Los Angeles County
Metropolitan Transportation Authority

Westside Subway Extension Project, Section 1

Contract C1045

Technical Requirements – (Divisions 2-34)

July 23, 2013

AMENDMENT 1

Metro

U.S. Department of Transportation
Federal Transit Administration

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SECTION 02 41 00

STAGING AREA CLEARING AND DEMOLITION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Site Area clearing and grubbing of objectionable material and demolition of structures at staging areas, including surface and subsurface removal and/or capping of public utility connections, removal; filling of basements and depressions; removal of existing fencing and installing temporary fencing within limits identified on Project Definition Documents (PDD).

B. Artwork and Signage removal and storage

1. Artwork panels and signage located on the façade of the existing Metro Customer Center.

C. The Contractor shall remove, protect, label, crate and store existing artwork and signage. Move the art work to a Metro facility in the LA Metropolitan area.

1.02 RELATED SECTIONS

A.	Section 01 31 30	Interface with Other Jurisdictions
B.	Section 01 33 00	Submittal Procedures
C.	Section 01 35 29	Health, Safety and Emergency Response Procedures for Contaminated and Hazardous Materials (where applicable)
D.	Section 01 35 35	Water Pollution Control
E.	Section 01 35 43	Environmental Procedures for Contaminated and Hazardous Materials (where applicable)
F.	Section 01 35 69	Lead Related Construction Work
G.	Section 01 35 70	Asbestos-Related Construction Work
H.	Section 01 43 10	Project Quality Program Requirements – Design/Build
I.	Section 01 56 26	Construction Fencing (Wood)
J.	Section 01 56 28	Construction Fencing (Chain Link)
K.	Section 01 57 19	Temporary Environmental Controls
L.	Section 31 20 00	Earthwork

1.03 REFERENCES

A. Standard Specification of Public Works Construction (SSPWC)

1. Section 300-1 Clearing and Grubbing

B. South Coast Air Quality Management District (SCAQMD):

1. Rule 402 Nuisance

2. Rule 403 Fugitive Dust

3. Rule 1403 Asbestos containing building material

C. California Occupational Safety and Health Administration (Cal/OSHA)

1. Title 8, CCR Section 1532.1 Lead in construction standard

1.04 QUALITY ASSURANCE

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

B. Perform Work in compliance with requirements of federal, state and local governing authorities having jurisdiction, and as specified.

C. Comply with City of Los Angeles Department of Building and Safety requirements P/BC 2008-039 and Los Angeles City Building code and Amendments.

D. Comply with City of Los Angeles Fire Department permit.

E. Comply with City of Beverly Hills Department of Building and Safety and other relevant departments within the City.

F. Coordinate with Metro Creative Services to have a representative present during artwork signage removal.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures, for submittal requirements.

B. Before Starting work, submit the following:

1. Final Approved Plans containing methods and schedule of demolition in conformance with Demolition Article, CAL/OSHA Construction Safety Orders, and other regulatory authorities; South Coast Air Quality Management District, Rule 1403, City Of Los Angeles, City of Beverly Hills, California Environmental Protection Agency.

2. Risk Management Plan describing the type of contaminants and subsurface features that may be encountered and procedures for evaluating and managing such material.

3. Any permits obtained by Contractor for demolition, removal, transport and disposal of debris.

4. Letter documenting arrangements for disposing of waste and excess materials at a legally licensed landfill/disposal facility outside Worksite.

5. Certificates of severance of utility services before final acceptance. Proposed haul route(s) from the demolition site to an authorized disposal site.

6. Written releases from the owners of private property upon which materials demolished and or removed from the site were stored either temporarily or permanently before final acceptance.

7. Permit from Underground Service Alert, if applicable.

8. Permits and notices authorizing demolition including, but not limited to, SCAQMD Rule 1403, Asbestos Emissions from Renovation/Demolition Activities.

9. The Contractor shall provide a workplan for the removal of artwork to Metro Creative Services for review and approval prior to scheduling work.

C. Other local agencies required submittals may include the following:

1. Demolition Permit.

2. Grading Permit and duplicated copies of hauling plans and bonds.

3. S. C. Air Quality Management District and Los Angeles City Fire Department Underground Tank Removal Permits.

4. S. C. Air Quality Management District Hazardous Material Removal Permits, Notifications and Manifest, and Insurance Certification.

5. Demolition Plans and Schedules.

6. A list of all construction equipments or materials intended to be used for the work in this Section.

7. Scaffolding and/or Temporary Support Drawings.

8. Shoring Permit.

9. Solid Resources Management Plan as maybe required by the City of Los Angeles and adopted by Metro. Further information can be found in City of Los Angeles General Requirements, Section 01572 – CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT.

10. Refer to Section 01 35 35, Water Pollution Control for WWECP and SWPPP requirements.

11. Compaction Certification.

12. Risk management Plan (RMP)

13. Clearance letter from Division of Oil, Gas and Geothermal Resources (DOGGR)

D. Upon completion of Work-Provide As-Built Drawing(s) of locations and depths of Sanitary Sewer Service Caps, water lines, gas lines, TV cable, etc.

E. Final Design Plans containing methods and schedule of demolition in conformance with Demolition Article, CAL/OSHA Construction Safety Orders, and other regulatory authorities; South Coast Air Quality Management District, Rule 1403, City Of Los Angeles, City of Beverly Hills, California Environmental Protection Agency.

F. Certificates

1. Any permits obtained for demolition, removal, transport and disposal of debris.

G. Submittals specified in Section 01 35 29, Health, Safety, And Emergency Response for Contaminated and Hazardous Sites and Section 01 35 43 Environmental Procedures for Contaminated and Hazardous Materials.

H. Record Documentation

1. Upon completion of Work, Provide As-built Drawing(s) of locations and depths of Sanitary Sewer Service Caps, water lines, gas lines, TV cable, etc.

2. Prepare As-Built drawings for sites with deep foundations where a portion of the piling foundation is left on site after demolition. The drawing shall provide location of each pile member, its size and type of material.

1.06 DEFINITIONS (NOT USED)

1.07 PERMITS

A. For Street Use Permits, contact relevant local agency representatives per Section 01 31 30, Interface with Other Jurisdictions at least 30 days before start of operations to make necessary arrangements and obtain permit, unless otherwise specified in the Master Cooperative Agreement between Metro and City of Los Angeles.

B. For Haul Route Permits, relevant local agency representatives per Section 01 31 30, Interface with Other Jurisdictions, for requirements at least 30 days before required start date of hauling operations, unless otherwise specified in the Master Cooperative Agreement between Metro and City of Los Angeles.

1.08 HAZARDOUS AND CONTAMINATED MATERIAL

A. Removal of Hazardous Materials will be by others if hazardous and contaminated materials are found onsite.

B. Refer to relevant Sections for handling of hazardous and contaminated material.

1.09 SITE CONDITIONS

A. Protection of Persons and Property

1. Visit and examine the Project site to assess and personally determine firsthand the extent of demolition, associated Work, debris removal, disposal and general Work to be done under this Section.

2. Post warning lights at perimeters of open depressions and excavations occurring as part of Work; when accessible through adjacent property or through public access. Operate warning lights during hours from dusk to dawn each day and as otherwise required. Excavations and depressions - Barricade in accordance with CAL/OSHA standards.

3. Protect utilities, pavements, adjacent building walls and facilities from damage caused by demolition vehicle equipment, settlement, lateral movement, undermining, washout and other hazards created by the demolition operations.

4. Repair any damage to sidewalks, adjacent building walls, driveways, curbs, fences, shrubs, trees, etc. adjacent to site that are the result of the Contractor's activities to original condition

5. Unless specified otherwise, clear parcel to the parcel lines. Enclose parcels entirely with construction fence per Technical Requirements, unless an existing wall or fence of at least equal height exists and the site can be made secure.

6. Erosion protection is to be provided throughout contract period, and shall be left in place at completion. Contractor shall comply with local stormwater and erosion control requirements.

B. Protect Active Utilities

1. Protect active sewer, water, gas, electric and another utilities; and drainage and irrigation lines indicated or, when not indicated, found or otherwise made known to the Contractor before or during demolition Work.

2. Immediately notify the Authority or its designee and the utility owner If a utility is damaged, during work,.

3. Take immediate steps as necessary to ensure that the service provided is not interrupted, If existing active services encountered are not indicated or otherwise made known to the Contractor and require protection or relocation,

4. Immediately notify the Authority or its designee and the utility owner if service is interrupted as a result of the Contractor's operations,.

5. Immediately notify the Authority or its designee in writing, requesting instructions if existing utilities are found to interfere with the permanent facilities under construction, under this Contract,. Do not proceed with the Work until written instructions are received from the Authority or its designee.

C. Unknown Conditions

1. Contract Drawings may not represent all surface nor sub-surface conditions at Worksite. Contractor shall inspect actual conditions for work planning before commencing demolition work.

2. Remove grade beams, caissons and other structural elements discovered during the Work as specified in this specification unless otherwise noted to remain.

3. Abandoned Oil Wells

a. If an abandoned oil well is encountered during excavation, notify Metro, CAL/OSHA representatives, and California Division of Oil and Gas (CAL/DOG).

b. Refer to Section 01 35 43, Environmental Procedures for Contaminated and Hazardous Materials

D. Dust Control

1. As specified in Section 01 57 19, Temporary Environmental Controls and South Coast Air Quality Management District Rule 403, fugitive dust, and all other regulatory limits.

E. Pollution Control

1. Refer to Section 01 57 19, Temporary Environmental Controls, for measures to mitigate dust, noise/vibration, water and other pollution created by the Work.

2. Metro will perform audit monitoring of air, noise, water, and other media to ensure compliance with specifications and legal regulatory requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide all temporary or permanent materials as required for the proper execution of the Work of this Section.

B. Provide construction fence and gates complying with Section 01 56 26, Construction Fencing (Wood) and Section 01 56 28 Construction Fencing (Chain Link).

PART 3 - EXECUTION

3.01 SECURITY AND ACCESS

A. Provide construction fence and gate complying with Section 01 56 26 or Section 01 56 28 where indicated on plan.

B. Fence gates at each parcel shall be locked and secured except when Contractor is working on that parcel. Doors to buildings and structures shall be locked except when work is occurring within the building.

C. Night time watch/security shall be provided for any structure under demolition when the work is not completed by the end of the business day.

3.02 EXISTING STRUCTURES AND RELATED FACILITIES

A. Demolish buildings and other structures, including foundations and base slabs, as indicated, and remove from Worksite. Completely remove buildings and structure foundations, footings and foundation systems, basements, stairs, hardscape, and walls except as otherwise indicated in specification below or on Project Definition drawings:

1. Building on pad footings, slabs or similar structures – complete removal of structure.

2. Building with basement or similar structures on floating foundation – complete removal of structure.

3. Building on piles/ caissons – removal of structure down to three feet below underside of pile cap.

4. Building with tie back – detention to all tie backs, saw cut and remove nearest three feet of tie back from the building structure.

B. Use methods as required to complete Work within limitations of regulations, and requirements of governing agencies and Metro.

1. Proceed with demolition Work in a systematic manner in accordance with Demolition Plan. Complete demolition Work above each floor or tier before disturbing supporting members on lower levels.

2. Remove walks, steps, walls, loading docks or platforms adjoining buildings, unless otherwise noted to remain. Do not remove sidewalks in the public way unless noted on the plans.

3. Remove poles (including street light, signal, sign, power, telephone and other poles), signs and fences, including footings unless otherwise noted to remain. Poles owned by utility company(s) will be removed by utility company(s). Poles and signs belonging to local authorities shall be removed and salvaged as noted on Demolition Plans.

4. Remove trees and shrubs within parcel limits.

5. Unless separated by retaining wall, grade unpaved parcel to match surrounding ground elevations along parcel lines. Fill in all holes with soil and flatten all dirt mounds. Grade site with on-site material and crushed miscellaneous base (CMB), except the top 3” shall be crushed rock per SSPWC Table 200-1.2(A) with ¾” nominal size.

3.03 PAVEMENT, SIDEWALK, AND CURB AND GUTTER

A. Perform the demolition and removal of demolition debris in accordance with the submitted and approved plan.

B. Sawcut and remove pavement, sidewalk, and curb and gutter as shown in the Contract Documents.

3.04 WIRING AND POLES

A. Remove wiring and poles in accordance with the submitted and approved site demolition plan and after clearance to proceed has been provided by Metro.

3.05 UTILITIES

A. Cap sewer service laterals at property line according to City of Los Angeles, Standard Plan S-110-1, Note 4. Note location and depth of cap on As-Built drawings, along with locations of other utility terminations.

B. Protect fire hydrants in place, unless otherwise shown.

3.06 BACKFILL OF DEMOLITION EXCAVATIONS

A. Excavations created by demolition activities shall be backfilled in the same manner as excavations created for the location of existing underground utilities as set forth in Section 31 20 00, Earthwork.

B. Backfill and compact depressions including basement cavities caused by any excavations, demolition and removal.

3.07 SALVAGE OR DISPOSAL OF MATERIALS

A. Materials indicated to be removed or demolished become property of Builder, except as noted in this section. Remove from Worksite and recycle or dispose of at legal disposal sites. Arrange for and pay required fees.

B. Do not allow non-salvageable material demolished or removed to accumulate at Worksite. Remove from Metro's property at frequent intervals, or as directed by Metro.

C. Burning of materials at the Worksite is not allowed.

D. Achieve a minimum of 80% for recycling of all demolition waste. Recycling facilities acceptance of concrete, brick, stone, metal, glass, wood, interior and exterior architectural details, etc. are to be provided to Metro. During loading of all materials into dump trucks the Builder shall meet the noise criteria. Large concrete slabs are not to be dumped into empty containers. A small amount of soil shall be loaded into the truck/container to act as a cushion/noise suppressant.

E. Repair, or replace with new material, salvaged material damaged or destroyed due to Contractor’s negligence, as determined by the Engineer.

F. Cleanup

1. Leave worksite clean and orderly at the end of the day. There shall be no off site migration of dust, dirt, or water. Each site shall have access, egress and adjacent sidewalk areas swept and clean at all times.

2. Builder shall be responsible for the removal of all dirt tracked out onto city streets.

3.08 REMOVAL AND STORAGE OF ARTWORK AND SIGNAGE

A. Artwork

1. The artwork installed at the exterior facades is comprised of 59 modular sections of powder coated dimensional steel panels attached to painted steel channels. The painted steel channels are installed on the vertical through-bolt attachment to a network of horizontal unistrut members, structurally attaching the entire artwork composition to the building facades.

2. Contractor shall protect all artwork elements during removal and crating. To remove artwork, Contractor shall support each modular section in location with web strapping from lift. Throughout removal, Contractor is to secure movement and protection of each modular section. To access socket cap screws securing modular sections to unistrut, Contractor must first carefully remove painted plugs at face of artwork. Contractor is to retain all painted plugs and hardware and include in crates with artwork.

3. Contractor shall design and build 7 wood crates lined with ½" dense foam capable of protecting and housing the total 59 modular artwork sections. Upon removal, Contractor shall label and crate each modular artwork section in accordance with the Workplan as approved by Metro Creative Services. During crating, Contractor shall layer one sheet of dense ½" foam between each modular artwork section for protection during transport and storage. Contractor shall label and store all crates indoors in a protected location for up to twenty four months from date of removal from building. Metro shall be provided with access to storage location. At the end of the twenty four month time period, deliver to a location within Los Angeles County.

B. Signage

1. Contractor shall remove and salvage the two Metro Logo signs, the neon channel letters comprising the word, "Metro" and all associated electrical elements. Contractor shall provide a workplan to Metro Creative Services for review and approval prior to scheduling work. A Metro Creative Services representative shall be present during all signage removal.

2. Contractor shall protect all signage elements during removal and crating. Contractor shall design and build a wooden crate lined with ½" dense foam capable of protecting and housing the signage elements. During crating, Contractor shall layer one sheet of ½" foam between each signage element for protection during transport and storage. Contractor shall coordinate delivery of crated signage elements to Metro.

C. See attachments **A through G** for the Metro Wilshire Customer Center Artwork Panel Layout.

END OF SECTION 02 41 00

SECTION 02 41 00

STAGING AREA CLEARING AND DEMOLITION

METRO ARTWORK ATTACHMENTS

A. Attachment A: Wilshire Customer Center Artwork Panel Layout

B. Attachment B: Wilshire Customer Center Artwork Panels and Signage Installed

C. Attachment C: Wilshire Customer Center Artwork Panels and Signage Installed

D. Attachment D: Wilshire Customer Center Artwork Panel Installation

E. Attachment E: Wilshire Customer Center Signage Fabrication Drawing 1

F. Attachment F: Wilshire Customer Center Signage Fabrication Drawing 2

G. Attachment G: Wilshire Customer Center Signage Fabrication Drawing 3

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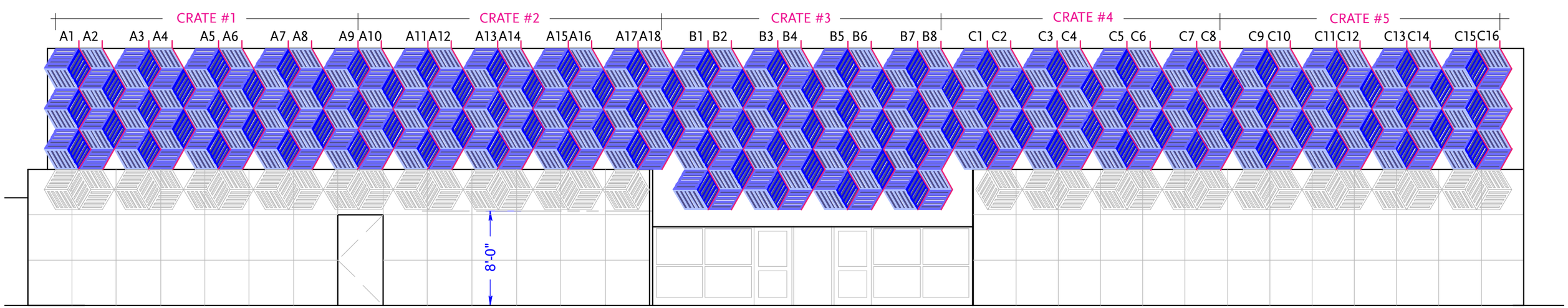
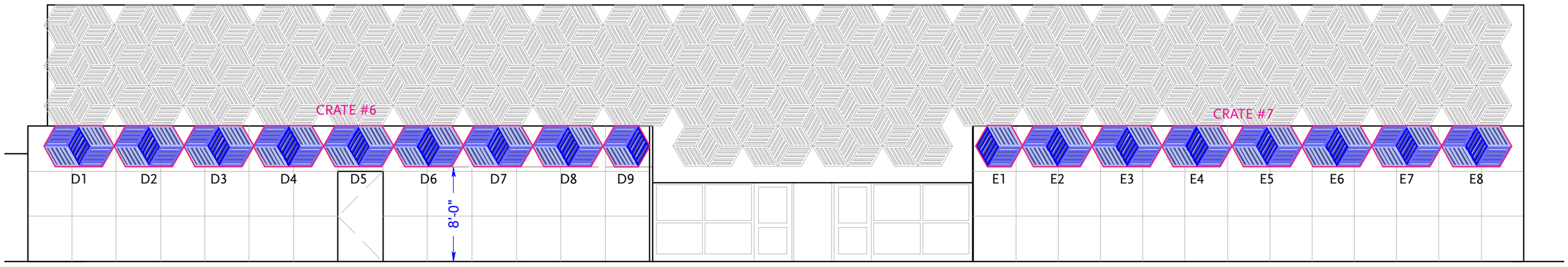


DEVELOPED ELEVATION, 1/8" = 1' - 0"

PANEL (A): 18 QTY AT 10'-3" X 3'-10"

PANEL (B): 8 QTY AT 13'-7" X 3'-10" PANEL

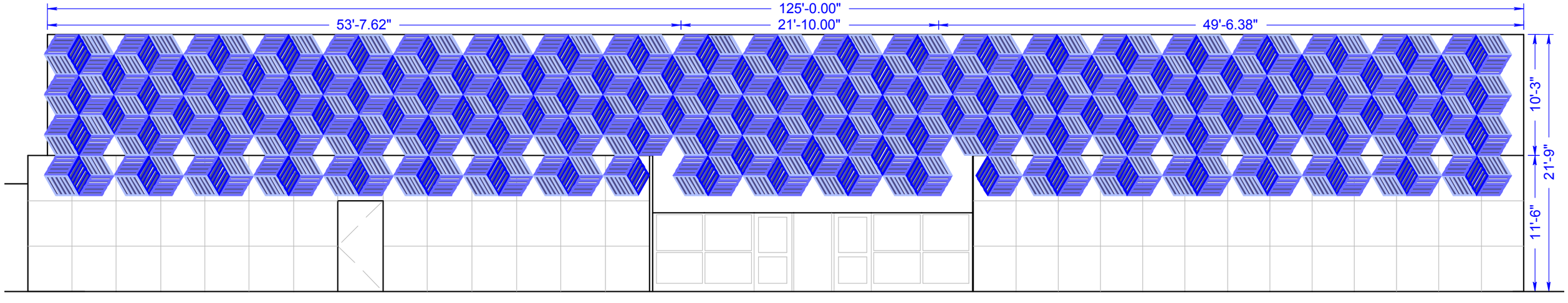
(C): 16 QTY AT 10'-3" X 3'-10"



DEVELOPED ELEVATION, 1/8" = 1' - 0"

PANEL (D): 9 QTY AT 5'-9" X 3'-10"

PANEL (E): 8 QTY AT 5'-9" X 3'-10"



