PART 1 - GENERAL

1.1 DESCRIPTION

This Section describes and specifies the performance requirements to design, furnish, install, test, and place into satisfactory operation the conductor rail which is part of overhead contact system and accessories at in the underground sections as indicated in the drawings. The conductor rail system consists of an aluminum alloy extrusion supported by insulator arrangements at regular intervals. A hard drawn copper contact wire shall be inserted at the bottom of the aluminum extrusion to provide a running smooth surface for the LRV pantograph to collect power for the LRV.

1.2 QUALITY CONTROL

A. The Contractor shall perform the Work included in this Section in strict accordance with the requirements of the Approved Contractor's Quality Control Program.

B. Comply with Section 01 43 10, Project Quality Program Requirements – Design/Build.

1.3 REFERENCE

The following, but not limited to, codes, regulations, reference standards, and specifications apply to work included in this Section.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI</td>
<td>C29.10</td>
<td>Wet-Process Porcelain Insulators - Indoor Apparatus type</td>
</tr>
<tr>
<td>ASTM</td>
<td>B187</td>
<td>Copper Bus Bar, Rod and Shapes</td>
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</tbody>
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1.4 SUBMITTALS

A. Submittals shall be in accordance with Sections 01 33 00, Submittals Procedures.

B. The proposed CR Systems shall have a proven transit tunnel application history of a minimum of 10 years. The Contractor shall submit proof of application and transit agencies that use the proposed CR system.

C. Manufacturer's product descriptions, catalog data; and information.

D. Manufacturer's arrangement and detail drawings including:
- Rigid bar details and chemical composition
- Conductor rail layouts
- Expansion joint arrangements
- Splice plates
- Overlap arrangements
- Mid-point arrangement
- Section insulator arrangements
- End approaches (ramps)
- Transition from soft support OCS to conductor rail (change in elasticity)
- General stagger arrangement
- Support insulators and double insulation
- Structural attachment to circular tunnel and cut-and-cover box
- Feeding arrangements

E. Calculation for thermal expansion, structural support, deflection, etc

F. Conductor rail Layouts

G. Installation method to install the copper contact wire into the rigid aluminum bar

H. Special tools to install rigid bar and installation of contact wire

I. Installation Plan

J. Operation and maintenance manual, with spare parts list.

K. Factory and field test Plan, test procedures, and test reports, including acceptance measurements and inspections.

PART 2 -PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

A. The traction power system (TES) shall be provided with a conductor rail in the underground sections of the line as indicate. The Contractor’s design and installation shall provide the following:

1. Smooth transition between the conductor rail and the soft at-grade type OCS.
2. The conductor rail shall be staggered to the maximum calculated values for tangent track and curved track.
3. Expansion joint arrangements to allow for the thermal expansion of the conductor rail. Contractor shall provide thermal expansion calculations for review and approval.
4. Smooth transition between adjacent conductor rail sections at expansion joints, overlaps, and section insulator arrangements.
5. Full capacity DC feeder jumpers shall be provided at expansion joints and at non-insulated overlaps.

6. Each length of rigid bar (between expansion joints and between end sections) shall be provided with a mid-point anchor to prevent longitudinal movement of the conductor rail relative to the mid-point anchor.

7. The rigid bar at support insulator shall allow for longitudinal movement of the conductor rail.

8. Insulated arrangement shall provide for double insulation. Higher rated insulators will be accepted instead of double insulation only with the concurrence of the CPUC.

9. Conductor rail shall be supported at intervals not greater than 33 feet (10m).

B. The following minimum dimensions shall apply:

1. Cross Section 3.1 in²
2. Depth of rigid bar 4.33 in
3. Length of rigid bar 30 to 40 ft
4. Weight 4.1 lbs/ft
5. Ixx - Moment of Inertia 8.1 in⁴
6. Iyy - Moment of Inertia 2.73 in⁴
7. Section equivalent to copper 2.17 in²
8. Coefficient of thermal expansion 24 x 10⁻⁶
9. Modulus of elasticity 10 x 106 lbs/in²
10. Minimum contact wire 14 ft-0 in

C. The design of the conductor rail shall be coordinated with the requirements of the traction power Load Flow Analysis (LFA)

D. Feeders to the conductor rail sizes and quantities shall be coordinated with the LFA results

2.2 MAIN SYSTEM COMPONENTS

A. Copper/Aluminum Corrosion: Safe Guards

Conductive connections between aluminum and copper should be established in the absence of an electrolyte in order to prevent corrosion.

For practical application, the following corrosion-inhibiting measures must be taken:

1. Each CR shall be provided with adequate drain holes (typically 4) on the bottom side to prevent formation of condensed water containing dissolved gases or aggressive substances within the section.

2. The contact wire shall be greased during installation by means of a through-sleeve connected to a grease pump. The grease has a protective effect but allows current flow between aluminum and copper because it contains a high percentage of zinc.

3. In the area of tunnel mouths and local moisture points the CR shall be provided with a protecting insulated cover from fire retardant material. This cover shall be rigid and have no great effect on the sag.
Important: Water dripping constantly from tunnels, bridges or other civil structures on the aluminum CR profile has to be avoided. Especially the so called concrete water destroys the aluminum. The protecting plastic cover can be a solution for this type of problem.

B. Interlocking Joint

Each section of the CR shall be connected by interlocking joints. The alloy of the interlocking joints shall be similar to that of the CR and all physical properties should be identical. The interlocking shall be designed in such way to avoid kink and consist of as few parts as possible to ease installation and maintenance.

C. Transition Bar

At the exchanging point between a conventional overhead contact system and the CR, a special designed transition bar shall be installed to ensure a gradual equalization of the difference in stiffness between traditional OCS and CR.

