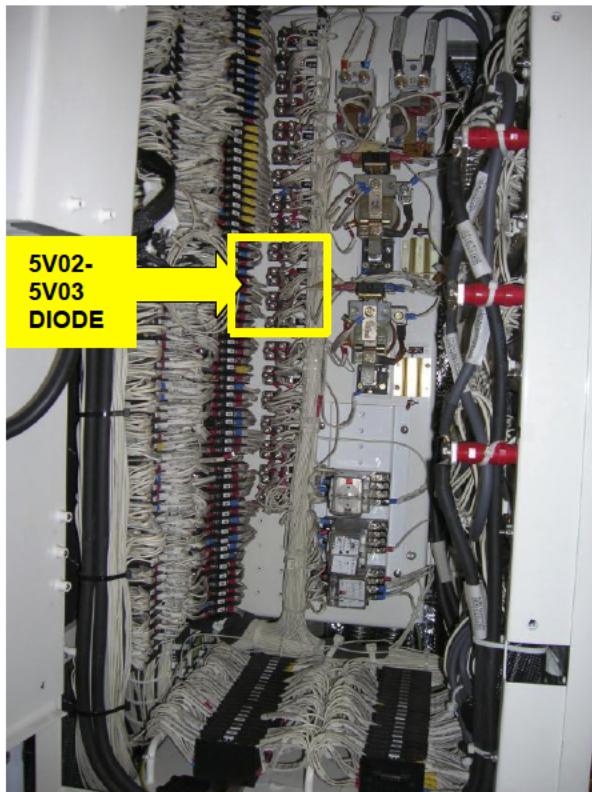
**REPLACEMENT(TYPICAL)**

### PROCEDURE (CONT'D):

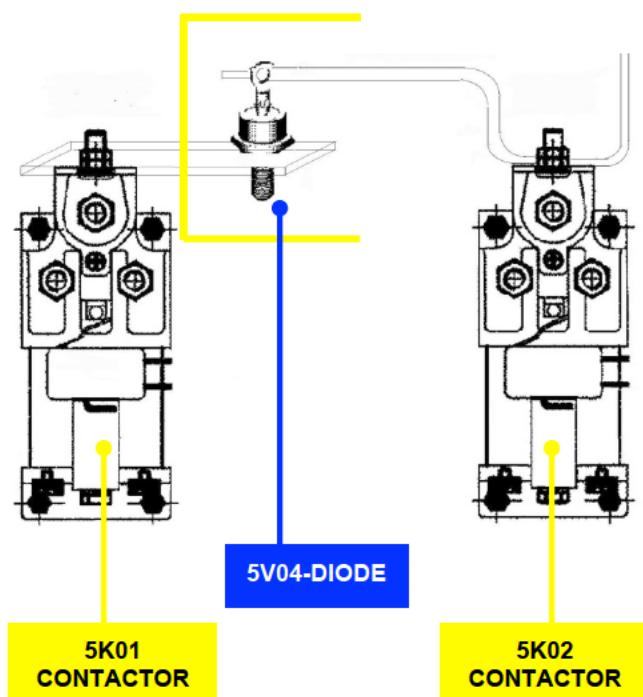
To perform the Task proceed as follows:

#### **REMOVAL** (refer to Figures 1 & 2)

1. Gain access to the Diodes Section on the side of the Rack installed in the "A" & "B" LV Lockers, by opening the relevant LV Locker Door using Maintenance Key.
2. Locate the Diode to be replaced.



**"A" & "B" ELECTRICAL LOCKERS**



**"A" ELECTRICAL LOCKER**

**FIGURE 1 DIODES LOCATION**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-03**

System:

**PANTOGRAPH**

Sheet:

**5/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**DIODE**

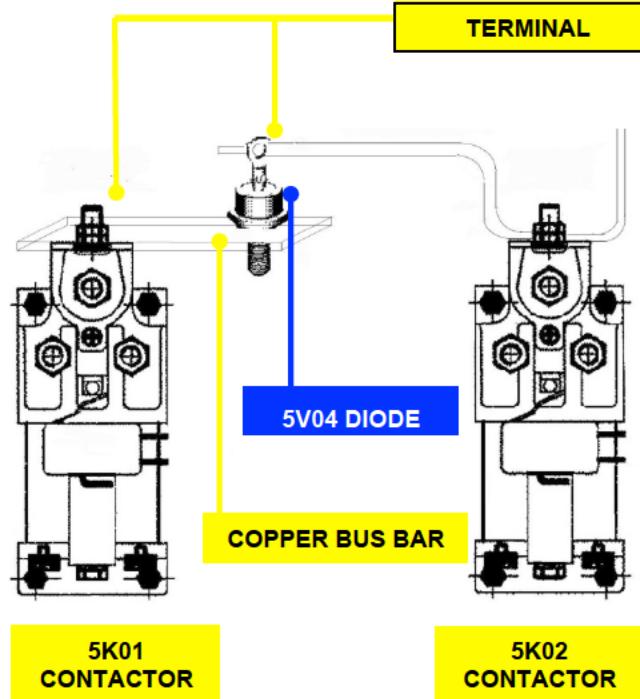
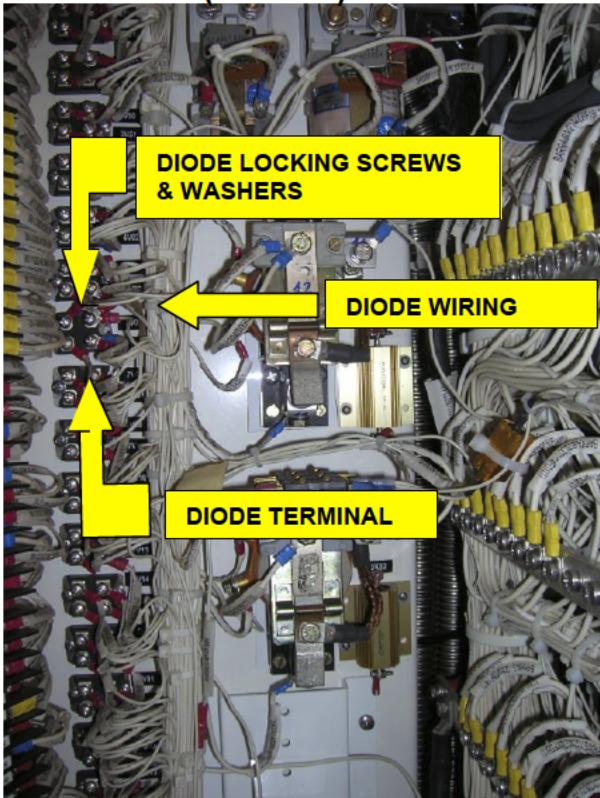
Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT(TYPICAL)**

### PROCEDURE (CONT'D):

**5V02 & 5V03 DIODES****5V04 DIODE**

### FIGURE 2 DIODES REPLACEMENT

- 3 To remove the 5V02 or 5V03 Diode proceed as follows:
- Take note of Wiring Color Codes and relevant positions on Diode Terminals.
  - Disconnect the Wiring from Diode Terminals by loosening and removing the relevant Screws on 4 Diode Terminals. Retain them for later use.
  - Loose and remove the Diode Locking Screws & Washers. Retain them for later use.
  - Remove the Diode and discard it.

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-00-00-00/R-03**

System:

**PANTOGRAPH**

Sheet:

**6/6**

Subsystem/Assy:

**PANTOGRAPH ELECTRIC PLANT**

Unit:

Component:

**DIODE**

Man Hours:

**0.5**

Maintenance Task:

**REPLACEMENT(TYPICAL)**

### PROCEDURE (CONT'D):

- 4** To remove the 5V04 Diode proceed as follows:
- Disconnect the Copper Bus Bar from 5K01 Contactor Terminal.
  - Disconnect the Diode Terminal from 5K02 Contactor Wire by means of soldering station.
  - Retain the fixing hardware for later use.
  - Discard the 5V04 Diode Kit consisting of the items shown in Fig 3.

**FIGURE 3 - 5V04 DIODE KIT**

### INSTALLATION

- 1** To install the 5V04 Diode proceed as follows:
- Clean both the Contactor Terminals using recommended Cleaner / Agent and lint-free rags
  - Use a new 5V04 Diode Kit
  - Connect the Copper Bus Bar to 5K01 Contactor Terminal
  - Connect the Diode Wire to 5K02 Contactor Terminal
  - Torque the Screw Terminals to **4 ft-\*lb**
  - Restore Electrical power
- 2** To install the 5V02 or 5V03 Diode proceed as follows:
- Install the Diode in position.
  - Install Diode Locking Screws & Washers. Tighten as required.
  - Connect the Wiring to the Diode Terminals according to their position and Color Codes previously noted. Tighten as required.
  - Leave the LV Locker and close the LV locker Door using Maintenance Key
  - Restore Electrical Power.

### FINAL OPERATIONS

Record Task Results on the Defect Report Card for administrative and maintenance planning.

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the replaced Equipment pertains.

Refer to **HOW TO USE THE R-CM SHEETS** (para 08-III-04-01-02 of this Section) and follow the prescriptions provided at Step 3 "**At every Task Completion.**"

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**1/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

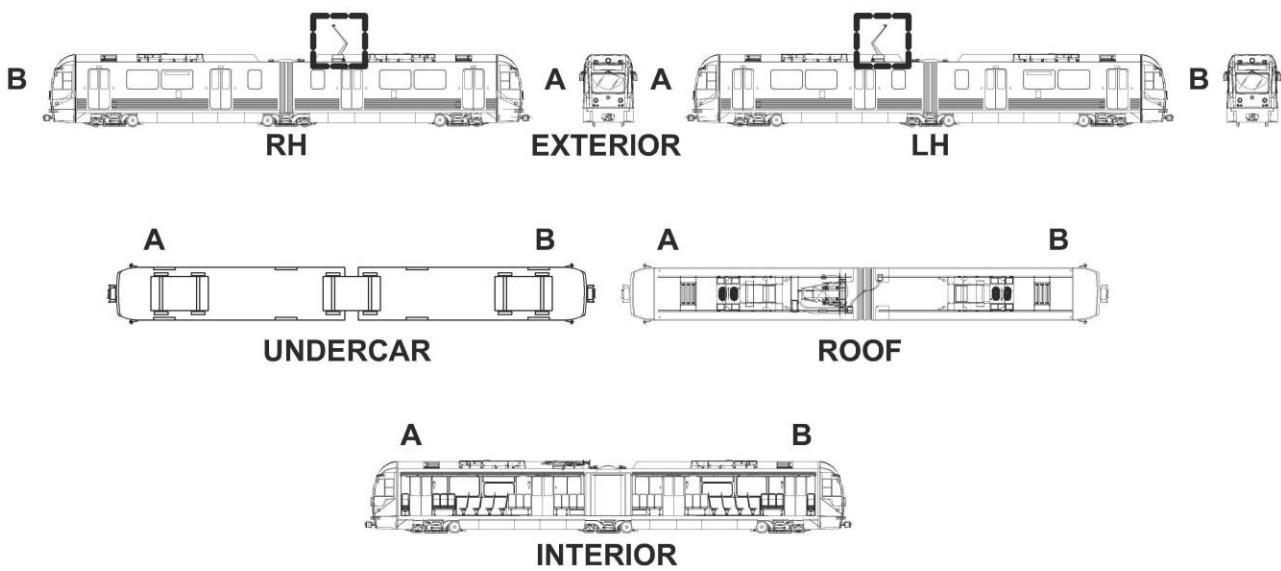
**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****LOCATION:**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**2/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****SAFETY PRECAUTIONS:**

**WARNING:** SHEET R-C-08-00-00-00/SP-00 PROVIDES STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.

THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.

THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.

USE EXTREME CARE WHEN REMOVING THE SAFETY PIN.

THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.

REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.

**CAUTION** LIFT PANTOGRAPH ONLY BY FOUR LIFTING LUGS ON BASE FRAME TO AVOID DAMAGING UNIT.

**CAUTION** DO NOT USE IMPACT WRENCH ON STAINLESS STEEL FASTENERS. STAINLESS STEEL TENDS TO SEIZE DURING ASSEMBLY PROCESS IF IMPACT WRENCH IS USED.

**CAUTION** IF ELECTRICAL LOWERING DEVICE WAS REPLACED, S3 AND S4 MUST BE ADJUSTED PER NOTE BELOW BEFORE OPERATING PANTOGRAPH WITH LRV CONTROL SYSTEM. IF S3 AND S4 ARE NOT ADJUSTED CORRECTLY, THE MOTOR CAN NOT SHUT OFF AND/OR THE INTERNAL CLUTCH CAN SLIP AND DAMAGE ELECTRICAL LOWERING DEVICE. DISCONNECT POWER SOURCE IMMEDIATELY IF THIS HAPPENS AND CHECK ADJUSTMENTS.

**TOOLS:**

LACMTA Maintenance Shop Standard Tools Kit

Schunk KM 11 Gauge or Spring Scale

Spanner Wrench P/N 351-05990

**CONSUMABLES:**

NOALOX Electrical Contact Grease or equivalent used by MTA

**SPARE PARTS:**

PANTOGRAPH ASSY P/N AA03D22 MFR P/N 1-11320.8309

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**3/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****PROCEDURE:****PRELIMINARY OPERATIONS**

1. Set the Vehicle in safety condition in accordance with LACMTA Maintenance Shop Regulations
2. Follow the Safety Precautions according to Sheet R-C-08-00-00-00/SP-00
3. Access Vehicle Roof according to MTA procedures.

**REPLACEMENT**(Refer to Figure 1)**1. REMOVAL**

**WARNING DANGER OF PERSONAL INJURY EXISTS DUE TO HEAVY WEIGHT.  
PANTOGRAPH ASSY WEIGHS APPROXIMATELY 523 LBS (237 KG). USE  
APPROVED LIFTING DEVICE. DO NOT STAND UNDERNEATH PANTOGRAPH  
DURING LOWERING OR TRANSPORTING.  
SOME SUBASSEMBLIES ARE HEAVY AND REQUIRE USE OF OVERHEAD  
CRANE AND LIFTING HARNESS DURING DISASSEMBLY PROCESS. CARE  
MUST BE USED TO PREVENT PERSONAL INJURY.**

- a. Lower Pantograph to resting position.
- b. Turn off or disconnect any Auxiliary Power Source to Vehicle.
- c. Prepare a pallet (or similar work surface) for the Pantograph Assembly to be placed on when removed.
- d. Remove attaching parts from Roof Adaptor (3).
- e. Remove Roof Adaptor (3) from Vehicle Structure.
- f. Secure Roof Adaptor (3) and attached Flexible Cable to Base Frame (4) with Ty-Wraps.
- g. Locate, tag and disconnect Grounding Wires to Pantograph as applicable.
- h. Disconnect Plug of Cable Conduit from Electric Lowering Device (5) at Vehicle Interface.
- i. Tag and disconnect the Vehicle Main Power Cables from the three Contact Plates on Base Frame (4).

**CAUTION LIFT PANTOGRAPH ONLY BY FOUR LIFTING LUGS ON BASE  
FRAME TO AVOID DAMAGING UNIT.**

- j. Secure an approved Lifting Harness of suitable capacity to the four Lifting Lugs (6) on the Base Frame.
- k. Connect the Lifting Harness to an Overhead Crane.
- l. Gradually remove slack in Lifting Harness until Pantograph Assembly is supported by the Crane.
- m. Remove attaching parts at four Roof Mounting Brackets (7).
- n. Lift Pantograph off Roof of Vehicle and lower to pallet.

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**4/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

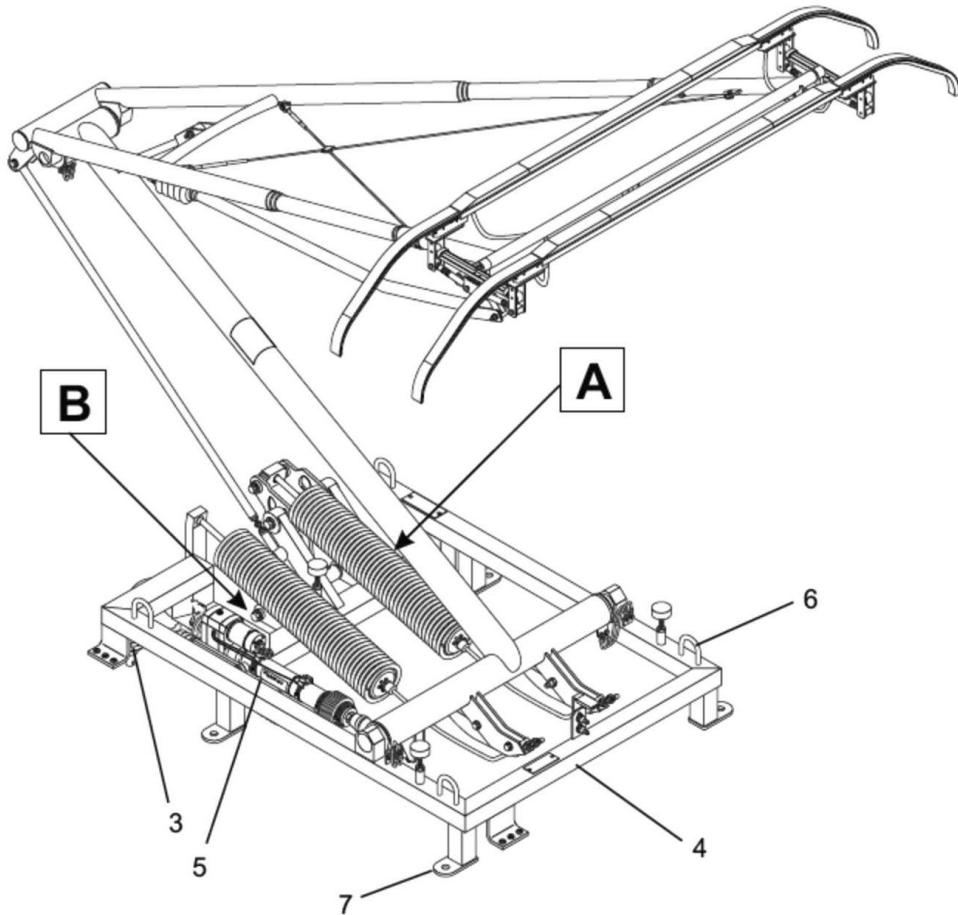
**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****PROCEDURE (CONT'D):**

**FIGURE 1 - PANTOGRAPH ASSY**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**5/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT**

### PROCEDURE (CONT'D):

#### 2. INSTALLATION

**WARNING DANGER OF PERSONAL INJURY EXISTS DUE TO HEAVY WEIGHT.  
PANTOGRAPH WEIGHS APPROXIMATELY 523 LBS. (237 KG). USE APPROPRIATE LIFTING DEVICE. DO NOT STAND UNDERNEATH PANTOGRAPH DURING LOWERING OR TRANSPORTING.  
DANGER OF PERSONAL INJURY EXISTS DUE TO ACCIDENTAL COLLAPSE OF PANTOGRAPH AFTER REASSEMBLY AND DURING ADJUSTMENTS. INSTALL SAFETY PIN PER ASSEMBLY PROCEDURE AND KEEP SAFETY PIN INSTALLED UNTIL PANTOGRAPH IS READY TO PLACE IN SERVICE.**

**CAUTION** DO NOT USE IMPACT WRENCH ON STAINLESS STEEL FASTENERS.  
STAINLESS STEEL TENDS TO SEIZE DURING ASSEMBLY PROCESS IF IMPACT WRENCH IS USED.

- a. Ensure that any Auxiliary Power Source to Vehicle is turned off
- CAUTION** LIFT PANTOGRAPH ONLY BY FOUR LIFTING LUGS ON BASE FRAME TO AVOID DAMAGING UNIT.
- b. Secure an approved Lifting Harness of suitable capacity to the four Lifting Lugs (6) on the Base Frame.
  - c. Connect the Lifting Harness to an Overhead Crane.
  - d. Gradually remove slack in Lifting Harness until Pantograph Assembly is supported by the Crane.
  - e. Lift Pantograph on the Roof of Vehicle and lower to mounting position.
  - f. Attach mounting Brackets (7) to Roof using relevant attaching parts.
  - g. Remove temporary Bindings from Roof Adaptor (3).
  - h. Orient Flexible Tube of Electrical Lowering Device (5) so Internal Flexible Cable will not bind.
  - i. Install Roof Adaptor (3) in to Roof Structure.
  - j. Attach Roof Adaptor with relevant attaching parts.
  - k. Locate and connect Grounding Wires per tags to Pantograph as applicable.
  - l. Connect Plug of Cable Conduit from Electric Lowering Device (5) at Vehicle Interface.
  - m. Connect the Vehicle Main Power Cables to the three Contact Plates on Base Frame (4).
  - n. Apply NOALOX electrical contact grease on mating surfaces.
  - o. Perform the following Adjustments /Checks & Tests (refer to next Steps 3 & 4)
    - Contact Force
    - Turning Capacity of the Pan Head
    - Electrical Lowering Device Proximity Switches
    - Resting Position of Pantograph
    - Parallelism of Carbon Strips
    - Diagonal Cables

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**6/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****PROCEDURE (CONT'D):****3 ADJUSTMENTS****a. ADJUSTMENT OF CONTACT FORCE (Refer to Figure 2)**

The contact force of the pantograph, in its entire range of operation, is an important parameter that has a direct effect on life of carbon strips and, in particular, the Catenary. The Schunk KM 11 Gauge is designed to measure static force of pantographs, recording the upward force over the whole raising height during both raising and lowering of the pantograph. The KM 11 Gauge can be used either stationary or as a mobile unit.

A spring scale can be used, but gives much less accurate readings.

**NOTE:** Adjustments to Coupling Rod directly affect Contact Force. Coupling Rod should generally not require adjustment once it is set.

**NOTE:** Before checking or adjusting the Contact Force, disconnect one end of the Hydraulic Oscillation Damper. In dynamic motion, the Hydraulic Oscillation Damper causes an increase in Contact Force. Contact Force is a static measurement taken through a continuous motion.

- 1) Loosen M10 Jam Nuts (2 and 3).
- 2) Adjust Coupling Rod Turnbuckle (4) so that Upper Frame (5) contacts two Bumpers (6) and Lower Frame (7) contacts Bumper (8) simultaneously. It may be necessary to adjust Bumpers. Tighten M10 jam nuts (1 and 2).

- NOTE** Base Frame (9), Lower Frame (7), and Upper Frame (5) should be fairly level to each other.
- 3) Using Schunk KM 11 Gauge or Spring Scale, check and record Contact Force through its entire range. Nominal Contact Force should be **20.9 lbs (93 N)**. ( $\pm 10\%$ ).
  - 4) If values are out of tolerance in lower range, loosen two M10 Jam Nuts (10) and turn M10 Adjustment Bolts (11) clockwise to increase or counterclockwise to decrease Contact Force. Make sure to adjust M10 Bolts (11) equally. Tighten M10 jam Nuts (10) when complete.
  - 5) If values remain out of tolerance after completing step 6, adjust length of Coupling Rod by readjusting Turnbuckle (4). Shortening Coupling Rod increases Contact Force. Lengthening Coupling Rod decreases Contact Force. Tighten M10 Jam Nuts (2 and 3) when complete.
  - 6) Using Schunk KM 11 Gauge or Spring Scale, check and record Contact Force through its entire range. Repeat steps 6 and/or 7 again as required.