DEVELOPED ELEVATION - SOUTH FACADE

DEVELOPED ELEVATION - CORNER FACADE

DEVELOPED ELEVATION - EAST FACADE

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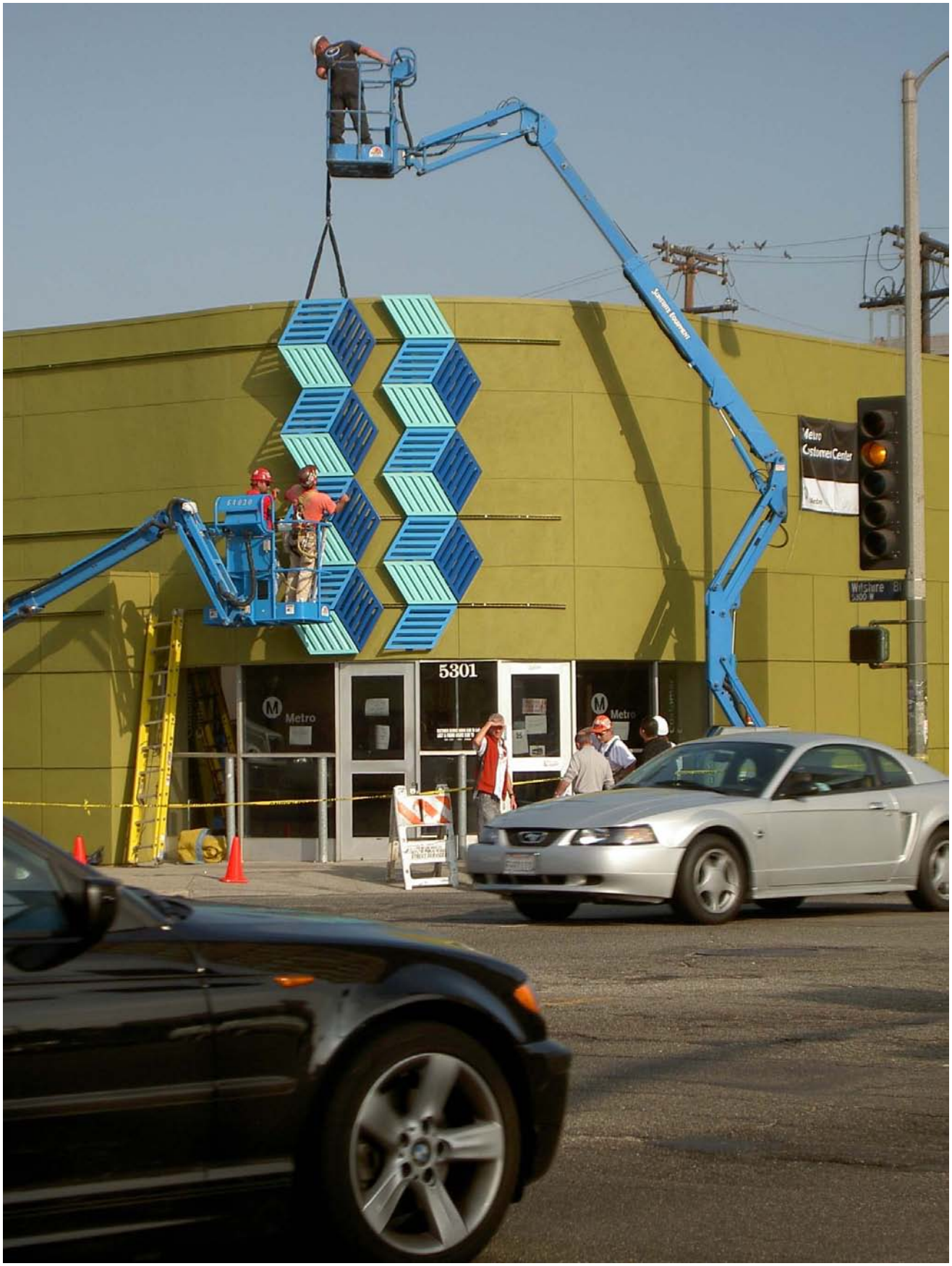
Attachment B: Wilshire Customer Center Artwork Panels and Signage Installed 01.18.13

Attachment C: Wilshire Customer Center Artwork Panels and Signage Installed 01.18.13



Attachment D: Wilshire Customer Center Artwork Panel Installation 01.18.13

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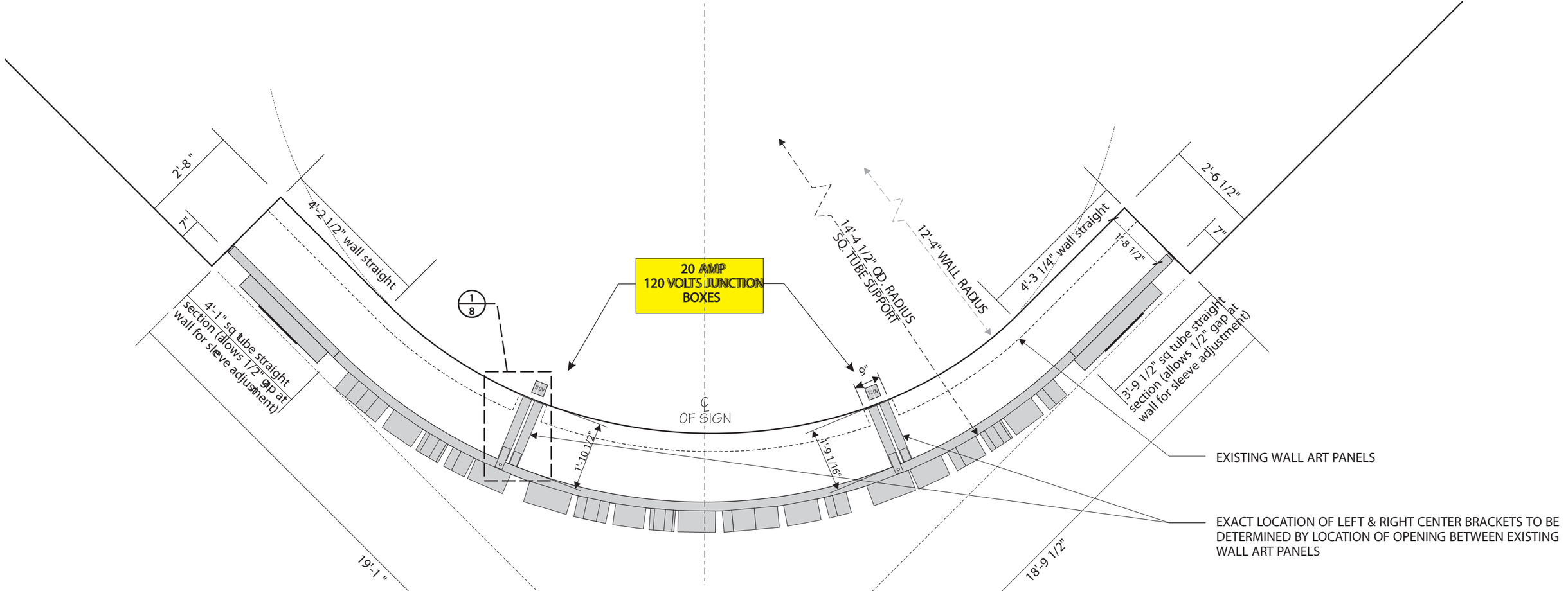
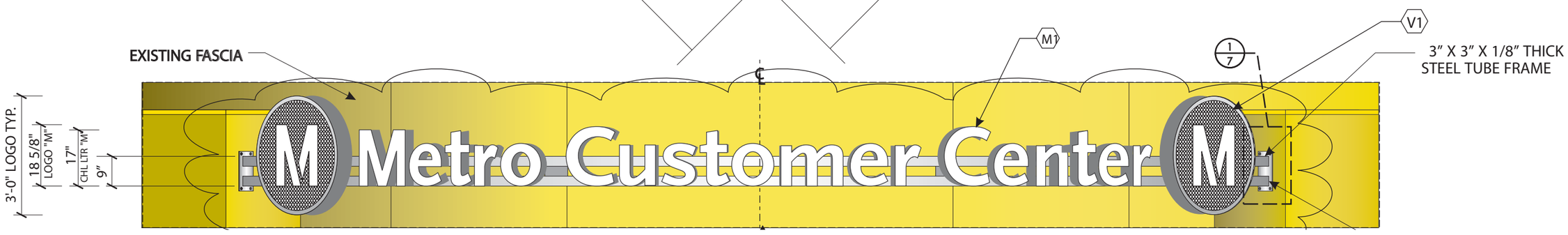


SIGN A- (PLAN VIEW)

SCALE: 3/8" = 1'-0"

SCOPE OF WORK:
1 SET SELF CONTAINED CHANNEL LETTERS & TWO (2) LOGOS ON STEEL SUPPORT STRUCTURE
LETTERS:
• 7" DEEP X .040" ALUMINUM RETURNS PAINTED MATTHEWS SILVER • 1/8" ~~TRANSLUCENT WHITE ACRYLIC~~ CLEAR ACRYLIC FACES W/ 3/4" TRIMCAP PAINTED TO MATCH RETURNS• 15 MM 6500 WHITE NEON INTERNAL ILLUMINATION•120 V VENTEX TRANSFORMER.
LOGOS:
•5" DEEP X .040" ALUMINUM RETURNS PAINTED MATTHEWS SILVER• 1/4" TRANSLUCENT WHITE ACRYLIC FACES W/3M PERFORATED VINYL OVERLAY & ½" THICK OPAQUE BLACKACRYLIC PAINTED WHITE • 1 1/4" RETAINERS PAINTED TO MATCH RETURNS
•15 MM 6500 WHITE NEON INTERNAL ILLUMINATION• 120 V VENTEX TRANSFORMER. LOGO WILL BE 1/2" THICK OPAQUE BLACK ACRYLIC PAINTED WHITE.



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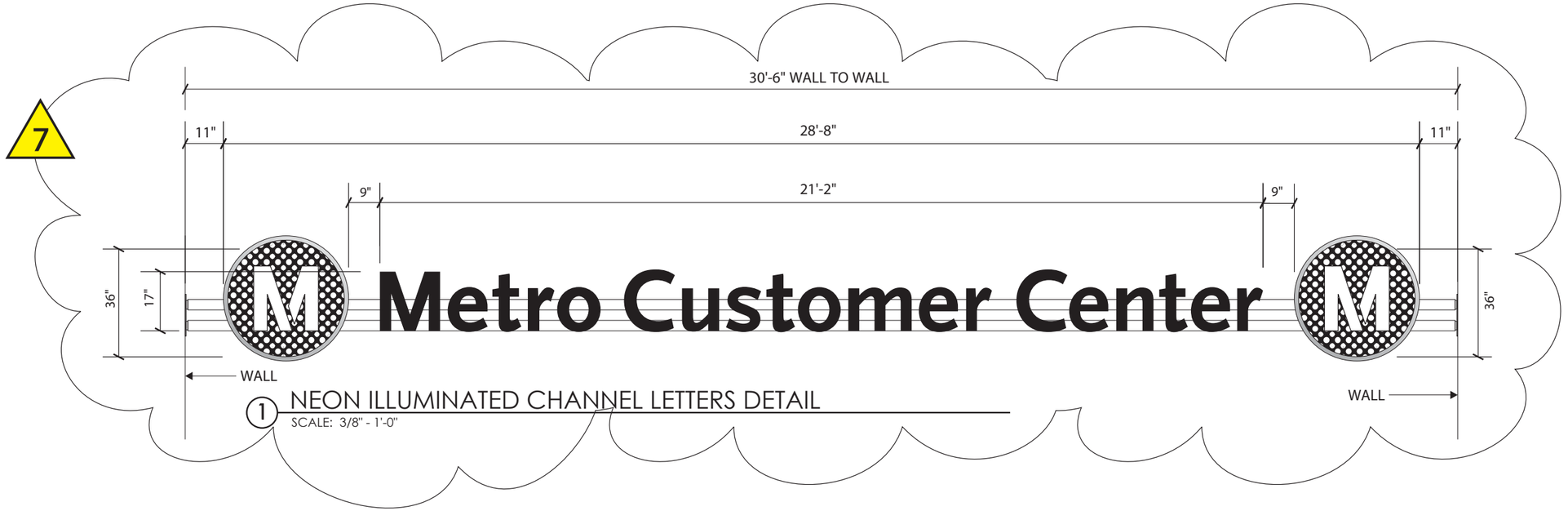
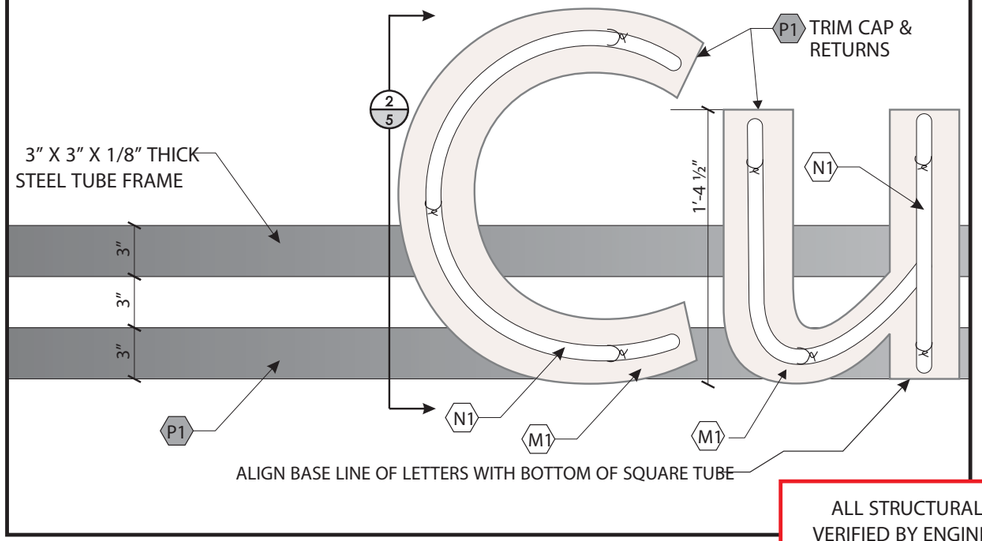
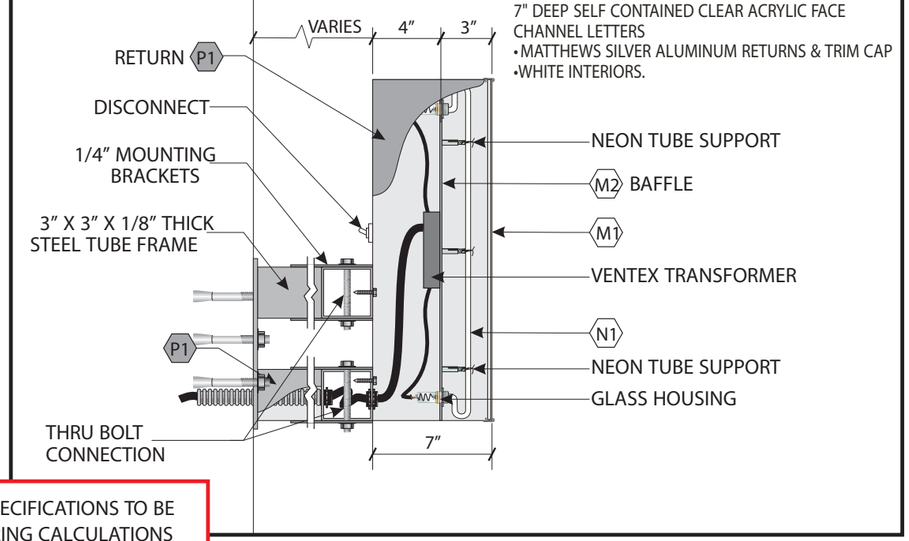


1 NEON ILLUMINATED CHANNEL LETTERS DETAIL
SCALE: 3/8" - 1'-0"



2 DETAIL
SCALE: N.T.S



3 DETAIL
SCALE: 1 ½" = 1'-0"

ALL STRUCTURAL SPECIFICATIONS TO BE VERIFIED BY ENGINEERING CALCULATIONS

MATERIAL LEGEND

MATERIAL FINISH- *Paint*

P1	Matthews Silver
P2	White

MATERIAL FINISH- *Vinyl*

V1	3M DUAL COLOR FILM BLACK 3636-222
V2	

MATERIAL- *Substrate*

M1	1/8" Clear Acrylic
M2	.063" Aluminum

MATERIAL FINISH- *Graphics*

G1	

TYPEFACES

T1	

NEON

N1	15 MM 6500 WHITE NEON

NOTE: MATERIAL LEGEND KEYS ARE FOR LNI INTERNAL USE AND MAY NOT CORRESPOND WITH ARCHITECT/CLIENT MATERIAL KEYS.

PROJECT NAME: LACMTA - CUSTOMER CARE CENTER	COMPUTER FILE DRAWING No: LACMTA - CUSTOMER CARE FACILITY R1	APPROVAL	DATE
ADDRESS: 5313 WILSHIRE BLVD	SCALE: AS NOTED	CLIENT	
CITY / STATE: LOS ANGELES, CA 90036	DRAWN BY: CR	SALES	
TELEPHONE: N/A	DESIGN DATE: 07/11/06	LANDLORD	
FAX NUMBER: N/A	SALES PERSON: THERESA ROTH	PROGRAMING	
		ENGINEER	

LNI CUSTOM MANUFACTURING
12536 Chadron Avenue
Hawthorne, CA 90250
Ph 310.978.2000
Fx 310.978.4000
http:\\www.lnisigns.com
DESIGNERS and BUILDERS of SIGNS

	DATE	BY	REVISION
6	09/15/06	MHL	Reduce letters/logo and support structure per field check. Add sleeve to end plate attachment.
7	09/18/06	MHL	Logo/Letters layout/sizes per Angelene Campuzano.
3	08/17/06	CR	CHANGE SIGN A TO SELF CONTAINED CONCEALED "OPEN" FACE CHANNEL LETTERS.
4	08/22/06	RTF	REVISED ATTACHMENT DETAILS (PG-5) AND CENTER MOUNTING PLATE TO MEASURING 8'-9" FROM THE GROUND
5	09/13/06	MHL	Move letters base line flush with bot. ofl ower hor. support. Logo location as elev. sht 4. Center plates from 9" to 10"

GENERAL NOTES

CUSTOMER TO PROVIDE PRIMARY ELECTRICAL SERVICE WITHIN 6'-0" OF SIGN ELECTRICAL CONNECTION.
ALL ELECTRICAL COMPONENTS TO BE U.L. APPROVED. MANUFACTURE'S LABEL AND U.L. LABEL SHALL BE PLACED ON SIGN ACCORDING TO CITY CODE.

SHEET 5 OF 8

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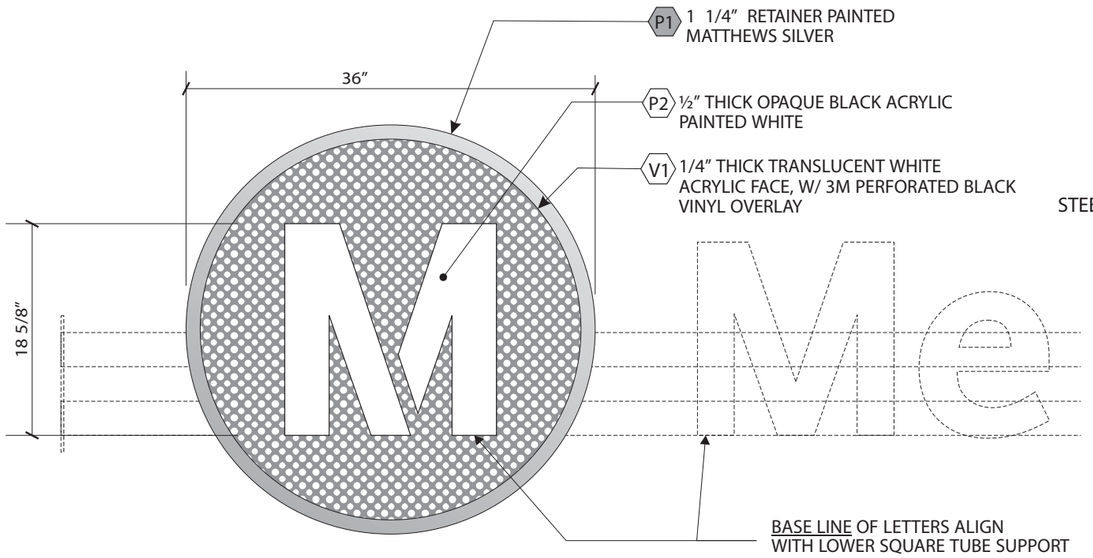
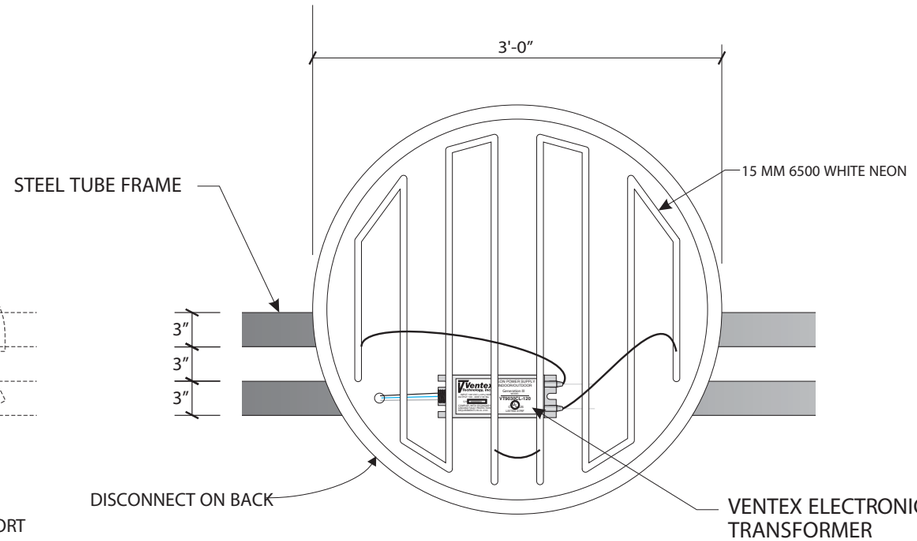


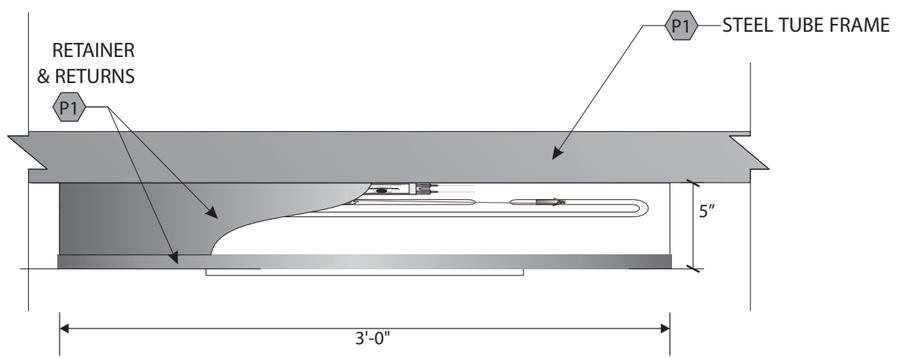
1 LOGO FACE DETAIL

SCALE: 1" = 1'-0"



2 LOGO ILLUMINATION DETAIL

SCALE: 1" = 1'-0"



3 LOGO PLAN VIEW

SCALE: 1 ½" = 1'-0"

MATERIAL LEGEND

MATERIAL FINISH- *Paint*

P1	Matthews Silver
P2	White

MATERIAL FINISH- *Vinyl*

V1	3M DUAL COLOR FILM BLACK 3636-222
V2	

MATERIAL- *Substrate*

M1	1/8" White Acrylic
M2	

MATERIAL FINISH- *Graphics*

G1	

TYPEFACES

T1	

NEON

N1	15 MM 6500 WHITE NEON

NOTE: MATERIAL LEGEND KEYS ARE FOR LNI INTERNAL USE AND MAY NOT CORRESPOND WITH ARCHITECT/CLIENT MATERIAL KEYS.