The equalization shall be achieved with a minimum of six out-cuts in the transition bar profile of progressively increasing depth.

To give the profile its original clamping force again, there should be additional bolts which press the flanks of the profile together. The out-cuts shall be protected against incoming water with a fire retardant insulated cover.

D. End Section

In turnouts or crossovers, an end section running in parallel to the main track shall be used to ensure a smooth pantograph run. Minimal distance from contact wire to contact wire is typically 5 inches (130 mm) to allow unhindered passing of the insertion device.

E. Expansion Joint

The expansion joints or non-insulated overlaps should be placed in a track section which is as straight as possible and above the track axis, without stagger.

In order to ensure a smooth pantograph passage, the CR supports shall be installed in short distances of typically 3.5 feet (around one meter) allowing a precise height regulation at the overlapping section. To guarantee the electrical continuity, the parallel CRs shall be connected with copper cables long enough to compensate the expected temperature movement of the respective CR sections.

The same arrangement may be used as an electrical sectioning, if the appropriate electrical clearance is applied.

F. Section Insulators

CR's that are part of different feeding sections shall be separated by Insulated Overlaps or Section Insulators (SI). The section insulator shall be placed in a section which is as straight as possible and, as is typical for all section insulators, above the track axis without staggering. Both ends should be in perfect alignment to avoid any torsion of the device.
The SI ends of the runners shall arcing horns for a better extinction of short-circuit arcs which may occur if a train enters an earthed section.

G. Electrical Connections

Electrical connections to and between CR sections (connection from messenger wire onto the CR, feeding from disconnects, interconnection of parallel routed CR's in turnouts etc.) shall be made by using the CR feeder clamps.

The electrical connection cables shall be flexible copper cables with adequate cross sectional area. The CR feeder clamp shall be made of aluminum alloy. Therefore the connection with copper cable terminals has to be effected with interposition of a bimetallic washer provided with the clamp.

H. Endpoint Anchor

The endpoint anchor shall take the tensile force of the contact wire entering the conductor rail (CR) and leads it into the civil structure. This means that with the exception of the transition section, the contact wire in the CR is not subjected to tensile forces. The messenger wire is typically anchored to the front part of the civil structures.

The transmission of the tensile force of the contact wire into the CR is carried out by the clamping force which exists between contact wire and the flanks of the CR profile.

An endpoint anchor assembly consists of the following items:

1. Contact wire anchor bar
2. Fixed point anchor plate
3. Anchor ropes with dead ends, turnbuckles, insulators and brackets.
4. Drop tubes or similar supports intended for independent anchoring of the ropes.

I. Fixed Point Anchor

A fixed point anchor shall be used to stabilize the various forces exerted on a CR section within two expansion joints.

A fixed point assembly consists of the following items:

1. Fixed point anchor plate
2. Anchor ropes with dead ends, turnbuckles, insulators and brackets.
3. Drop tubes or similar supports intended for independent anchoring of the ropes.

J. Supports
Conductor rail supports should be designed / adapted for tunnel applications. The supports should be capable of allowing the longitudinal expansion and retraction of the CR resulting from temperature variations over long CR sections.

The two main types of supports:

- Hinged supports
- Supports with gliding elements

A hinged support shall normally consist of the following elements:

1. Drop tube intended for anchoring the CR support to the tunnel ceiling.
2. Pre-assembled hinged bracket, Fixed to the drop tube and serving both as hinge and as a rough height adjustment.
3. Insulator 1.5 - 3 kV.
4. Stand-off bracket. Moving the swivel head horizontally in the stand-off bracket, the required stagger can be obtained and some of the installation tolerances (drilling works) can be compensated.
5. Swivel head. Allows the final adjustment of the CR to the requested contact wire height and serves also as a hinge.

A support with gliding suspension of the CR shall normally consist of the following elements:

1. Drop tube, intended for anchoring the CR support to the tunnel ceiling.
2. Bracket, fixed to the drop tube and serving as a rough height adjustment.
3. Insulator 1.5 - 3 kV.
4. Stand-off bracket. Moving the swivel head horizontally in the stand-off bracket, the required stagger can be obtained and some of the installation tolerances (drilling works) can be compensated.
5. Swivel head with gliding element. It allows the final adjustment of the CR to the requested contact wire height. For high speed application, spring elements are installed in the swivel head.

PART 3 -EXECUTION

3.1 GENERAL

A. Metro’s Representative may witness design and production tests of the rigid aluminum extrusions. The design tests shall be required on only one unit. The production tests
shall be performed on all units. If the manufacturer has previously performed design tests on similar equipment, a certified test report of the design tests shall be submitted for the review and approval. If the design tests performed meet the Metro’s approval, design tests shall not be required.

3.2 INSTALLATION

A. The construction of the CR shall be in accordance to the requirements of the aluminum extrusions. The CR shall be installed based on a 65 degree Fahrenheit (F) reference and adjusted for the ambient temperature in the tunnel at the time of regulation.

B. Staggers shall be based on design calculations. The calculations shall be submitted for Metro review.

C. Mid-point anchors shall be bolted to the underground structure using double insulation (or higher rated insulators per CPUC direction). No mid-point anchor shall be permitted at underground stations.

D. Install in accordance with these Contract Documents and the manufacturer's recommended methods.

E. Testing and acceptance shall be in accordance with approved test plans.

3.3 TESTING AND COMMISSIONING

The work includes testing and inspection of the CR, independently, and before integration with the traction power system and integrated testing. Testing and Commissioning shall include all electrical tests, operations tests, measurements and inspections as outlined in the PR's of the DB project and manufacturer recommendations

END OF SECTION