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**7/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****PROCEDURE (CONT'D):**

- 7) If necessary, adjust two Raising Springs (12) to achieve Nominal Contact Force per the following steps **a** to **c**:

- a) Loosen M16 jam nut on two threaded rods (13).

**WARNING** DANGER OF PERSONAL INJURY EXISTS DUE TO SPRINGS. AS SPRINGS CONTRACT, FINGERS CAN GET CAUGHT IN COILS. USE SPANNER WRENCH PART NUMBER 351-05990, OR EQUIVALENT, INSERTED IN END CAP TO PREVENT RAISING SPRINGS FROM ROTATING.

**CAUTION** DO NOT USE AN AIR IMPACT GUN TO LOOSEN OR TIGHTEN BOLTS. USE SPANNER WRENCH PN 351-05990, OR EQUIVALENT, TO PREVENT THE RAISING SPRINGS FROM ROTATING.

- b) Using a wrench or air ratchet, turn both Threaded Rods (13) clockwise to increase Contact Force or counterclockwise to decrease Contact Force while using Spanner Wrench 351-05990 to prevent keeping Spring Assembly from turning. Springs should be adjusted to equal lengths.
- c) When proper Nominal Contact Force is achieved, tighten M16 Jam Nuts on threaded Rods (13).

- 8) Reconnect end of Hydraulic Oscillation Damper (1) to Pantograph.

**b. ADJUSTMENT OF TURNING CAPACITY OF THE PAN HEAD** (Refer to Figure 3)

The Pantograph Head must track the OCS gradient over its full working range and at all vehicle speeds. Pan Head movement (Degrees of Freedom) is controlled by the Pan Head Guide.

Pan Head movement should be equal in both directions at mid working height of **65.5 inches** (1664 mm).

Adjust as follows:

- 1) Using a rope, secure the Pantograph at mid height **65.5 inches** (1664 mm).
- 2) Lay a straight edge across the top of the Carbons Strips. Place an Angle Finder on the top straight edge surface.
- 3) Check the degrees of freedom of the Pan-Head in both directions.

If equal, stop procedure and release the Pantograph for service. If not equal, adjust as follows:

- a) Remove M10 Self-Locking Nut (1) to disconnect Pan Head Guide (2) from Lower Frame.
- b) Loosen M10 Hex Nut (3).
- c) Screw Ball Joint (4) in or out to lengthen or shorten the Pan Head Guide as needed.
- d) Reconnect Ball Joint (4) and secure with M10 Self-Locking Nut (1).
- e) Recheck the degrees of freedom of the Pan Head in both directions.
- f.) Re-adjust Ball Joint (4) as needed.
- g) Tighten M10 Hex Nut (3) and when complete.

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**8/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

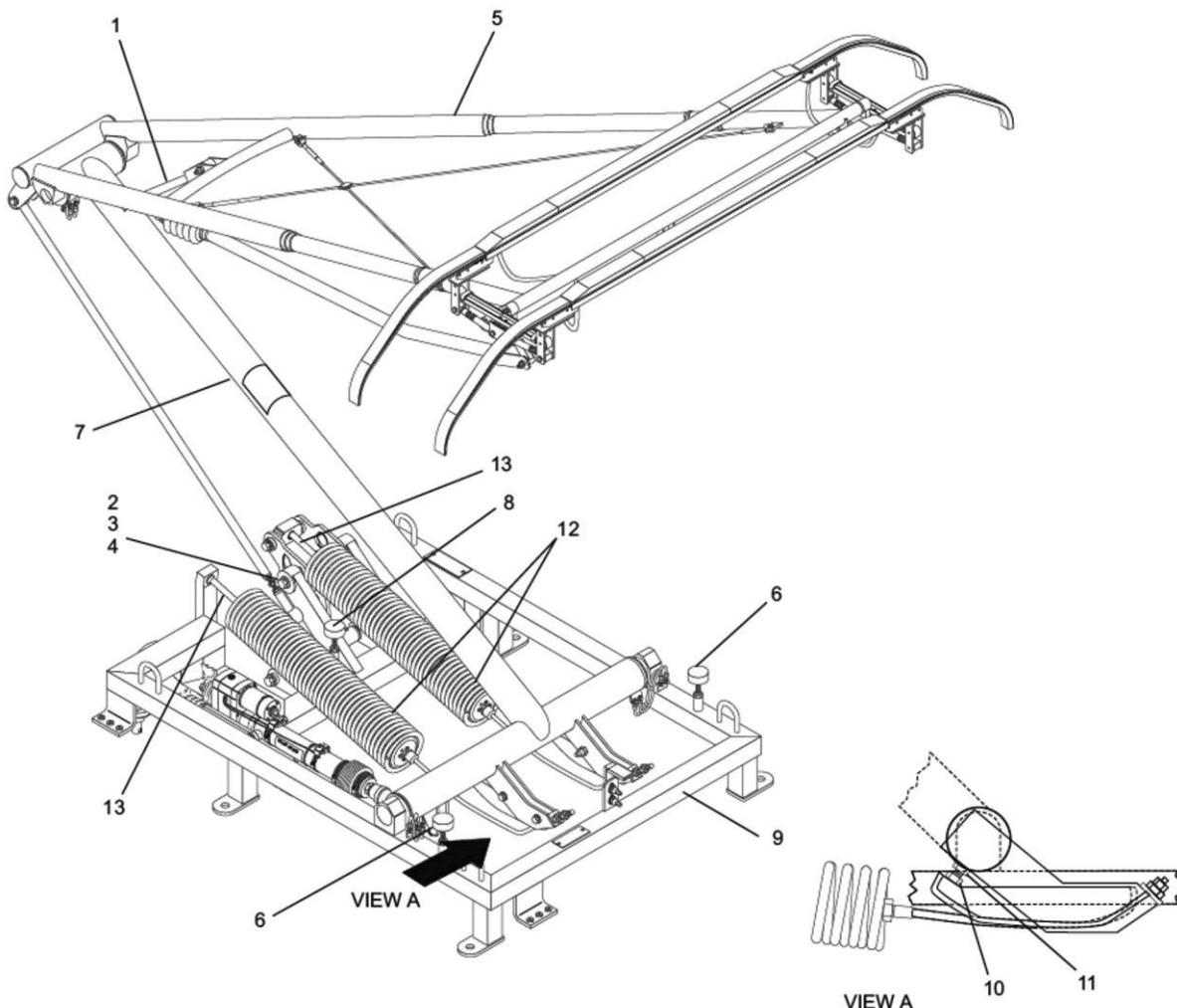
**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****PROCEDURE (CONT'D):**

**FIGURE 2 - CONTACT FORCE ADJUSTMENT**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**9/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

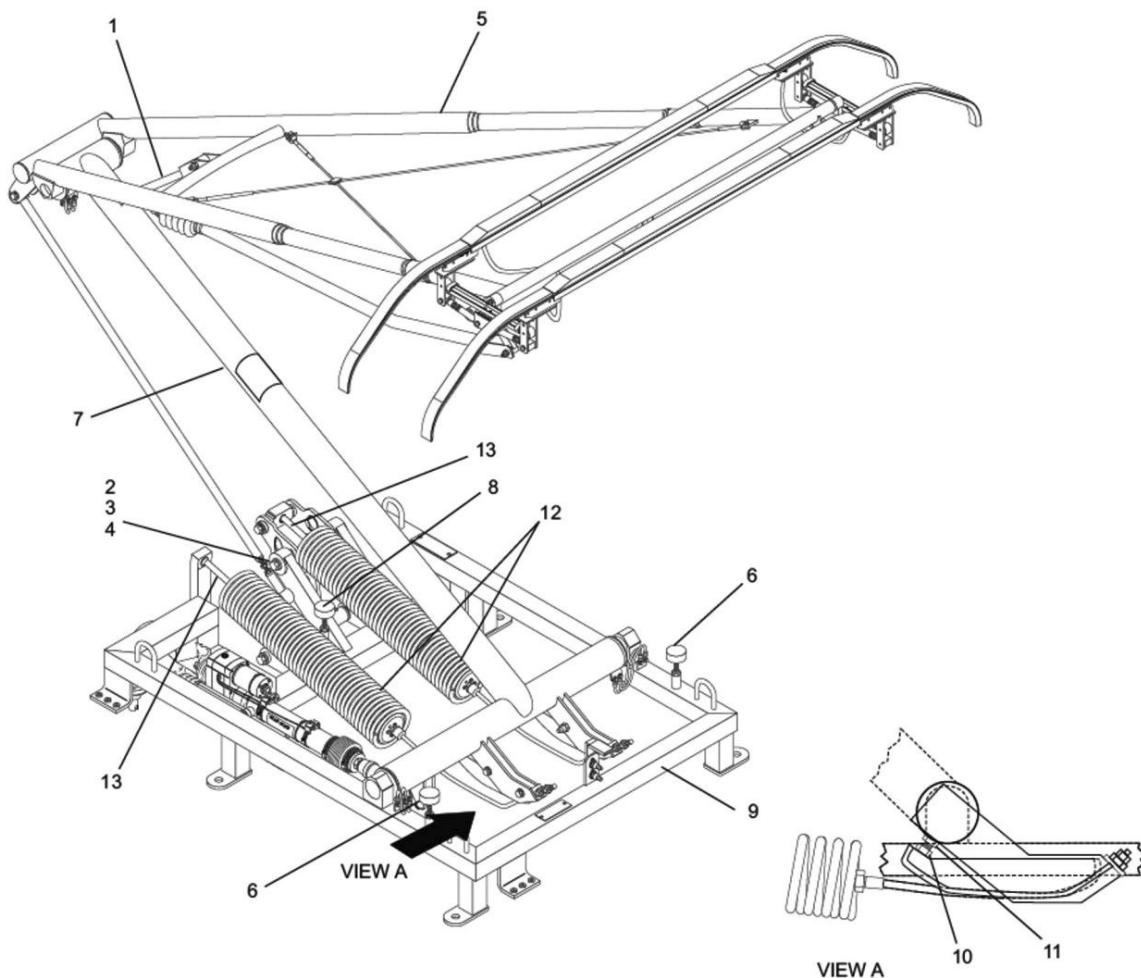
**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****PROCEDURE (CONT'D):**

**FIGURE 3 - TURNING CAPACITY OF PAN HEAD ADJUSTMENT**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**10/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****PROCEDURE(CONT'D):****c. ADJUSTMENT OF ELECTRICAL LOWERING DEVICE PROXIMITY SWITCHES** (Refer to Figure 4)

The Proximity Switch positions of the Electrical Lowering Device are set at the Factory.

The Proximity Switches are Limit Switches that tell the Vehicle Control System to turn off the Motor when the Pantograph reaches its working height and when it reaches the down (rest) position.

Switch S3 determines the working height position. Switch S4 determines the rest position.

Verify the operation by raising and lowering the Pantograph electrically. Adjust as follows if needed:

**CAUTION** IF ELECTRICAL LOWERING DEVICE WAS REPLACED, S3 AND S4 MUST BE  
ADJUSTED PER NOTE BELOW BEFORE OPERATING PANTOGRAPH WITH LRV  
CONTROL SYSTEM.