PROJECT NAME:	LACMTA - CUSTOMER CARE CENTER
ADDRESS:	5313 WILSHIRE BLVD
CITY / STATE:	LOS ANGELES, CA 90036
TELEPHONE:	N/A
FAX NUMBER:	N/A

DRAWING No:	LACMTA - CUSTOMER CARE FACILITY R
SCALE:	AS NOTED
DRAWN BY:	CR
DESIGN DATE:	07/11/06
SALES PERSON:	THERESA ROTH

APPROVAL	DATE
CLIENT	
SALES	
LANDLORD	
PROGRAMING	
ENGINEER	

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Hawthorne, CA 90250
Ph 310.978.2000
Fx 310.978.4000
http:\\www.lnisigns.com
DESIGNERS and BUILDERS of SIGNS

	DATE	BY	REVISION
6	09/15/06	MHL	Reduce letters/logo and support structure per field check. Add sleeve to end plate attachment.
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GENERAL NOTES

CUSTOMER TO PROVIDE PRIMARY ELECTRICAL SERVICE WITHIN 6'-0" OF SIGN ELECTRICAL CONNECTION.
ALL ELECTRICAL COMPONENTS TO BE U.L. APPROVED. MANUFACTURE'S LABEL AND U.L. LABEL SHALL BE PLACED ON SIGN ACCORDING TO CITY CODE.

SHEET 6 OF 8

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SECTION 08 33 23

OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 SECTION INCLUDES:

A. Designing, furnishing and installing face-of-wall mounted, motor-operated overhead coiling doors, labeled and non-labeled, as indicated and as required.

1. Overhead coiling doors are indicated as Roll Up Doors on Drawings.

1.02 RELATED SECTIONS

A.	Section 01 33 00	Submittal Procedures
B.	Section 01 43 10	Project Quality Program Requirements – Design/Build
C.	Section 01 78 23	Operation and Maintenance Data
D.	Section 01 78 43	Spare Parts, Illustrated Parts Catalog, and Replacement Materials
E.	Division 26	Electrical, for service conduit and wiring, disconnect switches, and overcurrent protection.

1.03 REFERENCES

A. California Code of Regulations (CCR) Title 24, Part 2

B. City of Los Angeles Building Code

C. County of Los Angeles Building Code

D. Metro Rail Design Criteria (MRDC)

E. American Society for Testing and Materials (ASTM)

1.	ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

F. National Electrical Manufacturers Association (NEMA)

G. National Fire Protection Association (NFPA)

1.	NFPA 80	Standard for Fire Doors and Other Opening Protectives
2.	NFPA 80A	Recommended Practice for Protection of Buildings from Exterior Fire Exposures

1.04 QUALITY ASSURANCE

A. Comply with requirements of Section 01 43 10.

B. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years experience in the fabrication and installation of security closures.

C. Installer Qualifications: Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.

D. Provide fire doors with Underwriters Laboratories Inc. (UL) label; provide oversize doors with UL Certificate of Inspection conforming to NFPA 80 and NFPA 80A.

E. Electrical components shall comply with NEMA as required.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Manufacturer's literature and product data, including MSDS and instructions and recommendations for preparation, fabrication and installation.

C. Shop Drawings and Erection Drawings.

D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

E. UL Certificate of Inspection for oversize fire rated doors and Certificate of Compliance for fire rated doors.

F. Door Samples: 12 inches by 12 inches of door including bottom rail/safety edge bottom bar, end locks, windlocks and guides.

G. Certificate of Inspection for oversize fire rated doors.

H. Operation and maintenance data for each piece of equipment in accordance with requirements of Section 01 78 23, Operation and Maintenance Data.

1. Include spare parts inventory with part numbers, prices, and photographs or cuts of repair parts, and certification of delivery.

2. Operation and maintenance manual containing printed instructions relative to operation, adjustment, care, and maintenance of the equipment.

3. Include wiring diagrams showing field changes, if any.

1.06 DEFINITIONS (NOT USED)

1.07 SPARE PARTS

A. Refer to Section 01 78 43 – Spare Parts, Illustrated Parts Catalog and Replacement Materials.

B. ~~Provide~~ **Propose** one set of critical spare parts for each door, boxed and identified, including installation instructions, wiring diagrams, and other information as necessary to make emergency repairs **as part of Section 01 78 43 List B submittal**.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Type and Manufacture: Roll-up (overhead coiling) service steel doors shall be motor-operated, steel roll-up type, face-mounted as indicated. Doors shall be counter-balanced for smooth and easy operation.

B. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

C. Identify rated and non-rated doors during design process. Submit complete design for system.

D. Performance Requirements:

1. Service Doors: Design and manufacture doors to be fully operable under wind load of 20 pounds per square foot.

2. Operation: Design door assembly, including operator, to operate for not less than 20,000 cycles.

3. Fire Rated Doors: Provide fire rated assemblies complying with NFPA 80 and listed in UL Directory or Intertek Testing Services (Warnock Hersey Listed) Directory.

2.02 OVERHEAD COILING, ROLL UP DOORS

A. Curtain: Interlocking roll-formed slats, minimum 20 gage galvanized steel, or heavier if required by design.

1. Curtain slats and hood shall be galvanized in accordance with ASTM A653 and receive rust-inhibitive, roll coating process, including manufacturer's standard prime paint and baked-on polyester top coat.

2. Color selected by Metro.

3. Non-galvanized exposed ferrous surfaces shall receive one coat of rust-inhibitive primer.

4. Include compressible weather seal mounted along bottom edge of door

B. Mounting Components: Fabricate brackets of rolled steel plate; designed to support weight of curtain and operating devices, resist operation thrust, and act as hood closure. Provide guides of standard shapes to retain curtain at stated wind pressure. Include anchors, fasteners and accessories.

C. Barrel: Design to rotate about torsion rod on permanently lubricated and sealed, self-aligning, ball bearing races with deflection limited to 0.03 inch per foot when fully loaded with weight of curtain. Torsion rod shall be high tensile, case-hardened carbon steel with adjustment wheel.

D. Counterbalance: Helical torsion spring type. Support curtain as required to permit operation with not less than 20 nor more than 25 pounds pull on operating device.

2.03 OVERHEAD COILING FIRE-RATED DOORS

A. Adjust design of non-rated doors to meet UL certification and include any required governors, automatic closure and safety devices.

2.04 POWER OPERATING EQUIPMENT

A. Appropriate motor and control panel for Final Design, include operators, operating stations with remote control with key switch and manual over-ride and locking capability.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that sizes and configurations of openings which will receive doors comply with design and details in accepted shop drawings.

B. Furnish templates and install anchoring devices for doors in adjacent supporting structures.

3.02 INSTALLATION

A. Install door in conformance with UL, NFPA 80, and manufacturer’s instructions.

B. Anchor to adjacent construction without distortion or stress.

C. Fit and align door and shutter assembly including hardware, plumb, level and square to ensure smooth operation.

D. Make wiring connections between power supply and operator and between operator and controls.

3.03 ADJUSTING

A. Adjust closures to operate smoothly throughout full operating range.

B. Verify that controls and safety devices operate properly in accordance with manufacturer’s safety checklist.

3.04 DEMONSTRATION

A. Demonstrate and instruct Metro about proper operation.

3.05 MAINTENANCE

A. Provide call-back maintenance service for period of one year, beginning from date of Acceptance of Work.

END OF SECTION 08 33 23

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SECTION 08 33 26

OVERHEAD COILING STAINLESS STEEL GRILLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Designing, furnishing and installing motor-operated roll-up security grilles at station entry portal.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 23 Operation and Maintenance Data

D. Section 01 78 43 Spare Parts, Illustrated Parts Catalog, and Replacement Materials

E. Section 22 14 00 Storm Drainage System (Plumbing)

1.03 REFERENCES

A. Metro Rail Design Criteria (MRDC)

B. Metro Rail Standard Drawings (MRSD)

C. American Society for Testing and Materials (ASTM)

1. ASTM A36 Standard Specification for Carbon Structural Steel

2. ASTM A48 Standard Specification for Gray Iron Castings

3. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

4. ASTM A240 Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

5. ASTM A480 Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

D. National Association of Architectural Metal Manufacturers (NAAMM)

1. AMP 500 Metal Finishes Manual for Architectural and Metal Products

E. National Electrical Manufacturers Association (NEMA)

1. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

F. The Society for Protective Coatings (SSPC)

1. SSPC SP 3 Power Tool Cleaning

1.04 QUALITY ASSURANCE

A. Comply with requirements of Section 01 43 10.

B. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years experience in the fabrication and installation of security closures.

C. Installer Qualifications: Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.

1.05 SUBMITTALS

A. Refer to Section 01 33 00.

B. Shop and erection drawings.

C. Product Data - Manufacturer's literature with safety edge, limit switches, and wiring diagram, including instructions and recommendations for preparation, fabrication and installation.

D. Certificates: certification from manufacturer, certifying that installer is approved by, licensed, or certified by manufacturer for installation of specified materials/products or systems.

E. Operation and maintenance data for each piece of equipment in accordance with requirements of Section 01 78 23, Operation and Maintenance Data.

1. Include spare parts inventory with part numbers, prices, and photographs or cuts of repair parts, and certification of delivery.

2. Operation and maintenance manual containing printed instructions relative to operation, adjustment, care, and maintenance of the equipment.

F. Include wiring diagrams showing field changes, if any..

G. Samples: Grille, 12 inch by 12 inch, including bottom rail, end locks and guides.

1.06 DEFINITIONS (NOT USED)

1.07 WARRANTY

A. Provide written warranty, signed by manufacturer, installer and Contractor, agreeing to replace component parts, or entire grille, showing defects or failure of materials or workmanship, at no cost to Metro or its designee for period of five years following date of final acceptance.

1.08 SPARE PARTS

A. Refer to Section 01 78 43 – Spare Parts, Illustrated Parts Catalog and Replacement Materials.

B. ~~Provide~~ **Propose** one set of critical spare parts for each grille, boxed and identified, including installation instructions, wiring diagrams, and other information necessary to make emergency repairs **as part of Section 01 78 43 List B submittal**.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Type and Manufacture: Roll-up (overhead coiling) security grilles shall be motor-operated, stainless steel, face-mounted as indicated. Grilles shall be counter-balanced for smooth and easy operation.

B. Single-Source Responsibility: Provide grilles, tracks, motors, and accessories from one manufacturer. May provide secondary components from source acceptable to manufacturer of primary components.

C. Performance Requirements:

1. Service Doors: Design and manufacture doors to be fully operable under wind load of 20 pounds per square foot.

2. Operation: Design door assembly, including operator, to operate for not less than 20,000 cycles.

D. Refer to MRSD A-006 for standard details.

E. Key and systems-related requirements are addressed in MRDC.

F. Refer to Section 22 14 00 for the adjacent trench drain and grating system.

2.02 MATERIALS

A. Stainless Steel: ASTM A240, Type 316, with a NAAMM AMP 500 No. 4 finish on visible surfaces, in accordance with ASTM A480.

B. Gray Iron Castings: ASTM A48.

C. Seamless Steel Pipe: ASTM A53.

D. Ferrous Metal: ASTM A36. Prepare in accordance with SSPC SP-3. Shop prime with manufacturer's standard rust inhibitive paint.

2.03 OVERHEAD COILING GRILLES

A. Curtain: Horizontal stainless steel rods with stainless steel spreader tubes, connected by vertical chains; connect to and between single and double links in alternating vertical pattern and assemble to prevent horizontal movement of links.

Connect ends of horizontal rods with continuous link assembly and end locks to prevent lateral movement of curtain and to retain horizontal bars in guides.

B. Stainless steel rails and guides.

C. Mounting Brackets: Rolled steel plate designed to support weight of curtain operating devices and resist thrust of operation.

D. Barrel: Seamless steel pipe, four inches or larger in diameter, designed to rotate about torsion rod on permanently lubricated and sealed, self-aligning, ball bearing races with deflection limited to 0.03 inch per foot when fully loaded with weight of curtain. Torsion rod shall be high tensile, case-hardened carbon steel with adjustment wheel.

E. Counterbalance: Provide counterbalance support of curtain as required to permit operation with not less than 20 nor more than 25 pounds pull on operating device. Counterbalanced by means of adjustable steel helical torsion springs.

F. Hood: Manufacturer's standard 22 gage stainless steel.

2.04 OPERATING DEVICES

A. Heavy duty, ball bearing motor, 460/480 Volt, 60 hertz, three phase, drip-proof, UL Listed. High starting torque, reversible, constant duty, Class A insulated electric motor capable of moving curtain from 2/3 foot per second to one foot per second in both opening and closing directions.

B. Hanging emergency chain operator with automatic disconnect and electrical safety interlock. Make hand chain for manual operation accessible from floor without the use of ladder.

C. Enclosure: NEMA 250, Type 4X.

2.05 CONTROLS/INDICATIONS

A. Locally control the roll-up grille from two local control stations and remotely/control from the Central Control Facility (CCF or ROC) as required by Metro.

B. Provide Safety Edge switch for obstruction detection. When an obstruction is encountered during grille closing, the grille shall stop, then immediately reverse direction, and go to its full open position unless it is within six inches of closing.

C. Provide time delay relay (delay on energization), range 20-200 second equipped with one "T" auxiliary switch, adjustable 0-60 seconds.

D. Limit Switches

1. Provide adjustable limit switches inside motor gearbox to detect fully open and fully closed operations.

2. Provide limit switch for a local audible alarm circuit. Unless the selector switch is in silence position, this limit switch shall activate the intrusion horn for 200 seconds, five seconds after the grille is fully closed or if someone tries to

physically lift the closed grille. Install at bottom of the grille's channel and have two Form C contacts, UL-listed in a standard industrial grade weatherproof enclosure. Use one of the contacts for intrusion detection.

E. Horn - Provide horn with an audible alarm of 100 dB sound pressure level.

F. When the audible alarm circuit is initiated, a normally closed contact from the 200 second timing relay shall open to indicate an intrusion alarm. The following status indications shall be provided locally at each LCS, and via voltage free contacts rated at 120 VAC, 1 amp for remote monitoring of grille OPEN, grille CLOSED.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that sizes and configurations of openings which will receive doors comply with design and details in accepted shop drawings.

B. Furnish templates and install anchoring devices for doors in adjacent supporting structures.

3.02 INSTALLATION

A. Install grille in conformance with accepted shop drawings and manufacturer’s instructions.

B. Anchor to adjacent construction without distortion or stress.

C. Fit and align door and shutter assembly including hardware, plumb, level and square to ensure smooth operation.

D. Make wiring connections between power supply and operator and between operator and controls.

3.03 ADJUSTING

A. Adjust closures to operate smoothly throughout full operating range.

B. Verify that controls and safety devices operate properly in accordance with manufacturer’s safety checklist.

3.04 DEMONSTRATION

A. Demonstrate and instruct Metro about proper operation.

3.05 MAINTENANCE

A. Provide call-back maintenance service for period of one year, beginning from date of Acceptance of Work.

END OF SECTION 08 33 26

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SECTION 08 71 11

FINISH HARDWARE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Designing, furnishing and installing finish hardware to provide a complete, operable facility.

B. Door hardware

1. Locking and exit devices
2. Security hardware and seals
3. Thresholds and kick plates
4. Locks, latches, and fasteners
5. Keying requirements

1.02 RELATED SECTIONS

A.	Section 01 33 00	Submittal Procedures
B.	Section 01 43 10	Project Quality Program Requirements – Design/Build
C.	**Section 01 78 43**	**Spare Parts, Illustrated Parts Catalog, and Replacement Materials**
~~C.~~**D.**	Division 07	Thermal and Moisture Protection, for sealants
~~D.~~**E.**	Division 08	Openings
~~E.~~**F.**	Division 21	Fire Suppression
~~F.~~**G.**	Division 28	Electronic Safety and Security

1.03 REFERENCES

A. California Code of Regulations (CCR) Title 24, Part 2

B. City of Los Angeles Building Code

C. County of Los Angeles Building Code

D. Metro Rail Design Criteria (MRDC)

E. Metro Rail Standard Drawings (MRSD)

F. National Fire Protection Association (NFPA)

1. NFPA 80 Standard for Fire Doors and other Opening Protectives
2. NFPA 101 Life Safety Code
3. NFPA 105 Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives
4. NFPA 252 Standard Methods of Fire Tests of Door Assemblies

G. American National Standards Institute (ANSI)

1. ANSI A156.3 Exit Devices
2. ANSI A156.4 Door Controls - Closers
3. ANSI A156.5 Cylinders and Input Devices for Locks
4. ANSI A156.11 Cabinet Locks
5. ANSI A156.13 Mortise Locks and Latches, Series 1000
6. ANSI A156.16 Auxiliary Hardware

H. American Society for Testing and Materials (ASTM)

1. ASTM F476 Standard Test Methods for Security of Swinging Door Assemblies (Withdrawn 2011)
2. ASTM F883 Standard Performance Specification for Padlocks

I. Building Manufacturers Hardware Association (BMHA)

J. Door Hardware Institute (DHI)

1. DHI/ANSI A114.IG Installation Guide for Doors and Hardware

K. Underwriters Laboratories Inc. (UL)

1. UL 10C Positive Pressure Fire Test of Door Assemblies
2. UL 305 Panic Hardware

1.04 QUALITY ASSURANCE

A. Comply with requirements of Section 01 43 10.

B. In case of conflict between type of hardware and type required for fire protection, furnish UL listed type required by NFPA.

C. Qualifications:

1. Provide a certified architectural hardware consultant (AHC), available at reasonable times during Design process and course of work for project hardware consultation to Metro, D/B Contractor and installer.

a. Responsible for detailing, scheduling and ordering of finish hardware. Detailing implies that the submitted schedule of hardware is correct and complete for the intended function and performance of the openings.

D. Hardware: Free of defects, blemishes and excessive play. Obtain each kind of hardware (latch and locksets, exit devices, hinges and closers) from one manufacturer.

E. Pre-Installation Meetings: Initiate and conduct with supplier, installer and related trades, coordinate materials and techniques, and sequence complex hardware items and systems installation. Include manufacturers' representatives of locks, panic hardware and door closers in the meetings. Convene prior to commencement of related work.

1.05 SUBMITTALS

A. Refer to Section 01 33 00.

B. Shop Drawings and detailed hardware schedule in a vertical format with data required in PART 3.

C. Keying schedule.

D. Manufacturer's specifications and installation data.

E. Notification of Delivery - Notify Metro of delivery of permanent cores and blank keys.

F. Samples

G. Closeout Submittals

1. Copy of final hardware schedule, edited to reflect, "As installed."

2. Copy of final keying schedule.

3. As installed “Wiring Diagrams” for each piece of hardware connected to power, both low voltage and 110 volts.

~~4. One set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.~~

1.06 DEFINITIONS (NOT USED)

1.07 COORDINATION

A. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements. Furnish related trades with the following information:

1. Location of embedded and attached items to concrete.

2. Location of wall-mounted hardware, including wall stops.

3. Location of finish floor materials and floor-mounted hardware.

4. At masonry construction, coordinate with the anchoring and hollow metal supplier prior to frame installation.

5. Locations for conduit and raceways as needed for electrical, electronic and electro-pneumatic hardware items. Fire/life-safety system and security system interfacing.

6. Manufacturers' templates to door and frame fabricators.

B. Keying Schedule: Arrange for a keying meeting with Metro and hardware supplier, and other involved parties to ensure locksets and locking hardware are functionally correct and keying complies with project requirements.

1.08 SPARE PARTS

A. ~~Furnish spares of uncombined cores and blank keys in quantity equal to five percent of total supplied for Project.~~**See Section 01 78 43, Spare Parts, Illustrated Parts Catalog, and Replacement Materials, for requirements.**

~~B. Special tools identified under Submittals article.~~

1.09 COMMISSIONING

A. Conduct these tests prior to request for certificate of substantial completion:

1. With installer present, test door hardware operation with climate control system and stairwell pressurization system both at rest and while in full operation.

2. With installer, access control contractor and electrical contractor present, test electrical, electronic and electro-pneumatic hardware systems for satisfactory operation.

3. With installer and electrical contractor present, test hardware interfaced with fire/life-safety system for proper operation and release.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Design document submittals shall include drawings, specifications and schedules at every stage and milestone.

1. Door control diagrams as indicated on MRSD.

2. Comply with MRDC requirements for Operations, Security, train induced transient air pressures at stations, and Metro’s Standard Keying System.

B. Coordinate with Metro for most current finish hardware policy prior to start of Design process.

1. Permanent cores to match and integrate with Metro's existing security system.

C. Design Requirements

1. Fire-Rated Openings: NFPA 80 compliant.

2. Furnish UL listed hardware of type required for use with types and sizes of fire doors and frames indicated.

3. Exit Doors: Operable from inside with single motion without the use of a key or special knowledge or effort. Where exit hardware is required on doors at fire-rated openings, comply with UL 305.

4. Furnish hardware to door manufacturer for factory installation. Provide supplementary label, Fire Exit Hardware, on each exit device certifying hardware has been panic-load tested with door.

5. Fasteners

a. Provide concealed fastenings wherever possible

b. Through-bolts: Do not use

D. When and where required by regulatory agencies, provide hardware conforming to requirements of such agencies and bearing appropriate labels.

2.02 HARDWARE

A. Hardware shall be UL (including positive or negative pressure) compliant for given type/size opening and degree of label.

B. Furnish hardware items required to complete the work in accordance with specified performance level and design intent, complying with manufacturers' instructions and code requirements.

C. Furnish items as required with proper size and quantity of screws, bolts and other fastening devices to properly hold items in place.

D. Match character and finish of items with those supplied.

E. Provide concealed fasteners wherever practicable. Furnish countersunk, tamperproof screws where concealed fastening is not possible.

2.03 HINGES

A. Drawings typically depict door swings, but doors will actually swing to maximum allowable. Swings need to be verified and revised during the Design process.

1. Use wide-throw conventional or continuous hinges as needed up to 8 inches in width to allow door to stand parallel to wall for true 180-degree opening. Advise Metro if 8 inch width is insufficient

B. Conform to manufacturer's published hinge selection standard for door dimensions, weight and frequency, and to hinge selection as scheduled.

1. Where manufacturer's standard exceeds scheduled product, furnish heavier of two choices; notify Metro of deviation from scheduled hardware.

C. Conventional Hinges: Steel or stainless steel pins and concealed bearings.

1. Hinge open widths minimum, but of sufficient throw to permit maximum door swing

2. Out-swinging Exterior Doors: Non-ferrous with non-removable (NRP) pins and security studs

a. Non-ferrous material at exterior doors and doors subject to corrosive atmospheric

2.04 LOCKSETS, DEADLOCKS, PADLOCKS

A. Heavy-duty, mortise-type, locksets and latchsets.

1. Solid, one-piece, 3/4-inch (19mm) throw, anti-friction latchbolt made of self-lubricating stainless steel

2. Deadbolt functions shall have 1 inch (25mm) throw bolt made of hardened stainless steel

3. Latchbolt and Deadbolt are to extend into the case a minimum of 3/8 inch (9.5mm) when fully extended

4. Auxiliary deadlatch to be made of one piece stainless steel, permanently lubricated

5. Provide sufficient curved strike lip to protect door trim

6. Lever handles must be of forged or cast brass, bronze or stainless steel construction and conform to ANSI A117.1. Levers that contain a hollow cavity are not acceptable

7. Lock shall have self-aligning, thru-bolted trim

8. Levers to operate a roller bearing spindle hub mechanism

9. Spindle to be designed to prevent forced entry from attacking of lever

10. Provide locksets with removable and interchangeable core cylinders

11. Each lever to have independent spring mechanism controlling it

B. Certifications:

1. ANSI A156.13, Grade 1 Operational.

2. ASTM F476, Grade 31, UL Listed.

3. ANSI A156.5, Grade 1.

C. Cabinet Locks, for use in electric controllers:

1. Conforming to ANSI A156.11, Grade 1.

D. Padlocks

1. Comply with ASTM F883, Grade 4.

2.05 CYLINDERS AND PERMANENT CORES

A. Mortise cylinders for mortise locksets, panic exit devices, or auxiliary deadlocks and rim cylinders for rim-type panic exit devices.

B. Provide the necessary cylinder housings, collars, rings, and springs, as recommended by the manufacturer.

C. Provide proper cylinder cams or tail pieces.

D. Seven pin interchangeable core removable by special control key without removing cylinder.

1. Interchangeable removable core parts: Extruded brass with ANSI/BHMA 626 finish for surfaces exposed to view.

2. Permanent cores to match and integrate with Metro's existing security system.

2.06 PANIC EXIT DEVICES

A. General Features:

1. Mortise-type or rim-type, touch-bar operated

2. Push-through push-pad design.

a. No exposed push-pad fasteners and no exposed cavities when operated.

b. Return stroke fluid dampeners and rubber bottoming dampeners, plus anti-rattle devices.

3. Deadlocking Latch bolts, 0.75 inch projection

4. End Caps: Impact-resistant, flush-mounted.

a. No raised edges or lips to catch carts or other equipment.

5. No exposed screws to show through glass doors.

6. Non-handed basic device design with center case interchangeable with every functions

a. No extra parts required to effect change of function.

7. Releasable in normal operation with door opening force requirements to meet CBC, unless specific locations require more stringent requirements at Final Design.

8. UL Tested In accordance with ANSI A156.3, Grade 1 for:

a. Accident Hazard for non-labeled doors

b. Fire Exit Hardware for labeled doors

B. Specific Features:

1. Exposed components shall be of metals and architectural finishes per Final Design.

2. Non-Fire Rated Devices: Cylinder dogging.

3. Lever Trim: Breakaway type, forged brass or bronze escutcheon.

a. Minimum. 0.130 inch thickness, compression spring drive, match lockset lever design.

4. Fire-Labeled Devices: UL label indicating “Fire Exit Hardware”

a. Vertical rod devices less bottom rod (LBR) unless otherwise scheduled

5. Delayed Egress Devices: Function achieved within single exit device component, including latch, delayed locking device, request-to-exit switch, nuisance alarm, remote alarm, key switch, indicator lamp, relay, internal horn, door position input, external inhibit input plus fire alarm input.

a. NFPA 101 “Special Locking Arrangement” compliant

6. Electrically Operated Devices: Single manufacturer source for electric latch retraction devices, electrically controlled trim, power transfers, power supplies, monitoring switches and controls.

7. Removable Mullions: Removable with single turn of building key

a. Securely reinstalled without need for key

C. Furnish storage brackets for securely stowing mullion away from door when removed.

2.07 DOOR CLOSERS

A. Surface Mounted Type Door Closers: Conforming to ANSI A156.4 Grade 1 UL certified.

B. Separate adjusting valves for closing, latching speed, and backcheck

C. Provide adapter plates, shim spacers and blade stop spacers as required by frame and door conditions

D. Mount closers on non-public side of door unless otherwise noted in Final Design specifications.

2.08 COMPONENTS

A. Automatic Flush Bolt - Low operating force design. ANSI A156.3 Type 25 (hollow metal doors) or Type 27 (wood doors).

B. Manual Flush Bolt - BHMA Designation L04201. ANSI A156.16.

C. Door Stops

1. BHMA Designation:L0210 for wall stops

2. BHMA Designation L02141 for floor stops.

3. Overhead stop surface mounted when a floor or wall stop cannot be used or when listed in hardware set. Heavy duty bronze or stainless steel.

D. Silencers - BHMA Designation—L03011

2.09 DOOR SEALS

A. Fire tested and UL approved silicone rubber formulation finished to match adjacent frame color.

B. Meeting Stile:

1. Adjustable type, surface-mounted-extruded aluminum, clear anodized finish with stainless steel screws

2.10 COMBINATION JUNCTION BOX AND GROUT PROTECTOR

A. Provide for door frames scheduled to receive electric butt hinge.

1. Junction Box: UL approved, galvanized, at least 0.040 inch thick.

2.11 DOOR COORDINATOR

A. For use on double doors with door closers or closer and automatic flush bolt where specified.

1. Steel, prime painted.

2. Provide length to suit width of door and frame filler to close header.

2.12 THRESHOLDS

A. Comply with CBC Section 1133B.2.4.1

1. Extruded aluminum alloy 6063-T5 with or without neoprene or silicone insert

2.13 KICKPLATES

A. Four beveled edges.

1. Sheet metal screws of stainless steel to match other hardware

B. BHMA Designation J102:

1. Stainless steel Type 316

2. Two inches less than door width by ten inches high by 0.050 inch thick.

2.14 MOP PLATE

A. BHMA Designation J103:

1. Stainless steel Type 316

2. One inch less than width of door by ten inches high by 0.050 inch thick.

3. Finish: BHMA 630.

2.15 GATE LATCH

A. Mechanically Galvanized (ST2H) Gate Latch, or approved equivalent.

2.16 WALL AND FLOOR MOUNTED ELECTROMAGNETIC DOOR HOLDERS

A. Incorporate into UL. listed fire and life-safety system

1. Doors release to allow closure and latching when door's zone is in alarm state

2.17 FASTENERS

A. Provide concealed fastenings wherever possible. Do not use self-tapping or sheet metal screws except for application of flush-mounted pushplates and kickplates.

1. Concealed Fasteners - Furnish hardware items with appropriate type and length of screws or other fastenings suitable to ensure permanent anchorage.

2. Exposed Fasteners - Unless otherwise indicated, furnish hardware items with countersunk, tamper resistant screws where concealed fastening is not possible. Match finish color of screws with hardware item being fastened.

2.18 KEYING

A. Determine specific keying requirements in consultation with Metro.

B. Process During Construction: the following may be adopted upon Metro approval:

1. Provide keyed brass construction cores and keys during the construction period. Construction control and operating keys and core shall not be part of Metro's permanent keying system or furnished in the same keyway (or key section) as Metro's permanent keying system.

a. Permanent cores and keys (prepared according to the approved keying schedule) will be furnished to Metro.

2. Cylinders, removable and Small Format interchangeable core system: Match Metro's existing system.

3. Permanent keys and cores: Stamped with the applicable key mark for identification. These visual key control marks or codes will not include the actual key cuts. Permanent keys will also be stamped "Do Not Duplicate."

4. Transmit Grand Masterkeys, Masterkeys and other Security keys to Metro by Registered Mail, return receipt requested.

5. Furnish keys in the following quantities, numbers to be adjusted during Design process:

a. 1 each Grand Masterkeys

b. 4 each Masterkeys

c. 2 each Change keys each keyed core

d. 15 each Construction masterkeys

e. 1 each Control keys

6. Metro will install permanent cores and return the construction cores to the Hardware Supplier.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install hardware to doors as recommended by hardware manufacturer and in accordance with DHI/ANSI A114.IG.

B. Mount hardware units at heights to comply with governing regulations.

3.02 SCHEDULES

A. Submit schedule including the following information:

1. List groups and suffixes in proper sequence.

2. Completely describe door and list architectural door number.

3. Manufacturer, product name, and catalog number.

4. Function, type, and style.

5. Size and finish of each item.

6. Mounting heights.

7. Explanation of abbreviations and symbols used within schedule.

8. Detailed wiring diagrams, specially developed for each opening, indicating all electric hardware, security equipment and access control equipment, and door and frame rough-ins required for specific opening.

END OF SECTION 08 71 11

SECTION 13 22 10

TRAIN OPERATING SUPERVISOR'S BOOTH

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Provide all labor, equipment and materials to furnish and install a prefabricated Train Operating Supervisor's (TOS) booth at the La Cienega Station as indicated. See Attachment A.

1.02 RELATED SECTIONS

A.	Section 01 33 00	Submittal Procedures
B.	Section 01 43 10	Project Quality Program Requirements – Design/Build
C.	Section 09 96 23	Anti-Graffiti Coating
D.	Section 21 00 00	Fire Protection Systems
E.	Section 22 05 10	Plumbing Piping Design (Design Build) Requirements
F.	Section 25 05 10	Basic Electrical Materials and Methods
G.	Section 26 50 00	Lighting
H.	Section 27 01 01	General Communications Requirements
I.	Section 28 00 01	Heating, Ventilation and Air Conditioning Equipment

1.03 REFERENCES

A. Metro Rail Design Criteria (MRDC)

B. California Code of Regulations (CCR)

1. CCR Title 24 Part 2, California Building Code (CBC)

2. CCR Title 24 Part 3, California Electrical Code (CEC)

C. National Fire Protection Association (NFPA)

1. NFPA 70, National Electrical Code (NEC)

2. NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems

D. Underwriters Laboratories Inc. (UL)

1.	UL 50	Cabinets and Boxes
2.	UL 67	Panelboards

1.04 QUALITY ASSURANCE

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

B. Structure shall be the product of a manufacturer with a minimum of 20 years-documented experience in the design and fabrication of portable steel buildings.

C. Prefabricated buildings by manufacturers other than the one approved shall submit sufficient data to enable approval to be given. As a minimum: design drawings and/or calculations, applicable certifications, catalog information, and color samples showing equal range of variety.

D. All factory-installed electrical devices and factory-installed wiring within the prefabricated building shall be UL listed and shall be in full compliance with the National Electrical Code and applicable sections of Federal, State, and local electrical and fire codes and regulations.

E. Design loads: Live Loads: Per State of California requirements for the installation location.

F. Comply with MRDC for train-induced Type B transient air pressure loads of 30 psf positive and 10 psf negative at the platform.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Shop Drawings:

1. Upon award of order, manufacturer shall prepare and submit shop drawings for the temporary TOS booth. Drawings shall include elevations, sections, floor plan, electric schedule and panel location, duplex outlet locations, fire sprinkler system connection, and prefabricated booth anchor clip details.

C. Samples:

1. Color charts illustrating available colors and patterns for specified finishes.

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Products of the following manufacturer to be the basis for design and quality intended.

1. B.I.G. Enterprises, Inc. South El Monte CA. (800) 669-1449 or approved equal

2.02 STRUCTURE

A. Prefabricated steel booth shall be single unit welded construction. Building to be shipped completely assembled. All welded joints ground smooth. Dimensions to be roughly 8’4” x 8’4” x 8’8” tall with a 7’6” ceiling height.

B. 2" x 2" cold drawn electro-welded structural mechanical type 304 stainless steel tubing with all exposed surfaces having a # 4 finish.

2.03 WALLS

A. 16-gauge Type 304 stainless steel interior and exterior panels with #4 satin finish, welded between frame and mullions for a self-aligning unitized system that creates a structural diaphragm.

2.04 BASE AND FLOOR

A. Unit to be attached to station platform finish floor.

B. Sill plate to be 1/4” Type 304 stainless steel.

C. Booth to be designed to mount directly to the level finished floor.

2.05 DOOR

A. Unit to have one commercial type 304 stainless steel framed insulated door stainless steel NRP hinges, Corbin Russwin stainless steel lever lock and a hydraulic closer.

2.06 WINDOWS

A. 16-gauge type 304 stainless steel window frame system with flush mounted corners and welded fastening. Unit to have stainless steel framed fixed windows as indicated. Glaze all windows d with 3/4” clear tempered glass.

2.07 ROOF

A. Roof surface shall be 16-gauge minimum type 304 stainless steel welded to stainless steel joists. Roof seams shall be welded and caulked and have a 10” tall stainless steel fascia with no overhang.

2.08 COUNTER

A. Booth to have a 22” deep full width L shape type 304 stainless shelf at the front and right side wall. Shelves mounted at 34” A.F.F.

B. Provide one locking cabinet consisting of three file drawers and two stacked utility drawers, and a locking unit with two stacked drawers and one file drawer below the counter shelf. All drawers to be 16-gauge galvanized steel painted metallic silver.

2.09 ELECTRICAL

A. Load Center shall be 125 Amp 120/208 volt, single phase, 3-wire 12-pole with 40 amp main breaker.

B. Provide duplex outlets for furnishings and equipment indicated in Attachment A. Coordinate with Metro on placement of outlets. Provide dedicated 120V GFCI branch circuits and duplex outlets for refrigerator and microwave.

C. Provide two 1’ x 4’ T8 fluorescent lights recessed in a 16-gauge type 304 stainless steel ceiling with # 4 finish with single pole wall switch,

2.10 MECHANICAL

A. Provide through the wall mounted Heat Pump (HP) with 13,600 BTU cooling and 11,200 BTU heating with dedicated outlet and remote thermostat. HP to be recessed under the rear shelf with 1” protruding from wall with an architectural louver grill painted Metallic Silver.

2.11 SYSTEMS EQUIPMENT

A. Provide provisions for train, radio and telephone communications and public address system for a temporary TOS booth per MRDC Section 10, Operations. Refer to Section 27 01 01, General Communications Requirements.

PART 3 - EXECUTION

3.01 GENERAL

A. Install prefabricated booth on flat and level floor surface in accordance with the manufacturer's recommendations. Position units over utility stub-ups, verify booth is level and anchor.

B. Install fully assembled prefabricated booth as a removable unit.

3.02 INSTALLATION

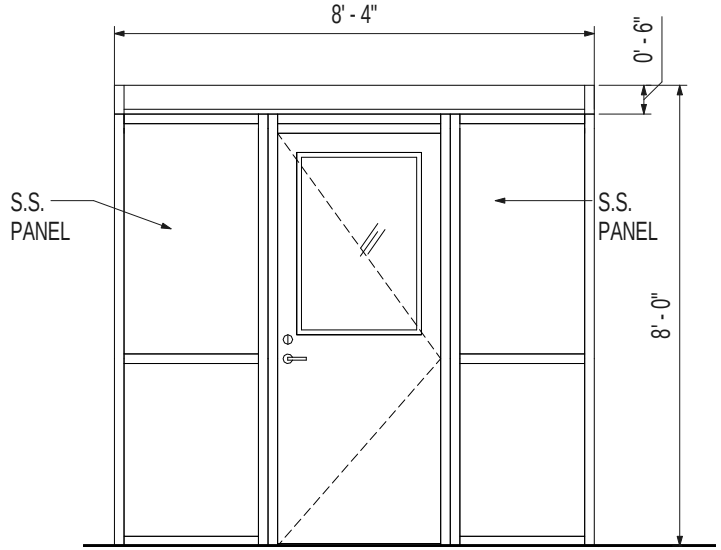
A. Units shall be shipped fully assembled, fully wired, fully glazed and thoroughly painted.

B. Position units over electrical stub-up on level floor. Drill and set expansion type anchor bolts.

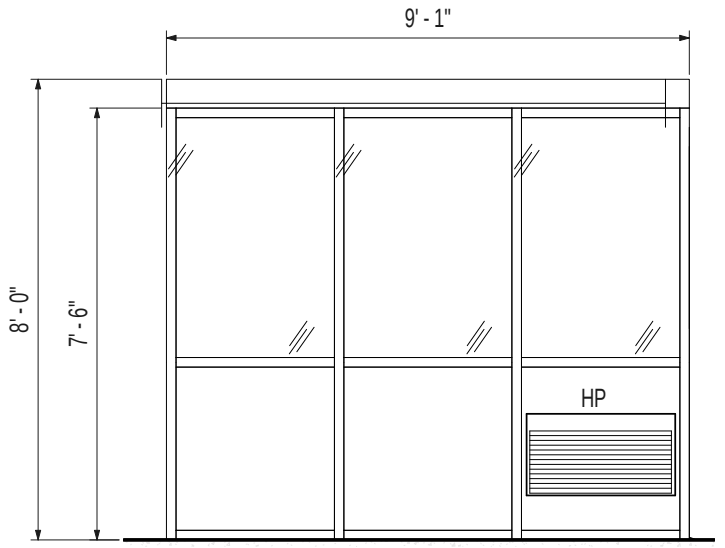
C. Connect power and seal around edges where the floor base meets finished floor