IF S3 AND S4 ARE NOT ADJUSTED CORRECTLY, THE MOTOR CAN NOT SHUT OFF  
AND/OR THE INTERNAL CLUTCH CAN SLIP AND DAMAGE ELECTRICAL  
LOWERING DEVICE. DISCONNECT POWER SOURCE IMMEDIATELY IF THIS  
HAPPENS AND CHECK ADJUSTMENTS.

**NOTE**

As an alternate to using the LRV control, normally closed switch S3 and S4 can be monitored with a Multimeter with power off. (See Figure 5 for Switch Diagram)

The Pantograph is raised with the Hand Crank until the Internal Stop is hit and then backed off 2 to 3 turns of the Hand Crank.

The position of Switch S3 is adjusted to open at this point.

The Pantograph is lowered with the Hand Crank until the Internal Stop is hit and then backed off 2 to 3 turns of the Hand Crank.

The position of Switch S4 is adjusted to open at this point.

- 1) Loosen clamp (1).
- 2) Raise the Pantograph electrically. Motor should turn off at desired height due to actuation of proximity Switch S3 (2).
- 3) If needed, adjust the position of Switch S3 by sliding the Switch.
- 4) Tighten Clamp (1).
- 5) Recheck function by lowering and raising Pantograph electrically.
- 6) Loosen Clamp (3).
- 7) Lower Pantograph electrically. Motor should turn off at Rest Position due to actuation of proximity Switch S4 (4).
- 8) If needed, adjust the position of Switch S4 by sliding the Switch.
- 9) Tighten Clamp (4).
- 10) Recheck function by raising and lowering Pantograph electrically.

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**11/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

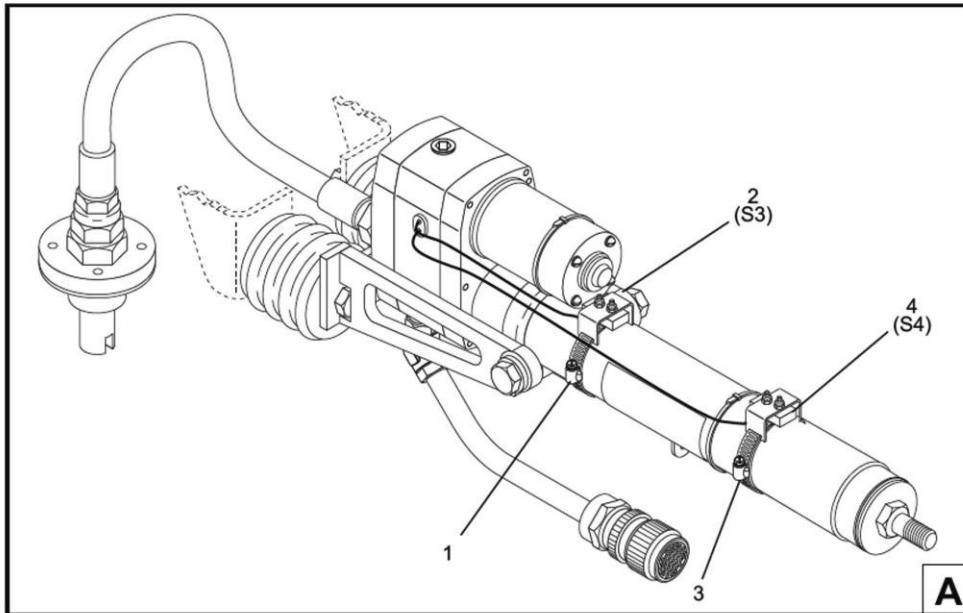
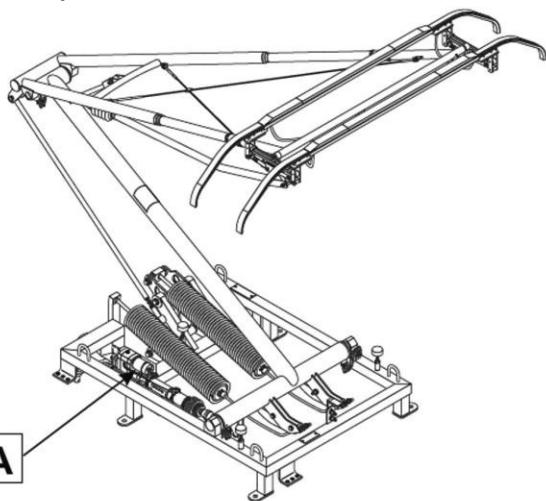
**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT**
**PROCEDURE (CONT'D):**


**FIGURE 4 - ELECTRICAL LOWERING DEVICE ADJUSTMENT**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**12/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

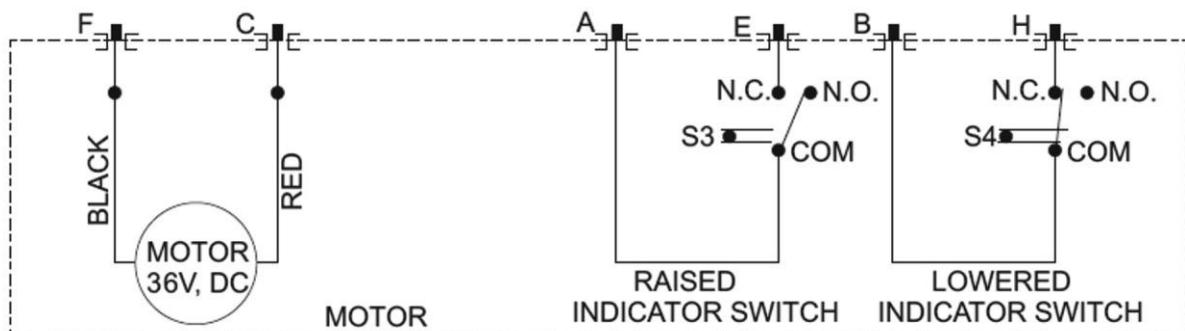
**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****PROCEDURE (CONT'D):****FIGURE 5 - VEHICLE CONTROL INTERFACE****d. ADJUSTMENT OF RESTING POSITION OF PANTOGRAPH (Refer to Figure 6)**

The M16 Bolt at the lever of the Lower Frame limits the Resting height. If set improperly, the Bolt will not allow the Upper Frame and Lower Frame to contact the Bumpers on the Lower Frame.  
If adjustment is needed, proceed as follows:

- 1) Raise pantograph electrically.
- 2) Loosen Hex Nut (1).
- 3) Unscrew M16 Bolt (2).
- 4) Lower Pantograph electrically.
- 5) Push Upper Frame (3) onto Bumpers (4).
- 6) Tighten M16 Bolt (2) so that Upper Frame will rest on the Bumpers.
- 7) Continue to torque the M16 Bolt (2) until Elastomer Spring (5) is compressed to **1.8 inches** (40 mm). The uncompressed length is **2 inches** (50 mm).
- 8) Tighten Hex Nut (1).

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**13/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

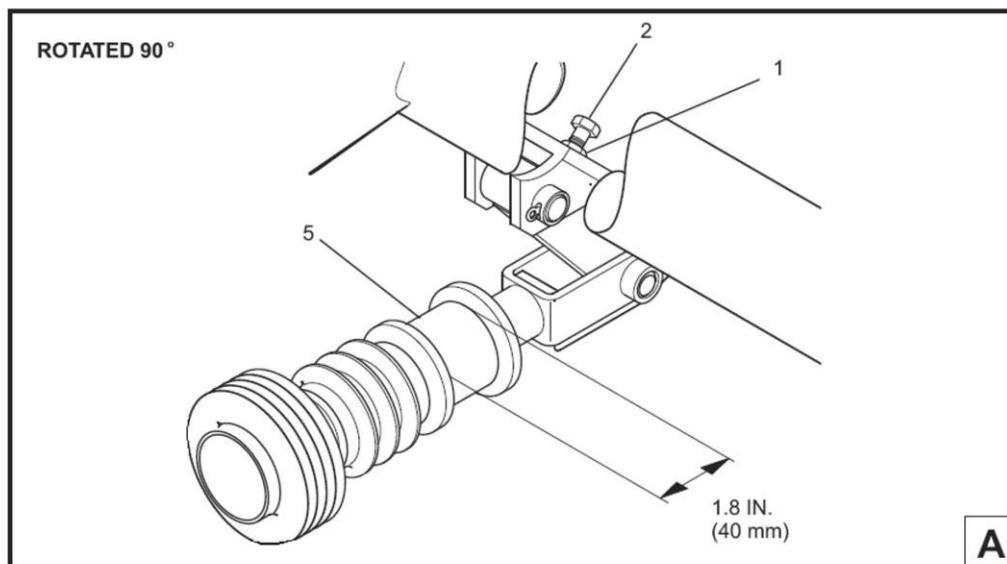
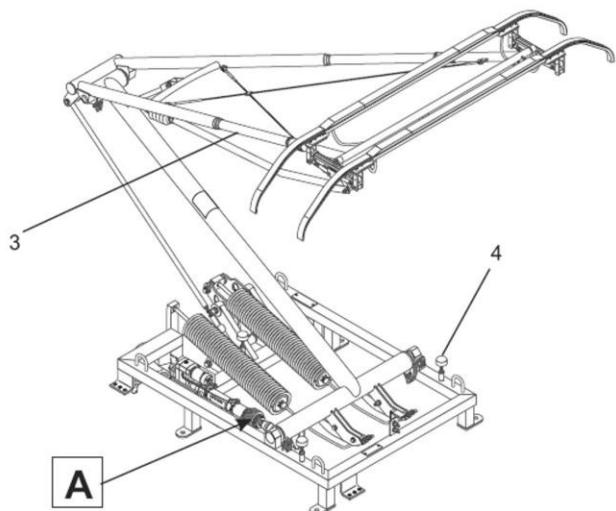
**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT**
**PROCEDURE (CONT'D):**


**FIGURE 6 - RESTING POSITION OF PANTOGRAPH ADJUSTMENT**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**14/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****PROCEDURE (CONT'D):****e. ADJUSTMENT OF PARALLELISM OF CARBON STRIPS** (Refer to Figure 7)

- 1) Loosen M10 Jam Nuts (1) on four Guiding Units.
- 2) Place a Straight Edge across both Carbon Strips (2).
- 3) Adjust Turnbuckles (3) in or out as necessary until Carbon Strips (2) are parallel throughout their entire length.
- 4) Tighten M10 Jam Nuts (1) when adjustments are complete.

**f. ADJUSTMENT OF DIAGONAL CABLES** (Refer to Figure 8)

The Diagonal Cables stiffen the Upper Frame and also keep it centered over the Base Frame. If adjustment is needed, proceed as follows:

- 1) Loosen M10 Jam Nuts (1) of Turnbuckles (2).
- 2) Adjust Turnbuckles (2) so that there is sufficient thread to allow adjustment.
- 3) Measure and mark midpoint of Cross Members of Upper Frame (3) and Base Frame (4) with a piece of masking tape for visual reference.

**CAUTION** USE CARE DURING NOT TO OVERTIGHTEN CABLES (5).  
OVERTIGHTENING CAUSES A TWIST IN UPPER FRAME.

- 4) Using Turnbuckles (2), tighten Cables (5) until they are snug and Upper Frame (3) is centered over Base Frame (4). Use masking tape as guide for centering.
- 5) Tighten M10 Jam Nuts (1) when adjustments are complete.

**4. RAISING AND LOWERING TEST**

- a. Position assistant beside Pantograph to observe Pantograph during raising and lowering.
- b. Raise Pantograph with Vehicle Control System. Pantograph should rise in about **7 (seven)** seconds. Operation should be smooth.
- c. Lower Pantograph with Vehicle Control System. Pantograph should lower in about **7 (seven)** seconds. Operation should be smooth.
- d. Raise and lower Pantograph by Hand Crank. Operation should be smooth.