D. Install anti-graffiti film as directed by Metro. Refer to Section 09 96 23

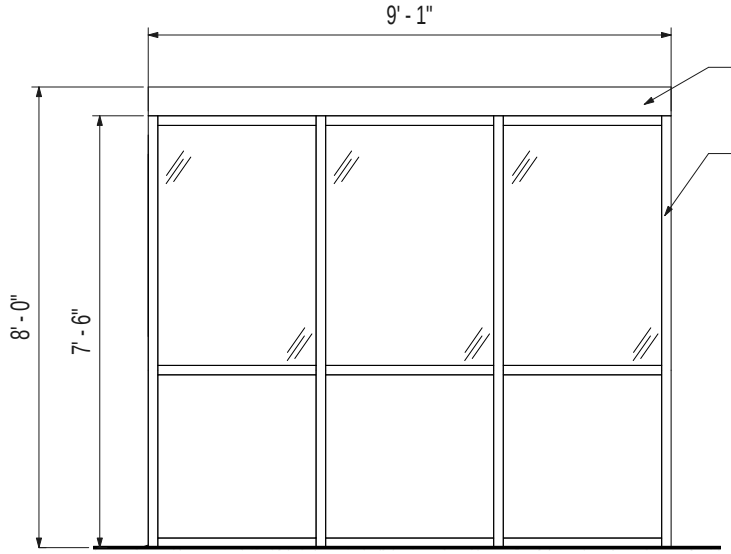
END OF SECTION 13 22 10



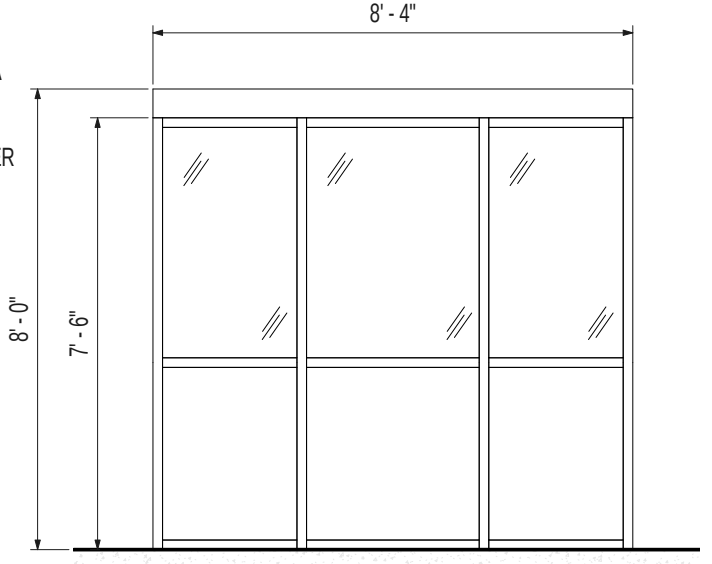
EAST ELEVATION



TRACKSIDE (NORTH) ELEVATION

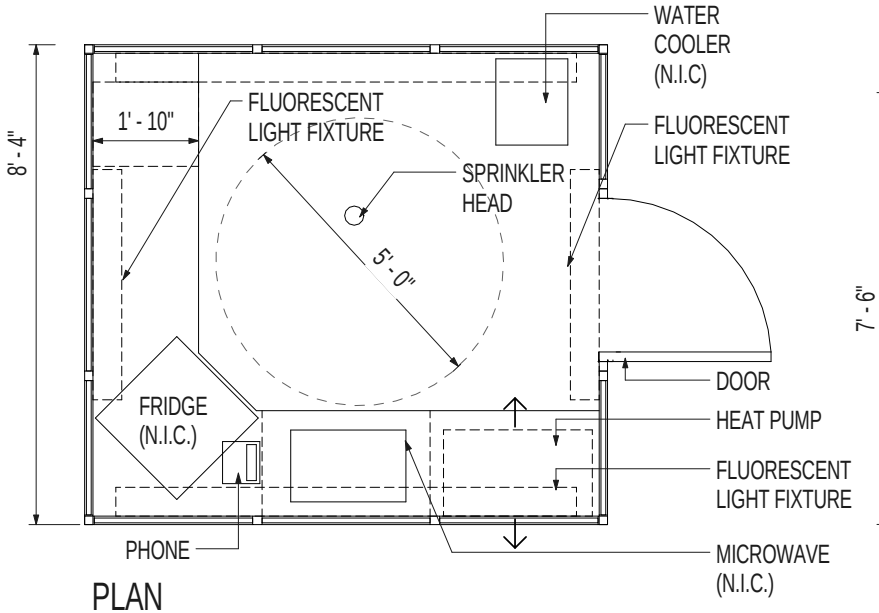


TRACKSIDE (SOUTH) ELEVATION

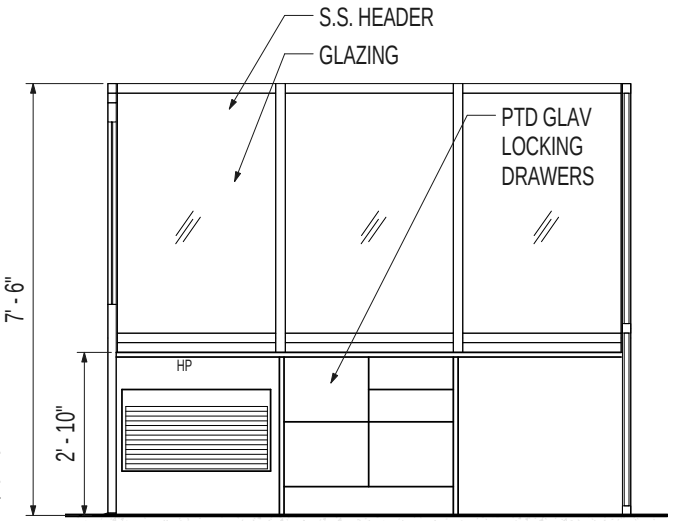


WEST ELEVATION

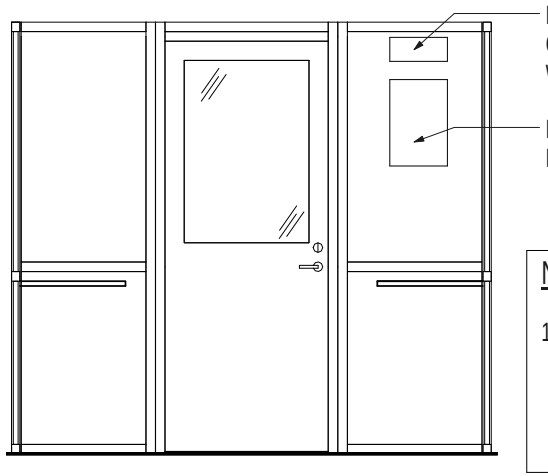
ATTACHMENT A: TRAIN OPERATING SUPERVISOR'S BOOTH



PLAN



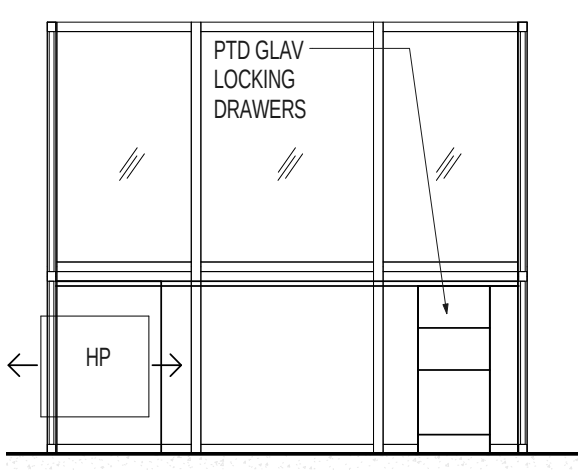
INTERIOR ELEVATION (TRACK SIDE) SOUTH



INTERIOR ELEVATION-EAST WALL

NOTE:

1. ALL COMMUNICATION AND DISTRIBUTION PANELS TO BE INSTALLED WITH FULL COMPLIANCE OF NEC AND ALL APPLICABLE CODES.



INTERIOR ELEVATION-WEST WALL

ATTACHMENT A: TRAIN OPERATING SUPERVISOR'S BOOTH

SECTION 14 24 23

HYDRAULIC PASSENGER ELEVATORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Designing, furnishing, and installing Heavy Duty Transit Elevators for stations.

B. Engineering, equipment, labor, and permits required to satisfactorily complete elevator installation required by Contract Documents.

C. Preventive maintenance as described herein.

D. Additional equipment or finishes furnished under other sections, installed under this Section:

1. CCTV system to coordinate with the Communications contractor

1.02 RELATED SECTIONS

A.	Section 01 29 76	Cost/Schedule Integration System
B.	Section 01 33 00	Submittal Procedures
C.	Section 01 43 10	Project Quality Program Requirements – Design/Build
D.	Section 01 43 38	Field Samples and Mock-ups
E.	Section 01 66 00	Product Storage and Handling Requirements
F.	Section 01 78 23	Operation and Maintenance Data
G.	Section 01 78 43	Spare Parts, Illustrated Parts Catalog and Replacement Materials
H.	Section 05 05 33	Basic Welding Requirements
I.	Section 07 13 70	Hydrocarbon-Resistant Elevator Cylinder Casing
J.	Section 07 80 50	Fireproofing and Firestopping
K.	Section 08 81 00	Glass and Glazing
L.	Section 09 91 00	Painting
M.	Section 09 96 23	Anti-Graffiti Coating
N.	Section 10 44 13	Stainless Steel Cabinetwork and Fire Extinguishers
O.	Section 21 00 00	Fire Protection Systems

P. Section 28 40 00 Communications Supervisory Control and Data Acquisition Remote Terminal Unit (SCADA RTU)

1.03 REFERENCES

A. American National Standards Institute (ANSI)

1. ANSI C1 – National Electrical Code (NFPA 70)
2. ANSI Z97.1 – Safety Glazing Materials used in Buildings - Safety Performance Specifications and Methods of Test
3. ANSI/ASME A17.1 – Safety Code for Elevators and Escalators
4. ANSI/ASME A17.2 – Guide for Inspection of Elevators, Escalators, and Moving Walks

B. ASTM International (ASTM)

1. ASTM A36 – Carbon Structural Steel
2. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
3. ASTM A240 – Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
4. ASTM A568 – Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
5. ASTM A1008 – Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
6. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate
7. ASTM B221 – Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
8. ASTM B151 – Copper-Nickel-Zinc Alloy (Nickel Silver) and Copper-Nickel Rod and Bar
9. ASTM C1172 – Laminated Architectural Flat Glass
10. ASTM E152 – Fire-Resistive Joint Systems

C. American Public Transportation Association (APTA)

1. APTA Heavy Duty Transportation System Elevator Design Guidelines, current version

D. California Code of Regulations (CCR)

1. Title 8 – Industrial Relations

a. Chapter 4 Division of Industrial Safety; Subchapter 6 - Elevator Safety Orders

b. Division of Occupational Safety and Health – Cal/OSHA

2. Title 19 – Public Safety Code

3. Title 24 – Building Standards Code

a. Part 2 – California Building Code (CBC)

b. Part 3 – California Electrical Code (CEC)

E. Americans with Disabilities Accessibility Guidelines (ADAAG)National Electrical Manufacturers Association (NEMA)

1. NEMA Standard 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

F. National Fire Protection Association (NFPA)

1. NFPA 80 Standard for Fire Doors and other Opening Protectives

2. NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Systems

G. Consumer Products Safety Commission (CPSC)

1. 16 CFR Part 1201 – Safety Standard for Architectural Glazing Materials

H. Underwriters' Laboratory, Inc. (UL)

I. American Welding Society AWS D1.1

J. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE 260.1 Standard Letter Symbols for Unit of Measurements (SI Customary Inch-Pound Units and certain Other Units)

K. South Coast Air Quality Management District (SCAQMD)

1. SCAQMD Rule 1113 – Architectural Coatings

L. Metro Rail Design Criteria (MRDC)

M. Metro Rail Architectural Standard Drawings

1.04 QUALITY ASSURANCE

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

B. Manufacturer and Applicator/Installer (Contractor) Qualifications:

1. Manufacturer's Qualifications: Minimum of 5 years experience in manufacturing of specified materials/products, with record of successful in-service performance.

2. Applicator/Installer (Contractor) Qualifications: Engage applicator/installer with minimum 5 years experience in installation, repairing and servicing elevators of types specified and materials/products similar in material, design, and to extent indicated for this Project.

a. Installer Certification: Obtain written certification from manufacturer, certifying that installer is approved by, licensed, or certified by manufacturer for installation of elevator car enclosures, hoistway entrances, signal equipment, buffers, machines, basic controller, and specified materials/products or systems.

b. Provide list of minimum 5 projects similar in nature and size to that of this Project, where specified elevator car enclosures, hoistway entrances, signal equipment, buffers, machinery , basic controllers and other required materials/products have been successfully installed/used.

c. Other Parts and Appurtenances - By elevator manufacturer or firms specializing in types of components required and acceptable to elevator manufacturer.

C. Elevator Contractor - Currently C-11 licensed.

D. Safety - Conform to requirements of ASME A17.1 and Supplements and ASME A17.2 and Supplements for safety devices, running clearance, testing and maintenance methods.

E. Environmental Operational Requirements

1. Provide elevators capable of operating with full specified performance while exposed to the following climatic and environmental conditions:

a. Design exterior installations which open directly to street or courtyard level, or are otherwise exposed to outdoor environment, to operate in dry bulb temperatures ranging from minus 25F to 120F while exposed to sunlight, rain and airborne dust.

b. Elevator Equipment Rooms - Design machinery to operate in underground temperatures ranging from 45F to 104F dry bulb and all conditions of relative humidity while exposed to airborne dust.

2. Elevator Pit Floor - Paint pit floor and, for hoistways enclosed in concrete and masonry walls, paint pit walls up to level of hoistway door sill. For hoistways

enclosed in glass and metal partitions, paint pit walls up to bottom of wall base.

3. Noise Levels - Do not exceed 50 dBA steady-state noise produced by elevators or associated equipment, excluding entrance door operations in public spaces three feet or more from elevator or associated equipment or within elevator cab at any location five feet above floor and one foot or more from any wall. Noise produced by operation of elevator door - Do not exceed 60 dBA three feet or more from elevator door inside and outside elevator cab; measure using fast meter response.

F. Corrosion Protection

1. Design elevator assemblies to prevent corrosion by galvanic action due to physical contact between dissimilar metals or other causes.

2. Where use of adjoining dissimilar metal is required, submit description of protective measure to be employed to prevent corrosive damage.

G. Hours of operation: 24 hours per day, seven days per week

H. Allowable Tolerances for Elevator Travel - Plumb and secure guide rails within overall tolerance of 1/16 inch maximum deviation (measured with no wind or solar load on building) and within 0.01 inch joint offset on rail surfaces.

I. Laboratory Testing - Comply with Code for laboratory testing of elevator component parts, including buffers, interlocks, door contacts, entrances, connectors, fasteners and other materials and products used in elevator Work. Label products and materials to indicate testing and certification by laboratory.

J. Design, fabricate and install elevator parts subject to repair and replacement to be readily and easily removable and replaceable without requiring modification of hoistway structure, equipment room or elevator equipment.

K. Machine, Controller, electrical control panel, automatic door operator, operating fixtures, signals, limit and safety switches and other parts subject to wear shall be standard interchangeable production items.

L. Precisely identify replacement parts, whether produced in Contractor's factories or secured from commercial factories and distributors. Make replacement parts, maintenance methods, technical information, wiring diagrams, testing procedures, design and performance criteria, and other publications related to elevator equipment provided available to Metro or its designee without prejudice or delay. Required quantities, uniform price and delivery time of replacement parts - On same basis as Contractor's most favored maintenance consumer.

M. Reliability/Maintainability

1. Elevator - Capable of operating at full load under normal modes of operation with Mean-Time-Between-Failure (MTBF) of 350 hours, where MTBF is determined by following formula:

MTBF = Operating Time "T" (all elevators)

Number of failures in time "T"

2. Elevator - Mean-Time-To-Repair (MTTR) of two hours, where MTTR is defined as average time required to repair elevator to operate after failure occurs and is calculated as follows:

MTTR = $\frac{T(t)}{f(t)}$ Where T (t) = total active repair time to repair failures occurring in time (t)

f (t) = the total number of failures occurring in time (t)

3. In lieu of demonstrating MTBF, Contractor may elect to demonstrate compliance with reliability criteria by Mean-Cycles-Between-Failures (MCBF). One operating cycle will be considered as consisting of 44 seconds of travel time, in UP and DOWN directions, plus two door open/close cycles. MCBF: 30,000 cycles.

N. Store critical safety-related repair parts in Metro's designated location.

O. The elevator specifications are intended to cover the complete installation of the elevator and to outline broadly the equipment required, but not to cover the details of construction. Such details are recognized to be the exclusive responsibility of the Manufacturer and Installer. It is hereby recognized that Metro or its designee did not invent or develop any part of the elevator systems, but has only made selections of capacities, speeds, control systems, materials, from choices made available by the manufacturers.

P. Seismic Criteria – Provide design, components and operation per California Code of Regulations, Title 8 and ASME A17.1..

Q. Fire-rated entrance assemblies where required: Opening protective assemblies including frames, hardware and operation shall comply with ASTM E152, UL 10B and NFPA 80. Provide entrance assembly units bearing UL Class B labels or recognized equivalent.

R. Comply with Section 28 40 00, Communications Supervisory Control and Data Acquisition Remote Terminal Unit (SCADA RTU), for SCADA Interface requirements.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. ~~Within 60~~**No less than 180** calendar days ~~after Notice to Proceed and before~~**prior to** beginning equipment fabrication, submit shop drawings and required materials for review as outlined in Section 01 33 00, Submittal Procedures and APTA Guidelines. Allow 30 calendar days for response to initial submittal.

1. Fully Dimensioned Layout: Plan of pit, hoistway, remote piping, and machine room indicating equipment arrangement, elevation section of hoistway, details

of car enclosures, car and hoistway entrances, car/hall signal fixtures, and firefighters' control panel (if required).

2. Design Information: Indicate equipment lists, reactions, and design information on layouts including ventilation requirements.

3. Power Confirmation Information: Include motor horsepower, code letter, starting current, full-load running current, and demand factor.

4. Hall, Car and Firefighters' Control Fixtures: Cuts, samples and shop drawings.

C. Acknowledge and respond to review comments within 14 calendar days of return. Promptly incorporate required changes due to inaccurate data or incomplete definition so that delivery and installation schedules are not affected. Manufacturer's revision response time is not justification for equipment delivery or installation delay

D. Samples:

1. Required metal finishes acceptable low and high range of variation in color and finish - Governed by control samples in Metro's or its designee's office.

2. Hall lanterns and call buttons.

3. Car finish materials

a. Floor covering: 12 inches square

b. Glazing panel: 12 inches square

c. Ceiling panel: Six inches square

d. Light fixture lens: Six inches square

e. Sill Section: Four inches long.

4. Tactile and visual control indicators including Braille message plates. Sample will be returned to Contractor.

5. Star of life plate, and floor designation signs. Sample will be returned to Contractor.

E. Shop Drawings - Complete detailed drawings for each elevator system, and fabricated Work. Detail following:

1. Outlet locations in hoistways, for connection of traveling cable for car lights, fire detectors, communication and control systems.

2. Plan view of pit and hoistway showing car, guide rails, buffers and other components located in hoistway for each elevator.

3. Clear inside hoistway and pit dimensions.

4. Refuge space on top of car and in pit.

5. Car rail bracket spacing and maximum horizontal seismic forces on guide rails.

6. Reactions at points of support.

7. Weight of principal parts.

8. Elevation/Section of hoistway showing, top and bottom clearances and over-travel of cars.

9. Loads on hoisting beams.

10. Plan view and wall elevations of each elevator equipment room, at scale of 1/2 inch equals one foot. Show arrangement of equipment.

11. Electrical drawings showing location of circuit breakers, switchboard panels or disconnect switches and feeder extension points in equipment rooms.

12. Complete wiring diagrams of elevator systems and subsystems and parts catalogues, using IEEE standard symbols and details of signal fixtures.

13. Electrical drawings showing electrical and mechanical details of elevator controller, power door operators, door interlocks including electrical protective devices and electrical contacts for communication system. Provide equipment ventilation requirements.

14. Detail drawings of each elevator car, elevator platform and elevator hoistway entrance, at the scale of three inch equals one foot. Include interior car elevations; floor plan, reflected ceiling plan and complete details of doors, frames, controls, fixtures, and accessory equipment.

15. Full scale detail drawings of graphics.

16. Provide record set of drawings with the changes made during installation of Work. At completion of Work submit for Metro use a complete set of "AS-BUILT" plans and wiring diagrams.

17. Power equipment including machine/pump unit and a diagram of hydraulic feed line routing and accessories.

18. Buffers and other pit equipment.

19. Guide rails connection details

20. Car construction details.

21. Removable glazed panels including details of glazing construction and mounting method.

22. Floor and base details.

23. Plenum chamber and ceiling details.

24. Car lighting and fan

25. Car doors, transom, vision panel and entrance column details.

26. Door operator, operator support and car entrance sill details.

27. Handrail and pad hook details.

28. Cut-outs for service cabinet, telephone, and car operating buttons.

29. Hoistway entrance details including strut angles, jamb strut alignment and anchorage, sill assembly, sill support and transom.

30. Header, hanger pocket, hanger cover, fascia and toe guard details.

31. Hoistway doors and glazed panel details.

32. Metal gauges and finishes.

33. Approximate car weight.

34. Motor size and horsepower criteria.

35. Elevator capacity and speed.

36. Machine loads, motor loads, calculations showing over design and factors of safety.

37. Elevator parts to be painted.

F. Manufacturer's Literature - Catalog cuts, manuals, illustrations, wiring diagrams and configuration drawings. Include configuration drawings to be used to cross reference, locate and identify hardware, components and systems submitted.

G. Drawings - Indicate manufacturer's unit assembly number or component part number as it appears in submitted literature. If component or subsystem is furnished by subcontractor, indicate name of subcontractor and subcontractor's part number, component, or subsystem identification number.

H. Configuration Drawings - Include pit, hoistway, and equipment room, typical layouts in plan and elevation, and elevator car and entrance typical layouts in plan, elevation and detail

I. Replacement parts, technical information, test procedures, design criteria, and other publications related to elevator equipment supplied.

J. Test Procedures.

K. Certificates and Test Reports - Certified reports for required tests; record dates performed, test method, test results, interpretation of results and recommended action; include:

1. Manufacturer's certificates of rated load test of safeties, and buffers.

2. Contractor's standard field test and data report.

3. Certificate of inspection by the authority having jurisdiction.

4. Operating permit issued by authority having jurisdiction.

L. Prior to installation, submit three preliminary sets of Operation and Maintenance Manuals for approval within 60 days after Notice to Proceed. The submittal shall consist of complete sets of maintenance and operating instructions as specified in Section 01 78 23, Operation and Maintenance Data.

M. Maintenance Program - Detailed, showing functions to be performed and scheduled frequency, not less than ~~90~~ **180** days before acceptance tests and substantial completion~~ elevators and escalators~~. Provide field operational and maintenance data for equivalent operating system for minimum of one year.

N. Spare Parts List - Not later than ~~90~~ **180** days before substantial completion~~ elevators and escalators~~, provide to Metro or its designee spare parts list; include description, part numbers and unit prices **for recommended parts to be purchased under List B – See Section 01 78 43**.

O. Reliability and Maintainability Demonstration - Report, demonstrating and documenting compliance with seismic criteria verifiable by prediction analysis, testing, or analysis of field operational data. If demonstration is accomplished by prediction analysis or testing, submit report not later than 90 days prior to start of revenue service. If demonstration is accomplished by analysis of field operational data submit report not later than 90 days prior to end of warranty period.

P. Welding procedures and qualifications of welders in accordance with Section 05 05 33, Basic Welding Requirements.

Q. Comply with Project Quality Program Requirements (see 1.02 above).

R. Safety Data Sheets (SDS) Manufacture’s Safety Data Sheets for each type of material used in Work.

S. Elevator Interface Schedule showing requirements of interface work between Contractor and Elevator Contractor.

1. Include only Work to be performed by Contractor. Incorporate interface schedule in submittal required by Section 01 29 76, Cost/Schedule Integration System.

2. Coordinated layout of standard elevator pit.

T. ~~Within 60~~**Not less than 180 calendar** days ~~after Notice to Proceed~~**prior to Substantial Completion**, submit a detailed comprehensive maintenance control program in compliance with the requirements of section 1.11, ~~Preventive~~ Preventive Maintenance.

1.06 DEFINITIONS

A. Terms used are defined in the latest edition of ASME A17.1 - Safety Code for Elevators and Escalators.

B. Reference to a device or a part of the equipment applies to the number of devices or parts required to complete the installation.

C. Provisions of this specification are applicable to every elevator unless identified otherwise.

D. VOC: Volatile Organic Compound, as defined in SCAQMD Rule 102 – Definition of Terms:

1. Any volatile compound of carbon, excluding methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, and exempt compounds.

E. SCAQMD: South Coast Air Quality Management District.

F. Defective is defined to include, but not limited to operation or control system failures, car performance below required minimum, excessive wear, unusual deterioration or aging of materials or finishes, unsafe conditions, the need for excessive maintenance, abnormal noise or vibration, and similar unsatisfactory conditions.

G. ~~Substantial Completion – Elevators and Escalators. Substantial Completion for elevators and escalators will occur no earlier than the date of commencement of revenue service.~~ **NOT USED**

H. The Preventive Maintenance Period is defined as the twelve month period commencing on the date ~~of Substantial~~**of Substantial** Completion~~ – Elevators and Escalators~~.

1.07 RELATED WORK PROVIDED UNDER OTHER SECTIONS

A. Available Site:

1. Access route available to elevator hoistway and equipment room, clear and free of construction materials and debris, to permit delivery of elevator materials and equipment to hoistway and equipment room.

2. Area in and around elevator hoistway, pit and equipment room is clear and free from construction materials and debris, to permit unloading and installation of rigging required for elevator materials and equipment.

3. Hydrocarbon-resistant elevator well casing in place with accessories as indicated in Metro's structural standard drawing SS-037; casing plumb, sealed and watertight; pipe sleeves for hydraulic fluid lines and conduit in-place; and embedded hydraulic lines and conduit in-place.

4. Embedded conduits, junction boxes, outlets and switches, installed.

5. Hoistway area dry and covered for protection from exposure to elements.

6. Elevator hoistway area constructed with rough openings for doors in concrete walls, hoistway door sill supports, embedded conduit and outlet boxes in place.

7. Elevator hoistway finished with plumb walls and rough openings for elevator doors, guide rail support, hoistway door sill supports, conduit and outlet box for car lights, conduit and pull box for communication, telephone and security circuits in place.

8. Elevator equipment foundation and overhead beam support in place.

B. Elevator Hoistway and Pit:

1. Clear, plumb, substantially flush hoistway with variations not to exceed 1 inch at any point.

2. Bevel cants not less than 75 degrees from the horizontal on any rear or side wall ledges and beams or mullions that project or recess 2 inches or more into the hoistway.

3. Supports at each floor for car guide rail fastening. Intermediate car guide rail support as designated on contract drawings. Building supports not to deflect in excess of 1/8 inch under normal conditions, 1/4 inch under applicable seismic conditions.

4. Continuous vertical car guide rail support between floors as shown on Contract documents, full height of hoistway.

5. Installation of guide rail bracket supports in concrete. Inserts or embeds, if used, will be furnished under this Section.

6. Wall blockouts and fire rated closure for control and signal fixture boxes which penetrate walls.

7. Cutting and patching walls and floors.

8. Opening in hoistway wall or pit wall for hydraulic piping. Trench and backfill underground piping.

9. Erect front hoistway wall after elevator entrances are installed.

10. Grout floor up to hoistway sills.

11. Pit access ladder for each elevator.

12. Structural support at pit floor for buffer impact loads, guide rail loads, and cylinder loads.

13. Waterproof Pit: Indirect waste drain or sump with flush grate and pump. If pump is not employed, provide piping to sump and accessible connection outside of hoistway for Metro pump truck.

14. Protect open hoistways and entrances during construction per Cal/OSHA Regulations.

15. Protect car enclosure, hoistway entrance assemblies, and special metal finishes from damage.

16. Hoistway venting if required.

17. Seal fireproofing to prevent flaking.

18. Glass Enclosed Hoistways: Laminated glass per specified requirements in Section 08 81 00, Glass and Glazing. Interior ledges created by glass mullions not to exceed 2 inches.

19. Provide 3'-0" square hole in pit floor to facilitate installation of protective secondary containment casing by Elevator Contractor. Fill hole with concrete after jack installation. Seal pit with non-permeable epoxy.

C. Machine Room and Machinery Spaces:

1. Enclosure with access.

2. Self-closing and locking access door.

3. Ventilation and Heating: Maintain minimum temperature of 55° F, maximum 90° F. Maintain maximum 80% relative humidity, non-condensing.

4. Paint walls and ceiling. Comply with requirements of Section 09 91 00, Painting.

5. Class “ABC” fire extinguisher in each elevator machine room. Comply with requirements of Section 10 44 13, Stainless Steel Cabinetwork and Fire Extinguishers.

6. Seal fireproofing to prevent flaking in accordance with requirements of Section 07 80 50, Fireproofing and Firestopping.

7. Fire sprinklers where required, complying with requirements of Section 21 00 00, Fire Protection Systems.

8. Coordinate secondary containment of pump unit oil reservoir with Elevator Contractor.

D. Electrical Service, Conductors and Devices:

1. Lighting and GFCI convenience outlets in pit and machine room. Provide one additional non-GFCI convenience outlet in pit for sump pump and oil return pump.

2. Three-phase 60 Hz mainline copper power feeder to terminals of each elevator controller in the machine room with protected, lockable “open,” disconnecting means

3. Minimum 10 foot candles illumination at elevator landings.

4. Single-phase copper power feeder to each elevator controller for car lighting and exhaust blower with individual protected, lockable “open,” disconnecting means located in machine room.

5. Emergency telephone line to each individual elevator control panel in elevator machine room.

6. Fire alarm initiating devices in each elevator lobby, for each group of elevators or single elevator and each machine room to initiate firefighters’ return feature. Device at top of hoistway if sprinklered. Device must be accessible from outside of hoistway. Provide alarm initiating signal wiring from hoistway or machine room connection point to elevator controller terminals. Device in machine room and at top of hoistway to provide signal for general alarm and discrete signal for Phase II firefighters’ operation.

7. Temporary power and illumination to install, test, and adjust elevator equipment, as necessary.

8. Wiring, conduit and/or phone lines from elevator machine room junction box to remote monitoring panels or consoles as required by Metro/ Rail Operations Control (ROC).

9. Conduit from the closest hoistway of each elevator group or single elevator to the ROC interface panel, firefighters' control room and main control console. Coordinate size, number, and location of conduits with Elevator Contractor, as required.

10. Means to automatically disconnect power to affected elevator pump unit and controller prior to activation of machine room fire sprinkler system, and hoistway fire sprinkler system. Manual shut-off means shall be located outside bounds of machine room.

11. When sprinklers are provided in the hoistway, electrical equipment, located less than 4'-0" above the pit floor shall be identified for use in wet locations. Exception, seismic protection devices.

12. Single-phase power feeders to main control console and firefighters’ control panel, as required.

13. Single-phase power feeders to controller(s) for closed circuit television (CCTV) with lockable “open” disconnecting means.

14. Wire shall be copper and exposed conduit shall be Galvanized Rigid Steel (GRS).

E. Standby Power Provision: (If available)

1. Standby power of normal voltage characteristics via normal electrical feeders to run each elevator at the same time at full-contract car speed and capacity.

2. Conductor from auxiliary form “C” dry contacts, located in the standby power transfer switch to a designated elevator control panel in each elevator unit. Provide a time delay of 30 - 45 seconds for pre-transfer signal in either direction.

3. Standby single-phase power to each elevator controller for car lighting, exhaust blower, emergency signaling device, intercom amplifier.

4. Standby power to machine room ventilation or air conditioning.

5. Standby power to emergency communications devices.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 01 66 00, Product Storage and Handling Requirements, for general requirements for product delivery, storage, and handling procedures.

B. Transport, handle, and store material in manner to ensure preservation of material quality and fitness for incorporation in Work.

C. Deliver material in Manufacturer’s original, unopened protective packaging.

D. Store material in original protective packaging. Prevent soiling, physical damage, or moisture damage. Store materials in a manner to facilitate inspection.

E. Protect equipment and exposed finishes from damage and stains during transportation, erection and construction period against damage and stains.

F. Erection Equipment - Subject to Metro or its designee's approval upon delivery to Worksite. Promptly bring to acceptable condition, or remove from Worksite equipment that proves unacceptable or hazardous to personnel and property. Obtain approval from Metro or its designee prior to use of heavy moving and erection equipment supported by station structures.

G. In event of notice of delay for access to construction Worksite, storage at Contractor's facility will be required.

1.09 RESPONSIBILITIES OF CONTRACTOR

A. Document Verification:

1. In order to discover and resolve conflicts or lack of definition which might create problems, Manufacturer must review Contract Documents for compatibility with its product prior to submittal of quotation. Metro will not pay for change to structural, mechanical, electrical, or other systems required to accommodate Manufacturer’s equipment.

B. Verify dimensions of hoistways and stub-outs for conduit in equipment rooms at site by accurate field measurements so that the elevator Work will be accurately fabricated to fit into hoistways and equipment rooms. Elevator Contractor - Review Working Drawings and verify by field observation that clearances and alignments are proper for installation of equipment. In event of major discrepancy, immediately notify Metro or its designee.

C. Coordinate elevator Work with Work of other trades and provide items to be placed during installation of other Work at proper time to avoid delays in overall Work. Place such items, including inserts and anchors, accurately in relation to final location of elevator components. Use Metro Facility Contractor's bench marks. Provide technical assistance to other contractors in connection alignment of elevator hoistway framing.

D. Temporary Use - Do not use elevators during construction period of station, without written permission from Metro or its designee. Provide temporary enclosures or hoistway opening protection, protection against damage to machine room equipment, cars, doors or door frames, if temporary use is permitted. Repairs or replacement to restore elevator equipment to original condition at User's expense.

1.10 PERMIT, TEST AND INSPECTION

A. Obtain and pay for permit, license, and inspection fee necessary to complete installation.

B. Perform tests required by Governing Authority in accordance with procedure described in ASME A17.1 and ASME A17.2 Guide for Inspection of Elevators and Escalators and APTA Guidelines in the presence of Metro's Authorized Representative.

C. Supply personnel and equipment for test and final review by Metro or its designee, as required.

1.11 PREVENTIVE MAINTENANCE

A. ~~Within sixty days after Notice to Proceed, and~~**No less than 180 calendar days** prior to ~~installation~~**Substantial Completion**, Contractor shall submit detailed Preventive Maintenance Control Programs, showing functions to be performed and their scheduled frequency. The Preventive Maintenance Period is defined as the twelve month period following Substantial Completion~~ Elevators and Escalators~~.

1. Program shall reflect requirements for Heavy Duty Transit Elevators for use in an exterior location at the job specific location.

B. Perform preventive maintenance and 24-hour emergency callback service during the Preventive Maintenance periods. Callback service shall be provided at no additional cost to Metro or its designee. All callbacks are included.

C. The preventive maintenance agreement shall also cover repairs and damage above and beyond regular maintenance including any vandalism or nuisance calls for the period of the agreement. The preventive maintenance is to be paid under the ~~bid item for Preventive Maintenance~~**lump sum bid item for Elevators** in Schedule A of the Schedule of Quantities and Prices. Repairs of damage from vandalism and the cost of nuisance calls will be paid under the provisional sum ~~established by Metro~~**in Schedule B of the Schedule of Quantities and Prices**.

D. Provide backup documentation of all labor hours and parts costs with the submission of Provisional Sum invoices. Provisional Sum invoices will only be considered for payment for services rendered due to vandalism or abuse or

shutdowns caused by forces outside of the normal operation of elevators. Provisional Sum payment will not be rendered for shutdowns due to defective equipment, software imperfections, component failure, poor workmanship or any other condition covered by Preventive Maintenance or pertaining to an item on the Metro punchlist.

E. Preventive maintenance shall be performed at a level sufficient for heavy duty transit elevators in a high traffic transit environment.

1. It should be noted that this environment is much more demanding than a typical commercial elevator environment.

F. Preventive Maintenance

1. Provide preventive maintenance and 24-hour emergency callback service for the Preventive Maintenance Period (as defined above). Required maintenance shall be of the same standard as other Metro transit elevators and shall include Metro's standard maintenance check chart and Manufacturer's O&M criteria. Systematically examine, adjust, clean and lubricate all equipment. Repair and replace defective parts using parts produced by the manufacturer of installed equipment.

2. Use competent personnel, acceptable to Metro, supervised and employed by Contractor.

3. Repair or replace defective parts using parts produced by the manufacturer of installed equipment.

4. Perform preventive maintenance in compliance with Title 8 and ASME A17.1. Provide a minimum of four mechanic hours per unit, per month of preventive maintenance. Required testing, major repairs exceeding one and one half (1.5) hours, and callbacks shall not be considered a part of the four hours of preventive maintenance. Equipment shall be adjusted to meet specified performance criteria.

5. Provide support for State Inspector and Metro or its designee's annual inspection.

6. Respond to trouble calls, first, with onsite personnel. If Contractor personnel are not on site, response between 6:00am and 9:00 pm shall be within 45 minutes, 90 minutes between 9:00 pm and 6:00 am. Coordinate maintenance work with Metro and Metro's ROC. Elevator shall not be removed from service for maintenance between the hours of 6:00 am and 9:00 am or 3:00 pm and 7:00 pm (peak hours).

7. During the Preventive Maintenance Periods, no elevator shall be out of service for more than 12 hours during weekdays or more than 24 hours during weekends.

8. The Preventive Maintenance Period specified in Item 1 above shall be extended according to the Elevator Performance Condition at no additional cost to Metro.

G. Elevator Performance Condition:

1. During the final 30 days of the Preventive Maintenance Period, the elevator shall run reliably and safely with no more than three similar trouble calls within a 96-hour period; and there shall be no failure of any component that causes the elevator to be out of service for more than 24 consecutive hours during the 30 day observation period (the "Elevator Performance Condition"). If at the end of the 30 day observation period, the elevator has operated as provided above, then "Elevator Performance Condition" shall be deemed satisfied. However, if at any time during the 30 day observation period the elevator does not meet the Elevator Performance Condition, Metro shall provide Contractor with written or electronic notice of the elevator's failure and a request for immediate repair and written confirmation of the repair. Once the repairs are made, the 30 day observation period shall reset and the repaired elevator must then meet the Elevator Performance Conditions in the next 30 days. This process shall be repeated until the Elevator Performance Condition has been met.

1.12 SPARE PARTS AND REPLACEMENT MATERIALS

A. Refer to Section 01 78 43, Spare Parts, Illustrated Parts Catalog, and Replacement Materials for ~~general~~ requirements.

~~B. Contractor shall deliver to Metro's designated location, the following expendable (spare) parts for each elevator. Parts shall become Metro's property. Parts may be used by the Contractor for maintenance but shall be restocked within two weeks of their use at no additional cost to Metro. Parts shall be delivered prior to Final Acceptance of the elevators.~~

~~1. One spare pump~~

~~2. One set of belts for pump to motor~~

~~3. One set jack packing~~

~~4. One door operator motor~~

~~5. One set of door operator belts~~

~~6. One set of door operator rectifiers, each kind~~

~~7. Six control relays, each size~~

~~8. One motor starter contact kit~~

~~9. One motor starter~~

~~10. One set motor starter overloads~~

~~11. One hoist way door interlock~~

~~12. Six interlock rollers~~

~~13. Six car door hanger rollers~~

~~14. One complete set of electronic printed circuit boards for each type on controller and door operator~~

~~15. One diagnostic service tool – microprocessor systems~~

~~16. Four rollers for roller guides~~

~~17.~~**B.** ~~Three sets of each car and hall button assemblies~~**Provide adequate spare parts on site to ensure minimal downtime of the elevators during the Preventive Maintenance and Warranty Period. Contractor may draw spare parts from Metro Warehouse for maintenance but shall restock such parts within two weeks of their use at no additional cost to Metro.**

1.13 WARRANTIES

A. Material and workmanship of installation shall comply in every respect with Contract Documents. Correct defective material or workmanship which develops to satisfaction of Metro or its designee at no additional cost, unless due to ordinary wear and tear, or improper use or care by Metro. Perform preventive maintenance and include cost of 24-hour emergency callback service during warranty period.

~~A.~~**B. The Warranty on the Elevators shall commence on the date of the issuance of the Certificate of Substantial Completion and shall remain in effect for one year after that date.**

1.14 REGULATORY REQUIREMENTS

A. Compliance with Regulatory Agencies: Comply with most stringent applicable provisions of the following Codes, laws, and Authorities having jurisdiction, including revisions and changes in effect:

1. Requirements of CCR, Title 19 and 24, and all other Codes, Regulations or Standards applicable within governing jurisdiction.

2. Local Fire Authorities

3. Metro Rail Design Criteria

4. Federal and State Accessibility Requirements

1.15 OPERATION AND MAINTENANCE MANUALS

A. After Metro approval of Operation and Maintenance Manuals, three final hard copy sets of the approved manuals and one electronic copy shall be provided to Metro by the Contractor. The manuals are due no less than fourteen days prior to Substantial Completion ~~– Elevators and Escalators~~ and shall include the following:

1. Complete Table of Contents

2. Complete instructions regarding operation and maintenance of equipment. Included will be complete illustrated, exploded views of all assemblies, and a complete, illustrated, exploded view for identifying all system parts.

3. Maintenance Control Program per ASME A17.1.

4. Complete nomenclature, lead time and location of replaceable parts, Original Equipment Manufacturer (OEM) and installer part numbers, current cost, and source. If product source is another vendor, contractor shall include name and address of other vendor.

5. Copies of approved preventive maintenance plan.

6. Descriptions of safety devices.

7. Safety rules, tests, and procedures, including testing of all systems and subsystems.

8. Troubleshooting techniques.

9. Detailed lubrication and cleaning schedule indicating weekly, monthly, quarterly, semiannual, and annual lubrication; and a description of each lubrication point, lubrication type, and specification.

10. Comprehensive list of error and fault codes with explanation of the fault and procedures to resolve the problem.

B. As-built drawings shall include:

1. Control and schematic electrical wiring diagrams of controller, including wiring of safety devices to connections with remote indication and control panels for each elevator and group of elevators.

2. Electrical layout showing placement of lighting, light switches, receptacles, light fixtures, disconnect switches, and convenience outlets in machinery room and pits.

3. Complete detailed drawings and wiring diagram of elevator fault finding device and connection to annunciator panel.

4. Electronic and hard copies of ladder diagrams, logic and program.

C. Certification

1. The OEM shall provide certification that Metro or its designee has been provided with copies of all documents related to maintenance, safety, operations, design changes, modifications, retrofits, and like items, which relate to any part, component, equipment, system, subsystem, or material and services applicable to the elevator provided.

2. All of the above referenced shall be provided by the installer as it pertains to the original installation through the end of the warranty period.

3. The referenced material shall be provided within thirty (30) days of publication or internal distribution by the OEM. The material, even if labeled PROPRIETARY, shall be delivered to Metro or its designee without prejudice or delay and at no additional cost.

D. Electronic Material:

1. Provide all material on CD-ROM in a format approved by Metro. Submit Safety Data Sheets (SDS) and product data sheets with an index listing each product, along with the application method of the product, approximate quantity of product per elevator, and the component the product is applied to or associated with. Allow six weeks for review of SDS by Metro or its designee.

PART 2 - PRODUCTS

2.01 PASSENGER ELEVATORS

A. Acceptable Manufacturers: Alternate Manufacturers must receive approval of Metro or its designee.

1. Hydraulic Elevators: CEMCOlift Elevator Systems, Fujitec, KONE, Minnesota Elevator, Mitsubishi, Otis, Schindler, ThyssenKrupp,.

2. Car Enclosure: City Lift, Eklund's Inc., Forms + Surfaces, Fujitec, Globe Architectural Metal, Gunderlin, Ltd., Hauenstein & Burmeister, KONE, Mitsubishi, Otis, Schindler, Sterling, ThyssenKrupp, Travertine, Tyler Gunderlin, Winter and Bain.

3. Hoistway Entrance: Fujitec, Hauenstein & Burmeister, KONE, Mitsubishi, Otis, Schindler, Swiss Dane, ThyssenKrupp, Tyler, Winter and Bain, Gunderlin.

B. Heavy Duty Transit Passenger Elevators: Provide single car elevators for concourse-to-platform locations; provide duplex elevators for plaza-to-concourse locations as indicated on Project Definition Drawings.