**NOTE** Lack of operation or rough operation are possibly due to improper assembly and adjustment, or pre-existing wear or damage.  
Lack of operation may also be due to Control System.

**FINAL OPERATIONS**

Record Task Results on the Defect Report Card for administrative and maintenance planning.

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the replaced Equipment pertains.

Refer to **HOW TO USE THE R-CM SHEETS** (para 08-III-04-01-02 of this Section) and follow the prescriptions provided at Step 3 "At every Task Completion."

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**15/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

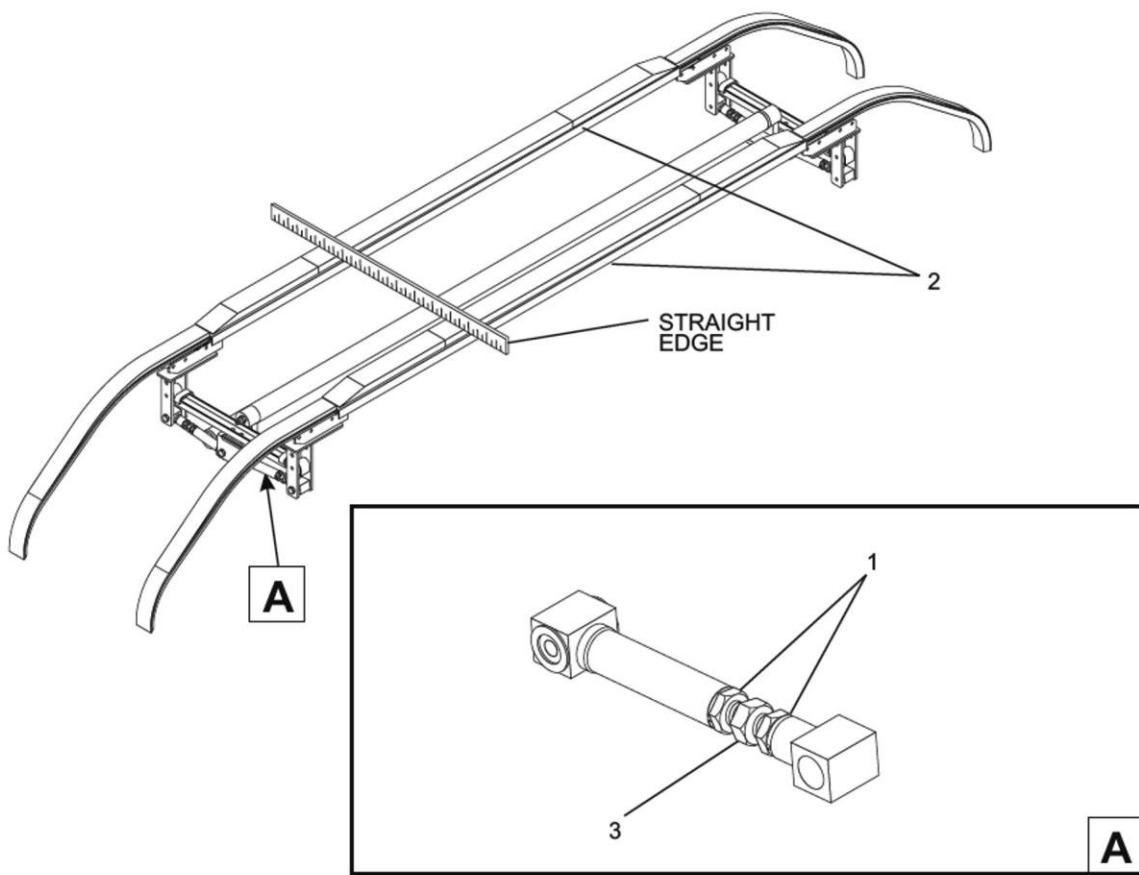
**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT**
**PROCEDURE (CONT'D):**


**FIGURE 7 - PARALLELISM OF CARBON STRIPS ADJUSTMENT**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-01-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**16/16**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

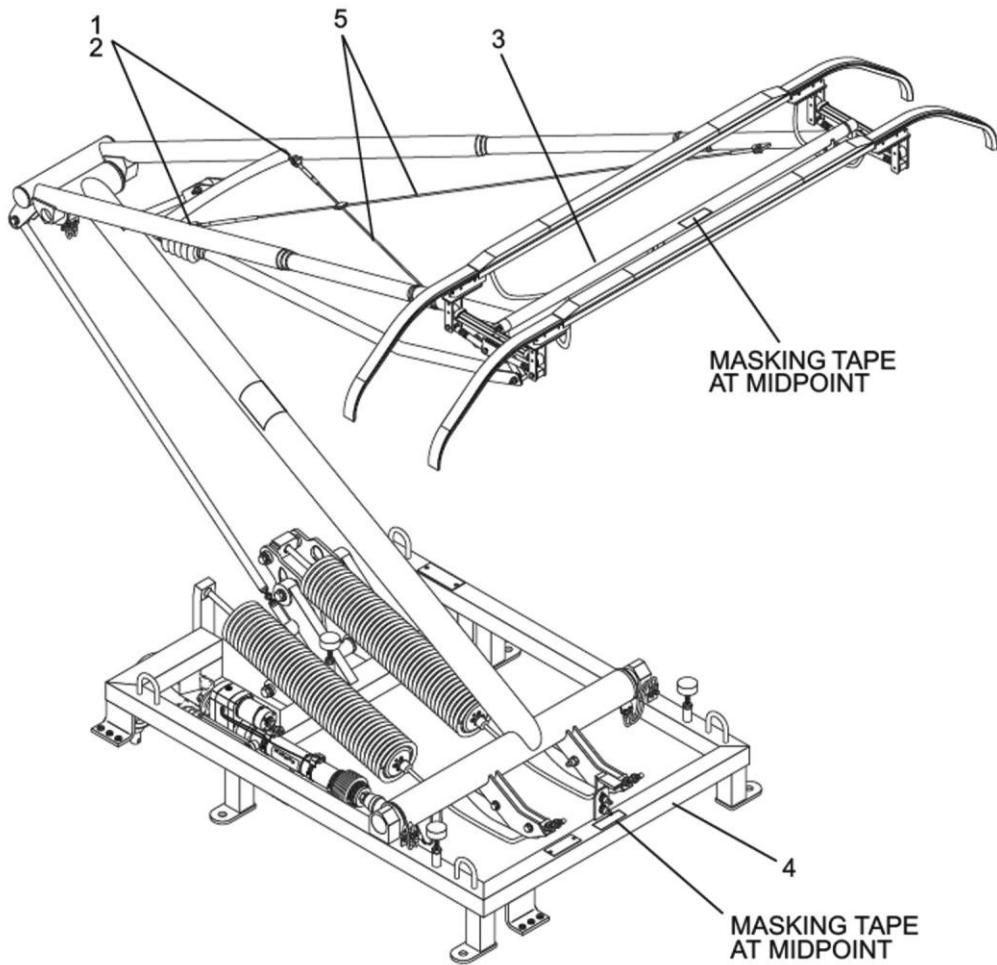
**PANTOGRAPH ASSY**

Component:

Man Hours:

**4**

Maintenance Task:

**REPLACEMENT****PROCEDURE (CONT'D):**

**FIGURE 8 - DIAGONAL CABLES ADJUSTMENT**

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**1/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

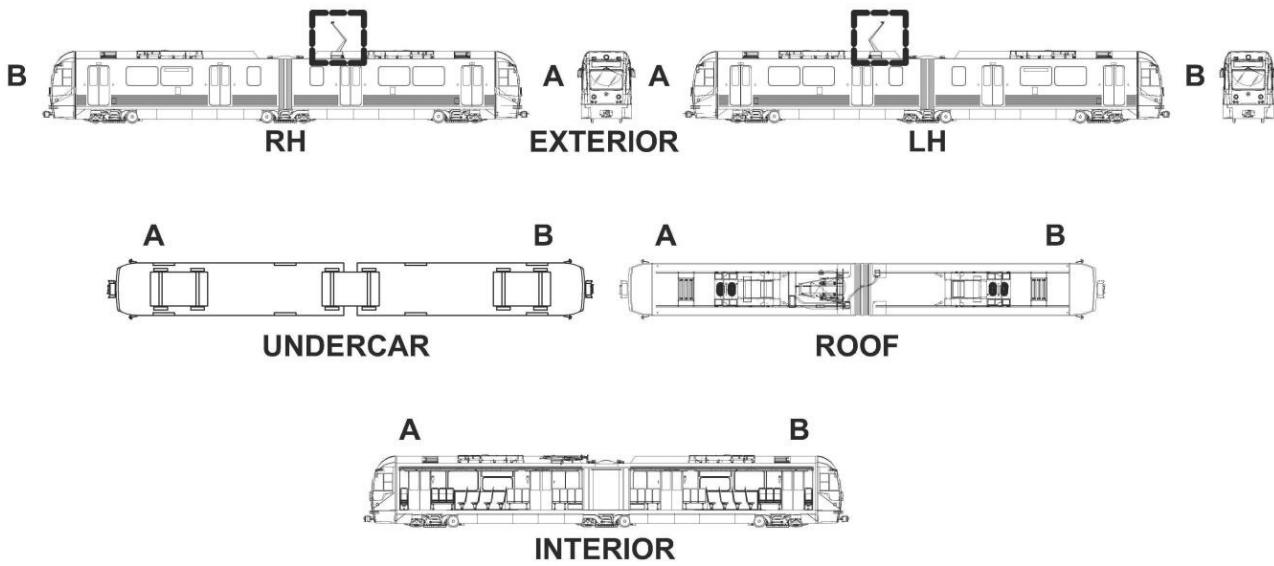
**COLLECTOR HEAD**

Component:

Man Hours:

**0.2**

Maintenance Task:

**REPLACEMENT**
**LOCATION:**


## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**2/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**COLLECTOR HEAD**

Component:

Man Hours:

**0.2**

Maintenance Task:

**REPLACEMENT**

### SAFETY PRECAUTIONS:

**WARNING: SHEET R-C-08-00-00-00/SP-00 PROVIDES STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.**

**USE EXTREME CARE WHEN REMOVING THE SAFETY PIN.**

**THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.**

**REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.**

### TOOLS:

LACMTA Maintenance Shop Standard Tools Kit

### CONSUMABLES:

Carbon Remover, M3      PN      161689

Grease Shell Alvania 2      PN      149973

NOALOX Electrical Contact Grease or equivalent used by MTA

### SPARE PARTS:

Carbon Contact Strip      P/N      SK806  
 End Horn      P/N      312891102

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**3/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**COLLECTOR HEAD**

Component:

Man Hours:

**0.2**

Maintenance Task:

**REPLACEMENT**

### PROCEDURE:

#### PRELIMINARY OPERATIONS

1. Set the Vehicle in safety condition in accordance with LACMTA Maintenance Shop Regulations.
2. Follow the Safety Precautions according to Sheet R-C-08-00-00-00/SP-00.
3. Access Vehicle Roof according to MTA procedures.

**CAUTION:** USE A LIGHT COAT OF DOW CORNING G-N METAL ASSEMBLY PASTE ON ALL THREADS TO REDUCE THE RISK OF SEIZING. THIS WILL ALSO HELP PREVENT STAINLESS STEEL FASTENERS THAT ARE THREADED INTO CARBON STEEL FROM RUSTING FAST.  
 DO NOT USE AN IMPACT WRENCH ON ANY FASTENERS. STAINLESS STEEL FASTENERS TEND TO SEIZE WHILE BEING ASSEMBLED, ESPECIALLY IF AN IMPACT WRENCH IS USED.