1. Number: Car Numbers As Indicated

2. Capacity: 3,500 lbs per ASME A17.1 / Comply with APTA Guidelines at 5250 lbs minimum

3. Class Loading: Passenger (Refer To APTA Guidelines)

4. Contract Speed: 150 fpm

5. Machine: Hydraulic Pump

6. Machine Location: Refer To Project Definition Drawings

7. Operational Control: Selective Collective Microprocessor Based System, Non-Proprietary

8. Motor Control: Single Speed Ac with SCR Solid State Reduced Voltage Start

9. Power Characteristics: 480 volts, 3 phase, 60 hertz (verify)

10. Stops: Per Project Definition Drawings

11. Openings: Per Metro Rail Architectural Standard Drawings (AS-010)

12. Floors Served: Per Project Definition Drawings

13. Travel: Per Project Definition Drawings

14. Platform Size: Per Metro Rail Design Criteria

15. Minimum Clear Inside Car:5-foot 10-inches wide by 6-foot 8-inches deep (excluding handrail) per MRDC requirements

16. Entrance Size: Minimum Clear 42” wide x 84” high

17. Entrance Type: Double Door, Single Speed, Center Opening per Metro Rail Standard Drawings

18. Door Operation: High Speed, Heavy-Duty, Door Operator, Minimum Opening Speed 2-1/2 feet per second (fps) GAL-MOVFRW (All Ferrous Material Zinc Plated)

19. Door Protection: Three Dimensional Infrared, Full Screen Device, With Differential Timing, Nudging And Interrupted Beam Time

20. Hydraulic Type: Direct Plunger

21. Guide Rails: Planed Steel Tees

22. Buffers: Spring

23. Car Enclosure:

    a. Custom glass car walls

    b. Car interior finishes provided under this section

    c. 8'-0" clear height under canopy

    d. Hinged, gasketed stainless steel shroud over door operator equipment and car top

    e. Car door interlock to delete need for hoistway fascia if front hoistway wall is glass to meet code requirements. Otherwise provide stainless steel hoistway fascia lining.

f. Battery powered emergency car lighting. Provide separate constant pressure test button in car service panel compartment. Illuminate portion of normal car lighting

24. Signal fixtures:

    a. LED Illumination

    b. Custom design

    c. Vandal resistant assembly.

    d. NEMA 4

25. Hall and Car Pushbutton: Single hall pushbutton riser car

26. Stations:

    a. Operating panel with flush hairline fire service operation and service cabinet doors. Operating permit behind flush lens in service cabinet door

    b. Vandal resistant car and hall pushbuttons. NEMA 4

27. Position indicator:

    a. Car multi-light vandal resistant with direction arrows and led illumination, transom mounted. NEMA 4

    b. Security control panel NEMA 4, (if required)

    c. Firefighters' control panel NEMA 4, (if required)

28. Hall lanterns:

    a. At floors with volume adjustable electronic chime or tone. Sound twice for down direction. Vandal resistant assembly. NEMA 4

29. Communication system:

    a. Comply with code and Metro/ROC requirements for remote control

    b. Self-dialing, vandal resistant, push to call, two-way communication system with recall, tracking and voiceless communication per Metro requirements. Provide Metro standard model T2100 phone or approved equal

30. Additional requirements:

    a. Meet APTA guidelines for Heavy Duty Transit Equipment in an Exterior Environment

    b. Duplex operations for plaza to concourse elevators

    c. Enhanced Remote Monitoring

d. Enhanced Elevator System Monitoring

2.02 MATERIALS

A. Steel:

1. Sheet Steel for Exposed Work: Stretcher-leveled, cold-rolled, commercial quality carbon steel, complying with ASTM A1008, matte finish.

2. Sheet Steel for Unexposed Work: Hot-rolled, commercial quality carbon steel, pickled and oiled, complying with ASTM A568.

3. Structural Steel Shapes and Plates: ASTM A36.

B. Stainless Steel:

1. Type 316 complying with ASTM A240, with standard tempers and hardness required for fabrication, strength and durability. Apply mechanical finish on fabricated work in the locations shown or specified, complying with NAAMM finish nomenclature, with texture and reflectivity required to match Metro's sample. Protect with adhesive paper covering.

2. Satin No. 4 finish: Graining directions as shown or, if not shown, in longest dimension.

3. Textured: 5WL as manufactured by Rigidized Metals Corporation, or equivalent as manufactured by Rimex Metals Group, or approved equivalent, with 0.050 inches mean pattern depth with Satin No. 4 finish.

4. Burnished: Non-directional, random abrasion pattern.\

C. Aluminum: Extrusions per ASTM B221; sheet and plate per ASTM B209.

D. Nickel Silver: ASTM B151 extrusion, alloy UNS #C74500, polished finish.

E. Trademarks – Do not display manufacturer's name, logo or trademark on exposed surfaces of materials and components visible to passengers.

F. Paint: Clean exposed metal parts and assemblies of oil, grease, scale, and other foreign matter and factory paint one shop coat of standard rust-resistant primer conforming to requirements of Section 09 91 00, Painting. After erection, apply one finish coat of industrial enamel paint conforming to requirements of 09 91 00 - Painting. Galvanized metal need not be painted.

G. Prime Finish: Clean metal surfaces specified to receive baked enamel paint finish, of oil, grease, and scale. Apply one coat of rust-resistant primer conforming to requirements of Section 09 91 00, Painting, followed by a filler coat over uneven surfaces. Sand smooth and apply final coat of primer.

H. Baked Enamel Finish: Prime finish per above. Unless specified "prime finish" only, apply and bake three additional coats of enamel in the selected solid color, conforming to requirements of Section 09 91 00, Painting.

I. Glass: Laminated safety glass, minimum 9/16" thick, conforming to the requirements of Section 08 81 00, Glass and Glazing.

J. Anti-Graffiti Film: Apply to exposed glass surfaces. Conform to the requirements of Section 09 96 23, Anti-Graffiti Coating.

K. Wiring and Electrical Interconnections – Comply with governing codes. Insulated wiring – flame retardant and moisture proof outer covering, and run in conduit, tubing or electrical wireways. Provide NEMA 4 rated equipment.

2.03 CAR AND GROUP PERFORMANCE

A. Car Speed: ± 10% of contract speed under any loading condition.

B. Car Capacity: Safely lower, stop and hold 125% of rated load.

C. Car Stopping Zone: ±1/4" under any loading condition.

D. Door Opening Time: 2.2 Seconds from start of opening to fully open.

E. Door Closing Time: 2.7 Seconds from start of closing to fully closed.

F. Car Floor-to-Floor Performance Time: 16.2 Seconds from start of doors closing until doors are 3/4 open (1/2 open for side opening doors) and car level and stopped at next successive floor under any loading condition or travel direction (20 feet typical, floor height).

G. Pressure: Fluid system components shall be designed and factory tested for 500 lbs./sq. in. Maximum operating pressure shall be 400 lbs./sq. in.

H. Car Ride Quality:

1. Horizontal acceleration within car during riding and door operating conditions~~.~~ **:** Not more than 15 mg peak to peak (adjacent peaks) in the 1 - 10 Hz range.

2. Acceleration and Deceleration: Smooth constant and not more than 3 feet/second^2 with an initial ramp between 0.5 and 0.75 second.

3. Sustained Jerk: Not more than 8 feet/second^3.

I. Noise and Vibration Control:

1. Airborne Noise: Measured noise level of elevator equipment during operation shall not exceed 50 dBA in elevator lobbies and 60 dBA inside car under any condition including door operation and car ventilation exhaust blower on its highest speed.

2. Vibration Control: Elevator equipment provided under this contract, including power unit, controller, oil supply lines and their support shall be mechanically isolated from the building structure and electrically isolated from the building power supply and to each other to minimize the possibility of objectionable noise and vibrations being transmitted to occupied areas of the building.

3. Mechanically isolate elevator equipment (including machines, solid-state components, AC conversion units, and support equipment) from structure and electrically isolate from building power supply and each other to prevent noise and vibration in occupied areas of building.

2.04 OPERATION

A. Selective Collective Microprocessor Based: Operate car without attendant from pushbuttons in car and located at each floor. When car is available, automatically start car and dispatch it to floor corresponding to registered car or hall call. Once car starts, respond to registered calls in direction of travel.

1. Do not reverse car direction until car call has been answered, or until hall call ahead of car.

2. Slow car and stop automatically at floors corresponding to registered calls, in the order in which they are approached in either direction of travel. As slowdown is initiated for a hall call, automatically cancel hall call. Cancel car calls in the same manner. Hold car at arrival floor an adjustable time interval to allow passenger transfer.

3. Illuminate appropriate pushbutton to indicate call registration. Extinguish light when call is answered.

B. Other Items:

1. Low Oil Control: In the event oil level is insufficient for travel to the top floor, provide controls to return elevator to the main level and park until oil is added.

2. Independent Service: Provide controls for operation of each car from its pushbuttons only. Close doors by constant pressure on desired destination floor button or door close button. Open doors automatically upon arrival at selected floor.

C. Firefighters' Service: Provide equipment and operation in accordance with Code requirements of ASME A17.1 and CCR Title 8, Chapter 4, Subchapter 6.

D. Automatic Car Stopping Zone: Stop car within 1/4 inch above or below the landing sill. Maintain stopping zone regardless of load in car, direction of travel or distance between landings.

E. Passenger Door Operation: Automatically open doors when car arrives at main floor. At expiration of normal dwell time, close doors.

F. Remote Monitoring and Diagnostics: Equip each controller with standard ports, interface boards, and drivers to accept maintenance, data logging, fault finding diagnostic, monitoring computers, keyboards, and programming tools. The system shall be capable of driving remote color CRT monitor(s) that continually scan and display the status of each car and call.

1. Metro/ROC Monitoring System: Provide on-site and remote monitoring and diagnostic capability. Display status of each elevator and each registered call at ROC.

G. Motion Control: AC type with unit valve suitable for operation specified and capable of providing smooth, comfortable car acceleration and retardation. Limit the difference in car speed between full load and no load to not more than ±10% of the contract speed in either direction of travel. Provide closed transition SCR soft start.

H. Metro/ROC Monitoring System: Provide the means via ROC control panel key switch for each elevator to return to a designated floor. Return elevator nonstop after answering registered car call and parking with doors closed until reset to normal operation.

I. Standby Power Operation (If Standby Power is available): Upon loss of normal power, adequate standby power will be supplied via building electrical feeders to simultaneously start and run each car at contract car speed and capacity.

1. Automatically return each car, nonstop to designated floor, open doors for approximately 3.0 seconds, close doors and park car. During return operation, car and hall call pushbuttons shall be rendered inoperative. After car completes designated floor return, system shall immediately select car to start and run upon demand.

2. Provide “Standby Power” indicator lights (one per car) in firefighters’ control panel and at main floor landing or as directed by Metro. Indicator light illuminates when corresponding car is selected to operate on standby power.

J. Battery Standby Power Transfer (If standby power is not available): Upon loss of normal power, provide controls to automatically lower the car(s) nonstop to the lowest landing. Upon arrival at the lowest landing, the elevator doors shall open automatically and remain open until regular door time has expired. The elevator shall then become deactivated. The standby power source shall be provided via 12-volt D.C. battery units installed in machine room, including solid-state charger and testing means mounted in a common metal container. Battery to be rechargeable lead acid or nickel cadmium with a 10-year life expectancy.

K. Upon restoration of normal power, the elevator shall automatically resume normal operation.

L. Emergency Features:

1. Emergency operation: Equip elevators with control system to operate and recall elevators to a designated or alternate designated floor in fire or other emergency condition. Provide terminals on controller for connection of signal from sensors provided under other Sections of Work. Operation - Similar on all elevators and operate visual/audible signal until return is complete or automatic operation restored. This mode of operation, when activated manually or automatically - Override other operations except car top operation.

2. Standby lighting and alarm: During power failure, supply car lighting, car alarm, and exhaust blower with standby power over same feeders supplying normal power to elevator controllers. In addition, provide car mounted battery unit to operate alarm bell and lighting only. Include solid-state charger and testing means enclosed in common metal container. Battery - Rechargeable lead acid or nickel cadmium with 10-year minimum life expectancy.

3. Elevator-to-lobby switches: Provide switch for each elevator in central control panel to return cars to secure floor. Activating switch - Return elevator to lobby level non-stop after answering preregistered car calls and park with doors open until switch is returned to normal position.

M. Operational Control - Duplex Selective Collective (where required)

1. General:

a. Elevators - Operate without attendants from buttons in each car and at each floor. With two cars in service and no calls registered, one car shall normally park at entry floor ("home" car). Other car shall park where last used ("free" car). Registration of hall call above entry floor, or car call in free car shall cause that car to start and begin operation. When car has been started, respond to calls registered for direction of travel in order in which floors are reached. Once direction of travel has been established, car will not reverse direction until all car calls have been answered or until all hall calls, ahead of car and corresponding to direction of car travel, have been answered.

b. Cars - Slow down and stop automatically at floors corresponding to registered calls, in order approached in each direction of travel. As slow down is initiated for hall call, automatically cancel call and hall button for that direction of travel shall remain ineffective until elevator leaves floor. Similarly cancel car calls. Car - remain at arrival floor for adjustable time interval to allow passenger transfer.

c. Car - Answer calls corresponding to direction in which car is traveling except answer call in opposite direction if call is highest call registered.

d. When free car is clearing calls, home car shall respond to:

1) Call registered on home car buttons.

2) Up hall call registered below free car while free car is traveling up.

3) Up or down call registered above car while free car is traveling down.

4) Hall call registered and free car is delayed in normal operation for predetermined period.

e. When both cars are clearing calls, only one car shall stop in response to registered hall call. First car to clear calls - Return to main floor and become home car. Should last service required bring both cars to main floor, car that arrived first shall become free car.

f. Registration of call - Cause appropriate button to illuminate. When call is answered, extinguish light

g. Other items:

1) Door operation - Automatically open doors when car arrives at main landing to permit egress of passengers whether or not terminal floor call has been registered in car. When another car is at main landing and is loading for departure arriving car shall close its doors until car is designated next for loading. If no other car is at main landing, an arriving car shall open its doors until car is dispatched or expiration of loading interval with no demand.

2) Automatic stopping accuracy - Provide automatic stopping device designed to govern stopping accuracy of car to within 1/4 inch above or below landing sill. Stopping operation - Avoid over travel, and under travel of car and maintain stopping accuracy regardless of load in car or direction of travel.

3) Independent service - Provide controls for operation of elevators from car buttons only. Under this operation, door closing time - By constant pressure on desired destination floor button. Automatically open doors upon arrival at selected floor.

4) Successive Starting - In event of power interruption, power units, including hoist motors, shall not start up simultaneously when power is restored. Provide controls so when transfer is made from normal to emergency power or emergency to normal power, inrush current is limited to 10 times full load running amperes of elevator requiring most power.

2.05 MACHINE ROOM EQUIPMENT

A. Arrange equipment in spaces shown on drawings.

B. Pump Unit: Assembled unit consisting of dry type positive displacement pump, induction motor, master-type control valves combining safety features, holding, direction, bypass, stopping, manual lowering functions, shut off valve, oil reservoir with protected vent opening, oil level gage, outlet strainer, drip pan, muffler, mounted on isolating pads. Provide external oil cooling unit or comparable means to maintain oil at operating temperature. Enclose entire unit with removable sheet steel panels lined with sound-absorbing material. Provide SCR soft start with closed transition. Design unit for a minimum of 120 upstarts/hour.

C. Landing System: Solid-state, optical, digital type.

D. Controller: UL/CSA labeled.

1. Compartment: Securely mount assemblies, power supplies, chassis switches, relays, on a substantial, self-supporting steel frame. Completely enclose equipment with covers. Provide means to prevent overheating.

2. Relay Design: Magnet operated with contacts of design and material to insure maximum conductivity, long life and reliable operation without overheating or excessive wear. Provide wiping action and means to prevent sticking due to fusion. Contacts carrying high inductive currents shall be provided with arc deflectors or suppressors.

3. Microprocessor-Related Hardware:

   a. Provide built-in noise suppression devices which provide a high level of noise immunity on solid-state hardware and devices.

   b. Provide power supplies with noise suppression devices.

   c. Isolate inputs from external devices (such as pushbuttons) with opto-isolation modules.

   d. Design control circuits with one leg of power supply grounded.

   e. Safety circuits shall not be affected by accidental grounding of any part of the system.

   f. System shall automatically restart when power is restored.

   g. System memory shall be retained in the event of power failure or disturbance.

   h. Equipment shall be provided with Electro Magnetic Interference (EMI) shielding within FCC guidelines.

4. Wiring: CSA labeled copper for factory wiring. Neatly route wiring interconnections and securely attach wiring connections to studs or terminals.

5. Permanently mark components (relays, fuses, PC boards,) with symbols shown on wiring diagrams.

6. Monitoring System Interface: Provide controller with serial data link through RJ45 Ethernet connection and install all devices necessary to monitor items outlined in Section 2.13. Elevator contractor is responsible to connect monitoring system interface to control room monitoring compartment and LAN. Wiring from the LAN to the control room monitoring compartment by others.

7. Provide controller or machine mounted auxiliary, lockable “open” disconnect if mainline disconnect is not in sight of controller and/or machine.

E. Muffler: Provide in discharge oil line near pump unit. Design shall dampen and absorb pulsation and noise in the flow of hydraulic fluid and meet the requirements of Item 2.05 H.

F. Piping and Oil: Provide piping, connections and oil for the system. Buried piping (if required) shall be secondarily contained with watertight Schedule 40 PVC sleeves between elevator machine room and pit. A minimum of two sound isolation couplings shall be provided between the pump unit and oil line and the oil line and jack unit. Provide isolated pipe stands or hangers as required.

G. Noise/Vibration Isolation: Elevator equipment provided under this contract including power unit, controller, oil supply liners and their supports and fastenings electrically isolated from building, shall be mechanically and electrically isolated from the building structure and main line power feeders, building power supply and each other to minimize objectionable noise and vibration transmission to car, building structure, or adjacent occupied areas of building.

H. Sound Isolation:

1. Limit noise level in the machine room relating to elevator equipment and its operation to no more than 80 dBA.

2. Take dBA readings three feet off the floor and three feet from the equipment using the “A” weighted scale.

2.06 HOISTWAY EQUIPMENT

A. Guide Rails: Planed steel T-sections for car of suitable size and weight for the application, including seismic reactions, including brackets for attachment to building structure. Provide rail backing to meet Code requirements, if required. Provide bracketing, at top and bottom of floor beams, if required. No additional structural points of rail attachment, other than those shown on the Contract Documents, will be provided.

B. Buffers: Spring type with blocking and support channels.

C. Hydraulic Jack Assembly: Per APTA Guidelines.

1. Cylinder: Seamless steel pipe. Design head to receive unit-type packing and provide means to collect oil at cylinder head and return automatically to oil reservoir. Provide scavenger pump to return oil to the oil reservoir in the machine room. Provide secondary containment/cylinder protection.

2. Plunger: Polished seamless steel tubing or pipe. If plunger length exceeds 24 feet, provide two or more sections not exceeding 16 feet in length, or coordinate installation of longer unit at the jobsite. Join sections by internal threaded couplings. Multiple section jack units shall be factory polished while assembled and marked for proper future reassembly. Isolate plunger from car frame.

D. Jack Support and Fluid Shut-Off Valves: Provide steel pit channels to support jack assembly and transmit loads to building structure. Provide intermediate stabilizers as required. Provide manual on/off valve in oil line adjacent to pump unit and jack unit in pit adjacent to jack unit.

E. Hydraulic Oil Line Piping:

1. Oil feed line piping will be ASTM 53, Schedule 80 steel, black pipe , welded and seamless with manufacturers certificates provided. The pipe will be adequately sized to accommodate capacity, speed and horsepower requirements.

2. Provide all piping connections between the hydraulic cylinder, operating valves and power unit.

3. Oil lines shall be routed so as to minimize the number of bends, offsets and elbows.

4. Welding – Gas Tungsten arc weld (GTAW), using AWS ER702S-2 or ER70S-6 filler metal with argon purge. Shielded metal arc well (SMAW) is acceptable for passes with AWS E7018 low-hydrogen electrodes. Do not use gas metal arc welding on hydraulic lines.

5. Welded pipe will be pressure tested with oil not to exceed 400 PSI for 15 minutes. Nitrogen testing will be at 500psi for 1 hour. Pressure will be monitored for holding consistency and welds will be inspected for pressure loss. After pressure testing the pipe will be wrapped and painted.

6. All exposed oil feed line piping will have threaded connections and will be pressure tested and visually examined for leakage, after installation.

7. Will be run from each pit to the machine room to accommodate a future scavenger valve by others, if required. Type K or greater. Nitrogen pressure testing at 25psi for 15 minute duration.

8. Provide 1/2-inch hydraulic scavenger (oil return) line between Elevator Machine Rooms and Hoistway Pits, where indicated.

    a. Pipe - ASTM A53, Schedule 40, black steel, screwed.

    b. Fittings - Threaded, black forged steel.

9. Coating System for Embedded Piping.

    a. Tape layer of polyethylene or PVC not less than five mils thick.

    b. Bituminous paint over pipe.

    c. Layer 1/2-inch PVC foam.

    d. Tape layer of polyethylene or PVC not less than five mils thick.

    e. Bituminous paint over tape.

10. Apply protective coating to buried piping as specified in Section 22 05 00, Basic Plumbing Requirements.

11. Install in non-metallic casing for double containment.

F. Well Hole Casing:

1. No additional compensation will be allowed for unforeseen conditions of any kind or spoil removal.

2. Install outer steel casing and HDPE liner per structural standard drawing SS-037. Install watertight PVC inner casing over jack assembly for secondary containment prior to insertion into the outer casing. Extend PVC inner casing through pit floor slab to underside of jack support beams and seal with non-permeable membrane. Inside diameter of PVC inner casing shall be capable of containing 110% of system fluid capacity. Seal well opening at the pit floor with hydraulic quick setting cement. Provide PVC vision/access ports.

G. Overspeed Valve(s): Provide a pressure sensitive, mechanically-actuated seismic safety valve, conforming to ASME A17.1. Connect valve directly to jack assembly inlet.

H. Terminal Stopping: Provide normal and final devices.

I. Electrical Wiring and Wiring Connections: Per APTA Guidelines for outdoor locations.

1. Conductors and Connections: Copper throughout with individual wires coded and connections on identified studs or terminal blocks. Use no splices or similar connections in wiring except at terminal blocks, control compartments, or junction boxes. Provide 10% spare conductors throughout. Run spare wires from car connection points to individual elevator controllers in the machine room. Provide eight pairs of spare shielded communication wires in addition to those required to connect specified items. Tag spares in machine room.