**CAUTION:** IF CARBON STRIP IS WITHIN SPECIFICATION ON ONE OF THE CARBON CARRIERS AND THE MATCHING ONE (ON THE OTHER CARBON CARRIER) IS WORN BEYOND SPECIFICATION, THEN BOTH CARBON STRIPS MUST BE REPLACED TOGETHER. REPLACING ONLY ONE CARBON STRIP CREATES AN UNEVEN CARBON HEIGHT CONDITION, RESULTING IN POOR CONTACT WITH THE CATENARY WIRE, RAPID CARBON WEAR, AND POSSIBLE ARCING.

### REPLACEMENT

#### 1. CARBON STRIP (Refer to Figure 1)

- a. Remove four M6 bolts (1, Figure 1) and Self Locking Nuts (2) from Carbon Holder (3) at both ends of Carbon Strip (4).
- b. Carefully remove both End Horns (5) from Carbon Holder (3) and Carbon Strip (4).
- c. Remove Carbon Strip (4).
- d. Apply NOALOX electrical contact grease on contact surfaces of both End Horns (5), both Carbon Holders (3), and Carbon Strip (4).
- e. Install new Carbon Strip (4) in Carbon Holders (3).
- f. Install both End Horns (5) on Carbon Holder (3) and Carbon Strip (4).
- g. Install four M6 bolts (1) and Self Locking Nuts (2).
- h. Tighten Bolts (1) and Self Locking Nuts (2).

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**4/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**COLLECTOR HEAD**

Component:

Man Hours:

**0.2**

Maintenance Task:

**REPLACEMENT****PROCEDURE (CONT'D):****REPLACEMENT (CONT'D)****2. END HORN (Refer to Figure 1)**

**NOTE:** Under normal wear conditions, End Horns require replacement every 2 to 3 sets of Carbon Strips.

- a. Remove four M6 bolts (1, Figure 1) and Self Locking Nuts (2) from Carbon Holder (3).
- b. Carefully remove End Horn (5) from Carbon Holder (3) and Carbon Strip (4).
- c. Discard End Horn (5).
- d. Apply NOALOX electrical contact grease on contact surfaces of new End Horn (5), Carbon Holder (3), and Carbon Strip (4).
- e. Install new End Horn (5) on Carbon Holder (3) and Carbon Strip (4).
- f. Install four M6 bolts (1) and Self Locking Nuts (2).
- g. Tighten Bolts (1) and Self Locking Nuts (2).
- h. Repeat as required for other End Horn.
- i. Perform the following Adjustments and Checks according to Sheet R-C-08-01-00-00/R-00.
  - Contact Force
  - Turning Capacity of the Pan Head
  - Parallelism of Carbon Strips

**FINAL OPERATIONS**

Record Inspection Results on the Defect Report Card for administrative and maintenance planning.

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the maintained Equipment pertains.

Refer to **HOW TO USE THE R-CM SHEETS** (para 08-III-04-01-02 of this Section) and follow the prescriptions provided at Step 3 “**At every Task Completion.**”

## P2550 PREVENTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**5/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**COLLECTOR HEAD**

Component:

Man Hours:

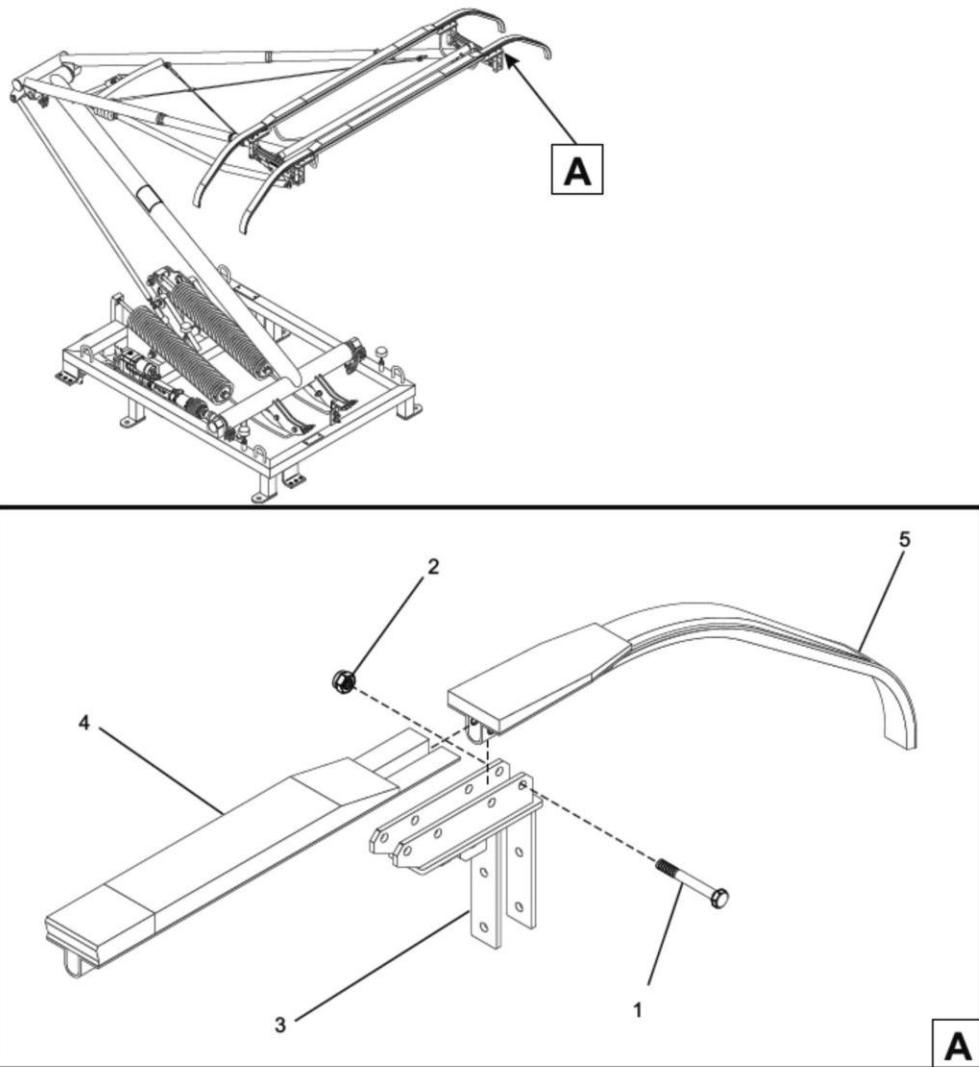
**0.2**

Maintenance Task:

**REPLACEMENT**

### PROCEDURE (CONT'D):

#### REPLACEMENT (CONT'D)



**FIGURE 1 - CARBON STRIP & END HORN REPLACEMENT**

**P2550 PREVENTIVE MAINTENANCE SHEET**

Card Code:

**R-C-08-02-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**6/6**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**COLLECTOR HEAD**

Component:

Man Hours:

**0.2**

Maintenance Task:

**REPLACEMENT****INTENTIONALLY LEFT  
BLANK**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-03-00-00/R-00**

System:

Sheet:

**PANTOGRAPH**
**1/4**

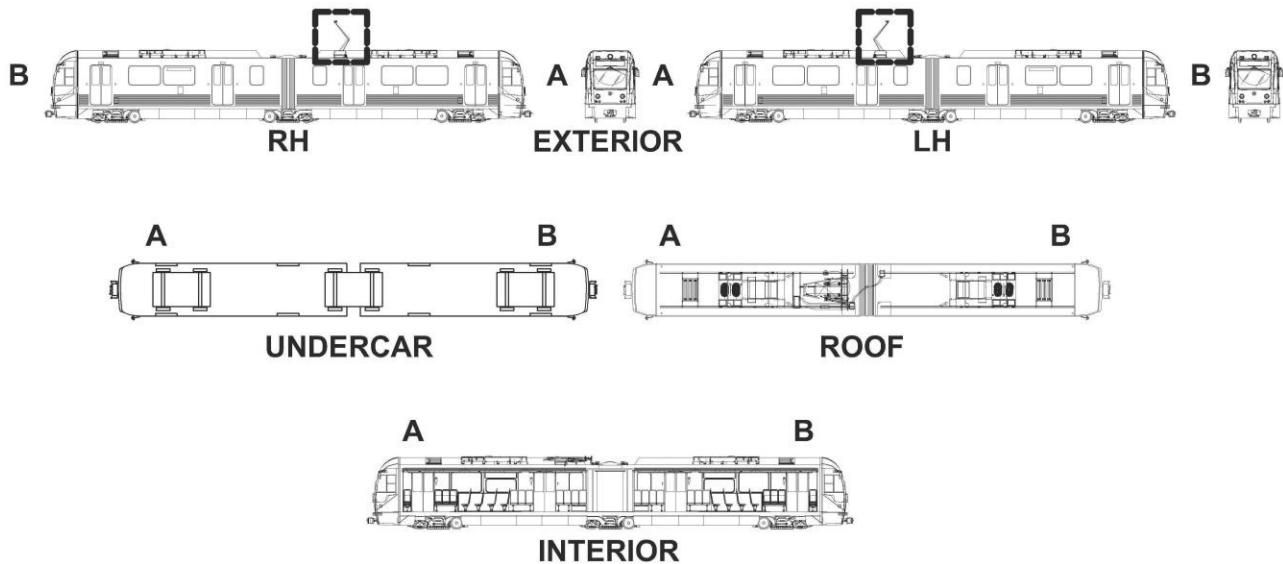
Subsystem/Assy:

 Unit:  
**MOTOR (04M01)**

Component:

 Man Hours:  
**1**

Maintenance Task:

**REPLACEMENT**
**LOCATION:**


## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-03-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**2/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**MOTOR (04M01)**

Component:

Man Hours:

**1**

Maintenance Task:

**REPLACEMENT****SAFETY PRECAUTIONS:**

**WARNING: SHEET R-C-08-00-00-00/SP-00 PROVIDES STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.**

**USE EXTREME CARE WHEN REMOVING THE SAFETY PIN.**

**THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.**

**REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.**

**TOOLS:**

LACMTA Maintenance Shop Standard Tools Kit

**CONSUMABLES:**

NOALOX Electrical Contact Grease or equivalent used by MTA

**SPARE PARTS:**

MOTOR GEAR BOX                    P/N            351-06399A01

MOTOR GEAR BOX ASSY              P/N            351-06399-01

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-03-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**3/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

**MOTOR (04M01)**

Component:

Man Hours:

**1**

Maintenance Task:

**REPLACEMENT**

### PROCEDURE:

#### PRELIMINARY OPERATIONS

1. Set the Vehicle in safety condition in accordance with LACMTA Maintenance Shop Regulations.
2. Follow the Safety Precautions according to Sheet R-C-08-00-00-00/SP-00.
3. Access Vehicle Roof according to MTA procedures.

#### REPLACEMENT

1. Remove the Pantograph according to Sheet R-C-08-01-00-00/R-00).
2. Disassembly the Electrical Lowering Device according to Sheet H-P-08-01-00-00 / OV-00.
3. Replace the Motor Gearbox Assembly.
4. Replace electrical wiring with damaged insulation.
5. Replace electrical contacts that are damaged or corroded.
6. Reassembly the Electrical Lowering Device according to Sheet H-P-08-01-00-00 / OV-00.
8. Install the Pantograph according to Sheet R-C-08-01-00-00/R-00).
9. Perform Pantograph Adjustments / Checks according to Sheet R-C-08-01-00-00/R-00 Step 3.
10. Perform Pantograph Tests according to Sheet R-C-08-01-00-00/R-00 Step 4.

#### FINAL OPERATIONS

Record Task Results on the Defect Report Card for administrative and maintenance planning.

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the replaced Equipment pertains.

Refer to **HOW TO USE THE R-CM SHEETS** (para 08-III-04-01-02 of this Section) and follow the prescriptions provided at Step 3 “**At every Task Completion.**”

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-03-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**4/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

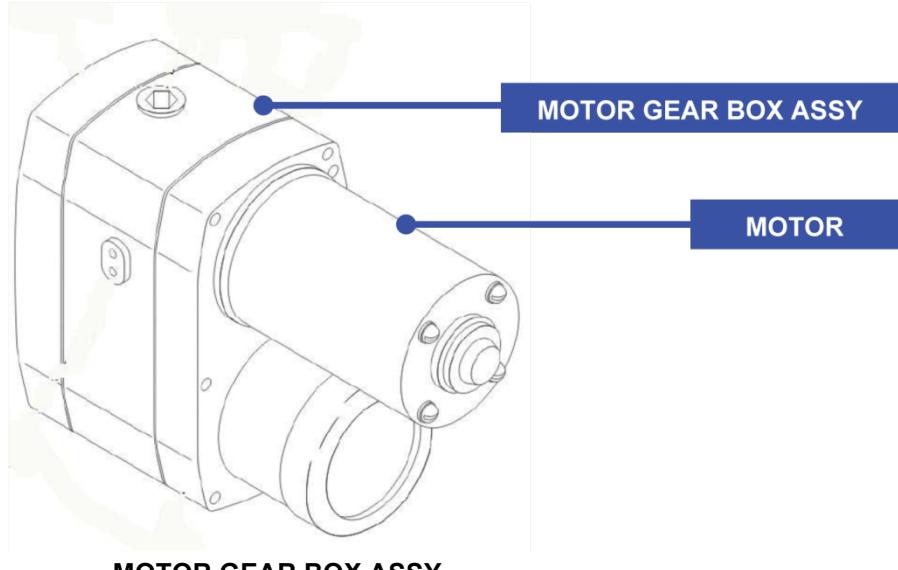
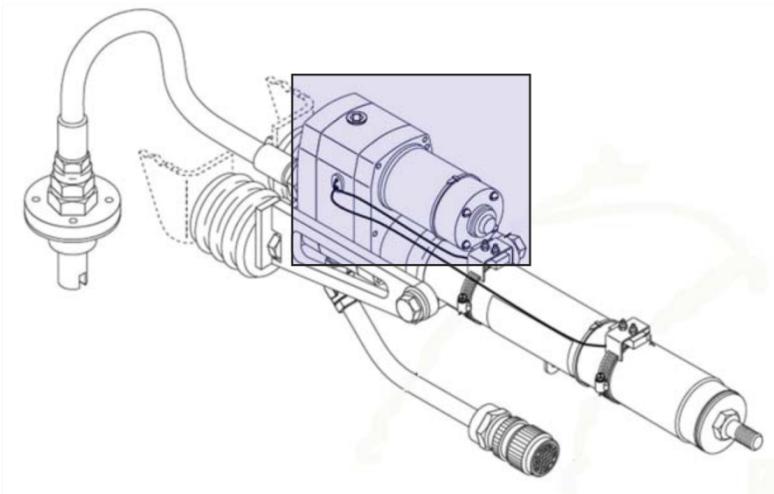
**MOTOR (04M01)**

Component:

Man Hours:

**1**

Maintenance Task:

**REPLACEMENT****PROCEDURE:**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-04-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**1/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

**PROXIMITY MICROSWITCHES (S03-S04)**

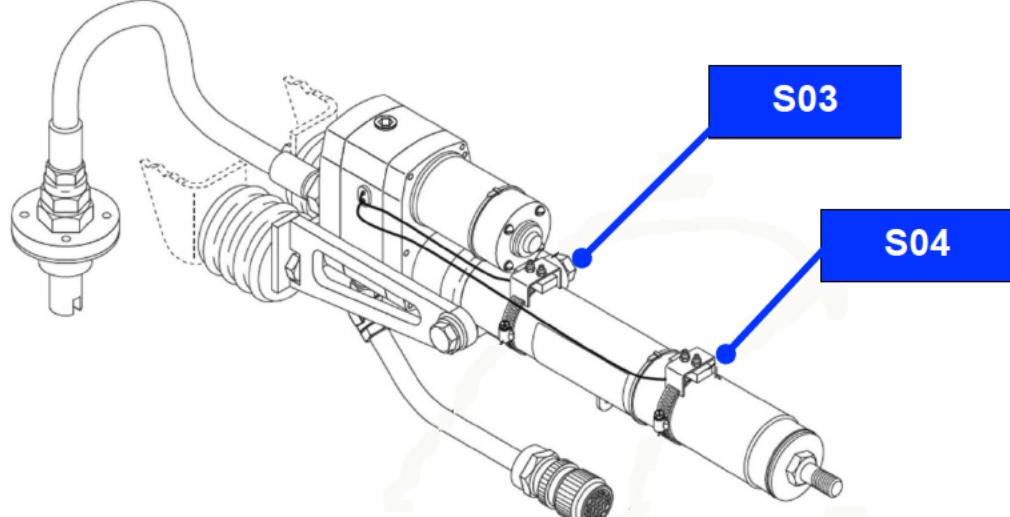
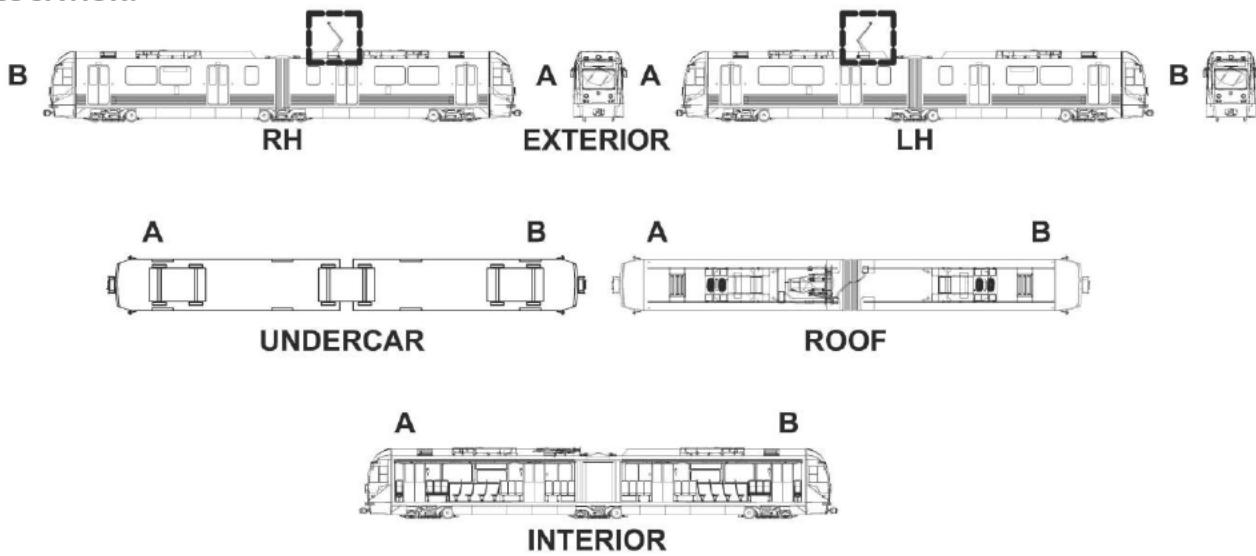
Man Hours:

**1**

Maintenance Task:

**REPLACEMENT**

LOCATION:



## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-04-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**2/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

**PROXIMITY MICROSWITCHES (S03-S04)**

Man Hours:

**1**

Maintenance Task:

**REPLACEMENT**

### **SAFETY PRECAUTIONS:**

**WARNING: SHEET R-C-08-00-00-00/SP-00 PROVIDES STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.**

**USE EXTREME CARE WHEN REMOVING THE SAFETY PIN.**

**THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.**

**REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.**

### **TOOLS:**

LACMTA Maintenance Shop Standard Tools Kit

### **CONSUMABLES:**

CRC 2000 Contact Cleaner or equivalent

### **SPARE PARTS:**

PROXIMITY SWITCH      P/N 351-06201-12      Q.TY =2

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-04-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**3/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

**PROXIMITY MICROSWITCHES (S03-S04)**

Man Hours:

**1**

Maintenance Task:

**REPLACEMENT****PROCEDURE:****PRELIMINARY OPERATIONS**

1. Set the Vehicle in safety condition in accordance with LACMTA Maintenance Shop Regulations.
2. Follow the Safety Precautions according to Sheet R-C-08-00-00-00/SP-00.
3. Access Vehicle Roof according to MTA procedures.

**REPLACEMENT****1. Removal**

- a. Remove Cable Ty holding Wiring of Switch S03/S04.
- b. Remove Cover at rear of Motor Gearbox Assembly.
- c. Tag and disconnect Wiring from Switch S03/S04 at Motor Gear Box Assembly.
- d. Slide Wires out of Grommet on Motor Gear Box Assembly.
- e. Loosen Clamp of Switch S03/S04.
- f. Remove Clamp with attached Switch S3 S03/S04 from Outer Tube.

**2. Installation**

- a. Install Clamps with attached Switch S03/S04 on Outer Tube.

**NOTE:** Locate Switch S3 so it will actuate (Open Contacts) when Magnets are under Switch in the fully retracted position of Ball Screw Assembly.

Locate Switch S4 so it will actuate (Open Contacts) when Magnets are under Switch in the fully extended position of Ball Screw Assembly.

- b. Tighten Clamp of Switch S03/S04.
- c. Feed Wires through Grommet on Motor Gear Box Assembly.
- d. Connect wiring of switch S3 /S4 at Motor Gear Box Assembly per tags.
- e. Dress Wires and install Cable Ty to secure wiring.
- f. Install Cover at rear of Motor Gearbox Assembly.
- g. Perform Switch (es) Adjustment / Checks according to Sheet R-C-08-01-00-00/R-00 Step 3.
- h. Perform Pantograph Test according to Sheet R-C-08-01-00-00/R-00 Step 4.

**FINAL OPERATIONS**

Record Task Results on the Defect Report Card for administrative and maintenance planning.

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the replaced Equipment pertains.

Refer to **HOW TO USE THE R-CM SHEETS** (para 08-III-04-01-02 of this Section) and follow the prescriptions provided at Step 3 “**At every Task Completion.**”

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-04-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**4/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

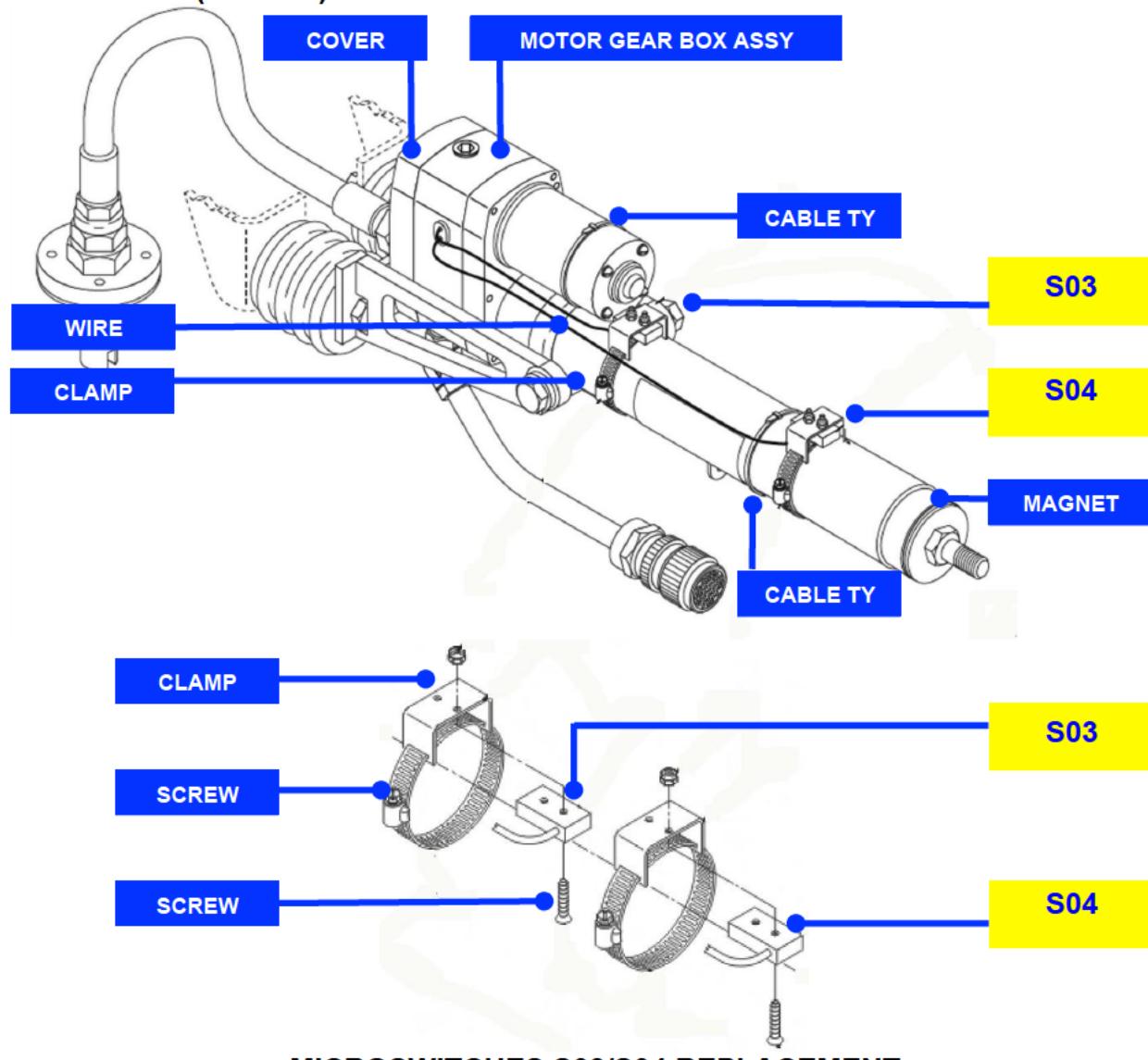
Component:

**PROXIMITY MICROSWITCHES (S03-S04)**

Man Hours:

**1**

Maintenance Task:

**REPLACEMENT****PROCEDURE (CONT'D):**

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-08-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**1/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

**BEARINGS**

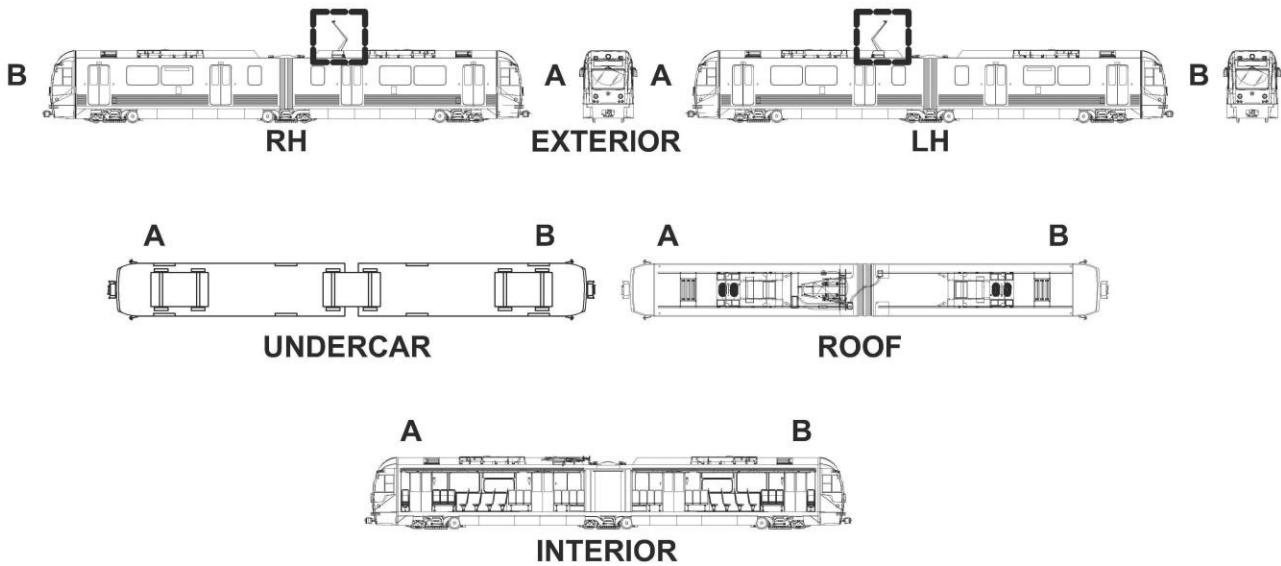
Man Hours:

**1.5**

Maintenance Task:

**REPLACEMENT**

LOCATION:



## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-08-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**2/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

**BEARINGS**

Man Hours:

**1.5**

Maintenance Task:

**REPLACEMENT**

### **SAFETY PRECAUTIONS:**

**WARNING: SHEET R-C-08-00-00-00/SP-00 PROVIDES STANDARD PROCEDURE THAT MUST BE DONE EACH TIME MAINTENANCE IS DONE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REMOVED FROM ITS STORAGE BRACKET AND INSTALLED BESIDE THE SHEAR PIN IN THE SAFETY SYSTEM LINKAGE BEFORE PERFORMING MAINTENANCE PROCEDURE ON THE PANTOGRAPH.**

**THE SAFETY PIN MUST BE REINSTALLED IN ITS STORAGE BRACKET ONLY AFTER WORK IS COMPLETED.**

**USE EXTREME CARE WHEN REMOVING THE SAFETY PIN.**

**THE SAFETY PIN SHOULD BE LOOSE. A TIGHT SAFETY PIN INDICATES THE SHEAR PIN HAS FRACTURED.**

**REMOVING THE SAFETY PIN UNDER THIS CONDITION WILL CAUSE THE PANTOGRAPH TO COLLAPSE SUDDENLY RESULTING IN SERIOUS PERSONAL INJURY AND DAMAGE TO EQUIPMENT. IF REQUIRED, REPLACE SHEAR PIN.**

### **TOOLS:**

LACMTA Maintenance Shop Standard Tools Kit

### **CONSUMABLES:**

Bearing Grease or equivalent used by MTA

### **SPARE PARTS:**

Upper Frame Bearing	P/N	04-0005	Alternate P/N	351-05670-09	Q.TY = 4
Lower Frame Bearing	P/N	02-0018	Alternate P/N	351-05652-03	Q.TY = 4
Coupling Rod Bearing	P/N	04-0005	Alternate P/N	351-05670-09	Q.TY = 4

## P2550 CORRECTIVE MAINTENANCE SHEET

Card Code:

**R-C-08-08-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**3/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

**BEARINGS**

Man Hours:

**1.5**

Maintenance Task:

**REPLACEMENT**

### PROCEDURE:

#### PRELIMINARY OPERATIONS

1. Set the Vehicle in safety condition in accordance with LACMTA Maintenance Shop Regulations.
2. Follow the Safety Precautions according to Sheet R-C-08-00-00-00/SP-00.
3. Access Vehicle Roof according to MTA procedures.

#### REPLACEMENT

1. Remove the Pantograph according to Sheet R-C-08-01-00-00/R-00)
2. Disassembly according to Sheet H-P-08-01-00-00 / OV-00 the:
  - Upper Frame Assy
  - Lower Frame Assy
  - Coupling Rod
3. Replace Bearings according to Sheet H-P-08-01-00-00 / OV-00.
5. Reassembly the Pantograph according to Sheet H-P-08-01-00-00 / OV-00.
6. Install the Pantograph according to Sheet R-C-08-01-00-00/R-00).
7. Perform Pantograph Adjustments / Checks according to Sheet R-C-08-01-00-00/R-00 Step 3.
8. Perform Pantograph Tests according to Sheet R-C-08-01-00-00/R-00 Step 4.

#### FINAL OPERATIONS

Record Task Results on the Defect Report Card for administrative and maintenance planning.

**NOTE:** At Task Completion it is recommended to check the correct operation and/or functions of the Subsystem to which the replaced Equipment pertains.

Refer to **HOW TO USE THE R-CM SHEETS** (para 08-III-04-01-02 of this Section) and follow the prescriptions provided at Step 3 “**At every Task Completion.**”

**P2550 CORRECTIVE MAINTENANCE SHEET**

Card Code:

**R-C-08-08-00-00/R-00**

System:

**PANTOGRAPH**

Sheet:

**4/4**

Subsystem/Assy:

**PANTOGRAPH ASSY**

Unit:

Component:

**BEARINGS**

Man Hours:

**1.5**

Maintenance Task:

**REPLACEMENT****INTENTIONALLY  
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### 08-III-05 CONSUMABLE MATERIALS LIST (R-CML)

The Consumable Materials needed to accomplish the Pantograph Running Maintenance are listed, sequenced in alphabetical order, by SUBSYSTEM /ASSY -UNIT / COMPONENT, in the following Table 08-III-05.1.

**Table 08-III-05.1 Running Maintenance Consumable Materials List (R-CML)**

<b>SYSTEM 08</b>		<b>PANTOGRAPH</b>	
<b>SUBSYSTEM /ASSY - UNIT / COMPONENT</b>	<b>AGENT</b>	<b>PN</b>	<b>MTA PN</b>
COLLECTOR HEAD	Carbon Remover, M3	161689	
	Shell Alvania 2 Grease	149973	
	NOALOX Electrical Contact Grease or equivalent	(Commercial)	
PANTOGRAPH ASSY	NOALOX Electrical Contact Grease or equivalent	(Commercial)	
PANTOGRAPH PROXIMITY MICROSWITCHES	CRC 2000 Contact Cleaner or equivalent	(Commercial)	

### 08-III-06 TEST EQUIPMENT & SPECIAL TOOLS LIST (R-TESTL)

The Tools and Test Equipment needed to accomplish the Pantograph Running Maintenance are listed, sequenced in alphabetical order, by SUBSYSTEM /ASSY -UNIT / COMPONENT, in the following Table 08-III-06.1.

Refer to "Tools and Test Equipment Manual" for Special Tools / Test Equipment Description and Maintenance.

**Table 08-III-06.1 Running -Test Equipment & Special Tools List (R-TESTL)**

<b>SYSTEM 08</b>		<b>PANTOGRAPH</b>		
<b>SUBSYSTEM /ASSY - UNIT / COMPONENT</b>	<b>LACMTA STANDARD TOOLS KIT</b>	<b>LACMTA WORKSHOP DEVICES</b>	<b>SPECIAL TOOL / TEST EQUIPMENT</b>	<b>PN</b>
COLLECTOR HEAD	X			
PANTOGRAPH ASSY	X		Contact Pressure Gauge KM 11	
			Spanner Wrench	351-05990
PANTOGRAPH MOTOR	X			
PANTOGRAPH PROXIMITY MICROSWITCHES	X			

**INTENTIONALLY LEFT BLANK**