2. Conduit: Galvanized steel threaded rigid conduit, or duct. NEMA 4 boxes. Conduit size, 3/4" minimum. Flexible heavy-duty service cord may be used between fixed car wiring and car door switches for door protective devices.

3. Traveling Cables: Type ET Flame and moisture-resistant outer cover. Prevent traveling cable from rubbing or chafing against hoistway or equipment within hoistway. Provide two CCTV communication cables within traveling cable from car controller to car top, plus 3'-0" excess loop at both ends. Provide two pair 14 gauge wire for CCTV power.

4. Auxiliary Wiring: Connect fire alarm initiating devices, emergency two-way communication system, firefighters' control panel (if required), CCTV, and Metro/ROC Monitoring/Control devices in each car controller or designated point in machine room.

J. Entrance Equipment:

1. Door Hangers: Two-point hanger roller with neoprene roller surface and suspension with eccentric upthrust roller adjustment.

2. Door Tracks: Bar or formed, cold-drawn removable stainless steel tracks with smooth roller contact surface.

3. Door Interlocks: Operable without retiring cam. Paint interlock box flat black.

4. Door Closers: Spring, spirator or jamb/strut mounted counterweight type. Design and adjust to insure smooth, quiet mechanical close of doors.

5. Hoistway Access Switches: Mount in wall at top and bottom floor. Provide switch with faceplate. Key to match existing elevators in the station.

K. Floor Numbers: Stencil paint 4 inch high floor designations in contrasting color on inside face of hoistway doors or hoistway fascia in location visible from within car.

2.07 HOISTWAY ENTRANCES

A. Complete entrances bearing fire labels from a nationally recognized testing laboratory approved within the governing jurisdiction.

B. Frames: Provide 14 gauge stainless steel hollow metal at floors. Bolted and lapped head to jamb assembly. Provide Arabic floor designation/Braille plates, centered at 60" above finished floor, on both side jambs of entrances. Floor designation shall be a minimum of 2" and on a contrasting background. Provide plates at main egress landing with “Star” designation. For designated emergency car, provide “Star of Life” designation plates at height of 78" – 84" above finished floor on both side jambs at floors. Braille indications shall be below Arabic floor designation. Provide cast floor designation/Braille plates as manufactured by SCS, Vision Mark, Entrada or approved equivalent.

C. Transom Panels: Sheet, offset labeled. Same construction and finish as hoistway door panels per Architectural Drawings.

D. Door Panels: 16 gage stainless steel, sandwich construction without binder angles. Provide leading edges of doors with rubber astragals. Provide a minimum of three gibs per panel, one at leading and one at trailing edge with gibs in the sill groove entire length of door travel. Construct door panels with interlocking, stainless steel stiffening ribs. Provide interior door panel components of stainless steel. Provide glass panels as shown on Architectural Standard Drawings. Provide additional layer of glass laminated to bring the surface of the glass flush with the door panel facing. Apply anti-graffiti film per Section 09 96 23, Anti-Graffiti Coating. Provide high doors if necessary to keep door related equipment from being exposed to view.

E. Sight Guards: Provide 14 gauge, same material and finish as hoistway entrance door panels. Construct without sharp edges.

F. Sills: Extruded nickel silver or stainless steel.

G. Sill Supports: Formed stainless steel designed to support door sill based upon car loading classification. Mount to eliminate need for grout under the sill. Provide 5 inch x 5 inch x 1/2 inch stainless steel angle, extending full width of hoistway. Fasten to building structure at maximum 18 inches on center.

H. Fascia, Toe Guards and Hanger Covers: Provide 14 gauge, Type 316 stainless steel. Provide car door interlock in order to negate the need for front fascia for express hoistway travel if glass front hoistway wall is provided. Otherwise, provide 14 gauge, Type 316 stainless steel front fascia on the hoistway wall. Provide hoistway toe guards, and hanger covers. Fascia above entrance shall be beveled to front hoistway wall at 75 degrees.

I. Struts and Headers: Provide for vertical support of entrances and related material. Provide door open bumpers on entrances equipped with vertical struts.

J. Finish of Frames and Doors:

1. Frames: Stainless Steel

2. Door Panels: Stainless steel with glass panels

2.08 CAR EQUIPMENT

A. Frame: Welded or bolted, rolled or formed stainless steel channel construction to meet load classification specified.

B. Platform: Isolated type, constructed of stainless steel. Design and construct to accommodate Class C3 load classification requirements.

C. Platform Apron: Minimum 14 gage stainless steel, reinforced and braced to car platform. Stencil car number on apron.

D. Guide Shoes: Roller type with three or more spring dampened, sound-deadening rollers per shoe. Maximum roller rotation speed, 350 revolutions per minute (rpm).

E. Sills: One piece extrusion nickel silver or stainless steel with extruded extension between car entrance columns to face of car front return. Extruded extension to match finish of sill.

F. Doors: Provide as specified for hoistway entrance doors, including glass door panels. Apply anti-graffiti protection film.

G. Door Hangers: Two-point hanger roller with neoprene roller surface and suspension with eccentric upthrust roller adjustment.

H. Door Track: Bar or formed, cold-drawn removable stainless steel track with smooth roller contact surface.

I. Door Header: Construct of minimum 12 gauge steel, shape to provide stiffening flanges.

J. Door Electrical Contact: Prohibit car operation unless car door is closed.

K. Door Interlock: Provide door interlock to negate the need to provide hoistway fascia, as allowed by ASME A17.1 and CCR Title 8.

L. Door Clutch: Heavy-duty clutch, linkage arms, drive blocks and pickup rollers or cams to provide positive, smooth, quiet door operation. Design clutch so car doors can be closed, while hoistway doors remain open. Clutches and pick-up rollers, shall not be visible through glass door panels.

M. Restricted Opening Device: Restrict opening of car doors outside unlocking zone.

N. Door Operator: High speed, heavy-duty door operator capable of opening doors at no less than 2-1/2 feet per second (f.p.s.). Accomplish reversal in no more than 2-

1/2 inches of door movement. Provide solid-state door control with closed loop circuitry to constantly monitor and automatically adjust door operation based upon velocity, position, and motor current. Maintain consistent, smooth and quiet door operation at floors, regardless of door weight or varying air pressure. Provide NEMA 4 enclosure for door operator.

O. Acceptable closed-loop door operators:

1. GAL: MOVFR-HSL, or approved equivalent, designed for exterior installation.

P. Door Control Device:

1. Infrared Reopening Device: Black, fully enclosed device with three dimensional full screen infrared matrix or multiple beams extending vertically along leading edge of each door panel to minimum height of 7'-0" above finished floor. Device shall prevent doors from closing and reverse doors at normal opening speed if beams are obstructed while doors are closing, except during nudging operation. In event of device failure, provide for automatic shutdown of car at floor level with doors open. Device shall be of weather resistant construction. Provide a one-piece full door height protective lens cover designed to be completely waterproof and to withstand impact, abrasion and vandalism.

2. Nudging Operation: After beams of door control device are obstructed for a predetermined time interval (minimum 20.0 - 25.0 seconds), warning signal shall sound and doors shall attempt to close with a maximum of 2.5 foot pounds kinetic energy. Activation of the door open button shall override nudging operation and reopen doors.

3. Interrupted Beam Time: When beams are interrupted during initial door opening, hold door open a minimum of 3.0 seconds. When beams are interrupted after the initial 3.0 second hold open time, reduce time doors remain open to an adjustable time of approximately 1.0 - 1.5 seconds after beams are reestablished.

4. Differential Door Time: Provide separately adjustable timers to vary time that doors remain open after stopping in response to calls.

a. Car Call: Hold open time adjustable between 3.0 and 5.0 seconds.

b. Hall Call: Hold open time adjustable between 5.0 and 8.0 seconds. Use hall call time when car responds to coincidental calls.

Q. Car Operating Panel:

1. One car operating panel without faceplate, consisting of a NEMA 4 metal box containing vandal resistant operating fixtures, mounted behind the car enclosure front return panel. Provide stationary front return with integral swing panel. Fire Service and Service Cabinet doors to be hairline flush fit.

2. Suitably identify floor buttons, alarm button, door open button, door close button and emergency push-to-call button with SCS, Visionmark, Entrada or

approved equivalent cast tactile symbols rear mounted. Configure plates per local building Code accessibility standards including Braille. Locate operating controls no higher than 48 inches above the car floor; no lower than 35 inches for emergency push-to-call button and alarm button. Braille plates shall include 5/8 inch floor designation with Braille located immediately below the floor designation. Spacing between floor buttons and Braille plates shall be a minimum of 3/8 inch. The raised floor designations shall be white on a black background. The call button for the main entry floor shall be designated by a raised star at the left of the floor designation.

3. Provide minimum 3/4 inch diameter raised floor pushbuttons, vandal resistant type which illuminate to indicate call registration.

4. Provide alarm button to ring bell located on car, and sound distress signal at Metro/ROC control panel. Illuminate button when actuated.

5. Provide keyed stop switch (EPCO-1 key) in locked service cabinet. Mark device to indicate "run" and "stop" positions.

6. Provide “door open” button to stop and reopen doors or hold doors in open position.

7. Provide “door close” button to activate door close cycle. Cycle shall not begin until normal door dwell time for a car or hall call has expired, except firefighters’ operation.

8. Provide firefighters’ Phase II key switch in locked Phase II compartment with engraved instructions filled red. Key shall match Innovation #EX515. Include light jewel, buzzer, manual stop switch, and call cancel button.

9. Provide lockable service compartment with recessed flush door located a minimum of 36 inches above the finished floor. Door material and finish shall match car return panel or car operating panel faceplate. Inside surface of door shall contain an integral flush window for displaying the elevator operating permit.

10. Include the following controls in lockable NEMA 4 service cabinet with function and operating positions identified by permanent signage or engraved legend:

    a. Inspection switch.

    b. Light switch.

    c. Two Speed Blower. Three-position exhaust blower switch.

    d. Independent service switch.

    e. Constant pressure test button for battery pack emergency lighting.

    f. 120-volt, AC, GFCI protected electrical convenience outlet.

    g. Stop switch.

h. Switch to select either floor voice annunciation, floor passing tone, or chime.

11. Provide black paint filled (except as noted), engraved signage as follows with approved size and font:

a. Phase II firefighters' operating instructions on inside face of Phase II compartment door, filled red.

b. Car number over main and auxiliary car operating panel.

c. 3/16 inch "Push for Alarm" and telephone usage instructions engraving. Per Metro requirements.

d. Car capacity in pounds and persons on main car operating panel.

e. "No Smoking" above main car operating panel.

R. Car Top Control Station: Mount to provide safe access and utilization while standing in an upright position on car top. Provide NEMA 4 enclosure.

S. Work Light and Duplex Plug Receptacle: GFCI protected outlet at top and bottom of car. Include on/off switch and lamp guard. Provide additional GFCI protected outlet on car top for installation of car CCTV. Provide with NEMA 4 rating.

T. Communication System:

1. "Push to Call," two-way communication instrument in car with automatic dialing, tracking and recall features with shielded wiring to car controller in machine room. Provide dialer with automatic rollover capability with minimum two numbers. Provide NEMA 4 enclosure. Provide Model T2100 instrument or approved equal to be compatible with Metro system.

a. "Push to Call" button or adjacent light jewel shall illuminate and flash when call is acknowledged. Button shall match car operating panel pushbutton design. Provide uppercase "PUSH TO CALL." "HELP ON THE WAY" engraved signage adjacent to button.

b. Provide "Push to Call" button tactile symbol, engraved signage, and Braille adjacent to button mounted integral with car front return panel.

2. Provide two-way communication between car and machine room if required.

2.09 CAR ENCLOSURE

A. Car Enclosure: Custom Glass Cars consisting of:

1. Side and Rear Walls: Partial stainless steel shell, mullion, etc. with clear laminated tempered safety glass with anti-graffiti film. Stainless steel, Satin No. 4 finish. Stainless steel frames and mullions at rear walls.

2. Glass: Conform with the requirements of Section 08 81 00, Glass and Glazing.

3. Canopy: Reinforced 12 gauge, Type 316 stainless steel with escape hatch opening. Provide hinged, gasketed satin stainless steel car top shroud.

4. Ceiling: Perimeter stainless steel secured coves with indirect fluorescent fixtures with vandal resistant lenses. Emergency lighting shall be incorporated into the overhead lights.

5. Front Return, columns and transom: Stainless steel satin No. 4 finish.

6. Doors: Laminated glass panels in stainless steel frame. Maximize glass panel size.

7. Handrail: Continuous 1-1/2 inch outside diameter (O.D.) round tube, stainless steel finish with wall mounted brackets on rear and side walls. Return handrail ends to wall. Locate mounting brackets a maximum of 18 inches on center. Mount with backing plates and captive nuts.

8. Base and panel reveals: Stainless steel No. 4 satin finish, with vent slots. Vents to be shielded to prevent intrusion of urine and other liquids.

9. Finish Flooring: 1/4 inch stainless steel diamond plate formed into a pan, 1-1/2 inches deep with welded seams and sealed at door threshold. Vents to be shielded to prevent intrusion of urine and other liquids. Seal around edges and at any butt joints.

10. Type 316 Stainless Steel pad buttons on front returns and walls, cars. One set of protective car pads.

2.10 LANDING CONTROL STATIONS

A. Pushbuttons: Provide one riser with flush mounted faceplates. Include pushbuttons for each direction of travel which illuminate to indicate call registration. Include approved engraved message and pictorial representation prohibiting use of elevator during fire or other emergency situation as part of faceplate. Pushbutton design shall match car operating panel pushbuttons. Provide vandal resistant pushbutton and light assemblies. Provide NEMA 4 pushbuttons and enclosures.

B. Faceplate Material and Finish: Stainless steel, Type 316, Satin No. 4 finish.

C. Hoistway Access Switches – Mount in entrance frame side jamb at top terminals. Mount in entrance frame at bottom terminals where walk-in pits are not provided. Provide fixture with faceplate as detailed on architectural drawings of 11 gauge satin No. 4 finish, Type 316 stainless steel.

2.11 SIGNALS

A. Hall Lantern: Provide NEMA 4 fixture at each entrance to indicate travel direction of arriving car. Locate as detailed on architectural drawings. Illuminate up or down LED lights and sound tone once for up and twice for down direction prior to car arrival at floor. Sound level shall be adjustable from 20 - 80 dBA measured at 5'-0" in front of hall control station and 3'-0" off floor. Illuminate light until the car doors start to close. Provide advanced hall lantern notification to comply with ADA hall call

notification time. Car direction lenses shall be arrow shaped with faceplates. Lenses shall be minimum 2-1/2 inches in their smallest dimension. Provide vandal resistant lantern and light assemblies consisting of series of lines for maximum visibility.

B. Car Position Indicator: Multi-light indicator containing floor designations and direction arrows a minimum of two inches high to indicate floor served and direction of car travel. Locate NEMA 4 fixture in transom above car entrance. When a car leaves or passes a floor, illuminate indication representing position of car in hoistway. Illuminate proper direction arrow to indicate direction of travel. Provide multi-numeral vandal resistant indicator and light assemblies.

C. Faceplate Material and Finish: 11 gauge stainless steel, Type 316, Satin No. 4 finish.

D. Floor Passing Tone: Provide an audible tone of no less than 20 decibels and frequency of no higher than 1500 Hz, to sound as the car stops at a floor served.

E. Voice Synthesizer: Provide electronic device with easily reprogrammable message and female voice to announce car direction, floor, emergency exiting instructions and other standard messages. Comply with ADA requirements.

2.12 REMOTE MONITORING AND CONTROL OF CAR OPERATION

A. Provide remote monitoring and control as directed by Metro/ROC

1. Provide remote control capabilities for both emergency and routine operation. Originate remote control from system central control and from station emergency management panels via the Metro Emergency Management Programmable Logic Controller (PLC). Others to provide Ethernet connection, conduit and wiring from elevator machine rooms to the ROC. Provide terminals in each elevator controller for the following functions:

a. Send to top floor control

b. Send to bottom floor control

c. Home elevator control (From Emergency Management Panel. Does not override fireman key switch operation). Elevator remains in the home position while contact is closed.

d. Top floor lockout control (disables top floor hall call only; cab remains operable)

e. Bottom floor lockout control

f. One trip control (Allows one hall call during a lockout. Times out in 5 minutes if no call)

g. Emergency service call indication

h. Bottom floor hall call indication

i. Top floor hall call indication

j. Car at top floor indication

k. Car at bottom floor indication

l. Car alarm button indication

m. Low oil indication

n. Trouble indication

2. Duplex Operation: Where elevators are indicated to be Duplex Operation individual control and indication for each car.

3. Electrical:

a. Elevator contractor shall coordinate with the contractor and appropriate trades in relation to the CCTV, communication systems, public address, smoke detectors, shunt trip breakers, power and cab lighting requirements.

b. All indication contacts shall have a minimum rating of 24 VDC at 2 amps.

c. All indication contacts shall be normally open.

d. Adjacent terminal block locations shall be assigned for each indication Common (C) and Normally Open (NO) contact. It shall be possible to insert a jumper bar to connect each common terminal.

e. Adjacent terminal block locations shall be assigned for each control. Each control shall be isolated and provide two terminals.

f. All controls shall be momentary contact closures and activate on rising edge of a minimum 250ms pulse with the exception of the HOME function which shall be active while the associated contact is closed.

g. Contractor supplied control voltage shall not exceed 24VDC and shall be current limited to 2 amps.

B. Firefighters' Control Panel: (If required) Locate in building fire control room as shown on Project Definition drawings. Fixture faceplate, stainless steel Satin No. 4 finish, including the following features:

1. Car position and direction indicator (digital-readout or color SVGA display type). Identify each position indicator with car number.

2. Indicator showing operating status of car.

3. Manual car standby power selection switches and power status indicators. (If Required)

4. Two-position firefighters' emergency return switches and indicators with engraved instructions filled red.

C. Fixtures and monitor shall be located as directed by Metro. Where applicable, identify indicators and manual switches with appropriate engraving. Provide wiring to control panel. Coordinate size and location with Building Console Supplier.

D. Firefighters' Key Box: Flush-mounted box with lockable hinged cover. Engrave instructions for use on cover per local Fire Authority requirements.

1. Firefighter keys to match existing Metro elevator keys or replace existing keys to match new elevator keys, to meet Code requirements.

2.13 ENHANCED ELEVATOR SYSTEM MONITORING

A. Elevator trouble indication shall alarm for any system trouble or for the enhanced monitoring described in this section.

B. The elevator controller shall activate the enhanced trouble alarm indication anytime a car is not detected to change to a valid floor position for 20 or more minutes when hall calls can normally be serviced.

C. The elevator controller shall clear the enhanced trouble alarm indication anytime a car successfully transitions to a valid floor position.

D. The elevator controller shall periodically and automatically call a car as required during periods of low activity to test the operation and prevent false trouble alarms while hall calls can normally be serviced.

2.14 ENHANCED REMOTE MONITORING

A. The elevator controller shall support Ethernet based monitoring for service maintenance personnel.

B. The monitoring shall not allow any remote control or configuration.

C. The monitoring shall provide detailed system status, diagnostic and performance information including event logs as required for efficient and effective preventive, predictive and unplanned maintenance.

D. The monitoring shall only require network connection and a standard web browser. No special client software shall be required.

E. It shall be possible to set a password to prevent unauthorized access.

F. The Contractor shall provide an industrial firewall (Phoenix Contact MGUARD-RS or Metro approved equivalent) to block all outside traffic except valid HTTP/HTTPS requests from authorized networks/clients.

G. Network connection and configuration will be performed by Metro.

2.15 SEISMIC OPERATIONS AND EQUIPMENT

A. Provide design, components and operation per governing Code and as specified.

PART 3 - EXECUTION

3.01 SITE CONDITION INSPECTION

A. Prior to beginning installation of equipment, examine hoistway and machine room areas. Verify that no irregularities exist which affect execution of Work specified. Particularly, note:

1. Hoistway size and plumbness

2. Sill supports and pockets.

3. Support areas for brackets, beams, and like items.

4. Divider beams.

B. Do not proceed with installation until Work in place conforms to project requirements.

3.02 INSTALLATION

A. Install equipment in accordance with Manufacturer's instructions, referenced Codes, specification and approved submittals.

B. Install machine room equipment with clearances in accordance with referenced Codes and specification.

C. Install equipment so it may be easily removed for maintenance and repair.

D. Install equipment for ease of maintenance.

E. Install equipment to afford maximum accessibility, safety, and continuity of operation.

F. Provide elevator car enclosure. Provide elevator hoistway as shown on Architectural Standard Drawings and specified. Elevator Contractor - Supervise and coordinate drawings and materials specified, install cars, and be responsible for following:

1. Furnish and install electrical controls and signal fixtures, lighting fixtures, and wire complete. Provide minimum ten foot candle illumination at car sill with doors closed. Provide temporary lighting as required.

2. Furnish and install emergency lighting incorporated into the overhead lighting. Locate to provide minimum 0.2 foot candle illumination 12 inches in front of main car station measured 48 in. above finish floor.

3. Furnish and install on-board conduit and wiring to lighting and ventilating fixtures, as required.

4. Furnish and install hangers and gibs on car doors and hang doors.

5. Furnish and install car fixtures complete.

6. Furnish and install communication system as specified.

7. Furnish and install two-speed squirrel cage 350 cfm exhaust blower. Blower - Isolate from car steel canopy on rubber grommets.

G. Remove oil, grease, scale, and other foreign matter from the following equipment and apply one coat of field-applied machinery enamel.

1. Exposed equipment and metal work installed as part of this work which does not have architectural finish.

2. Machine room equipment, hoistway equipment including guide rails, guide rail brackets, and pit equipment.

3. Neatly touch up damaged factory-painted surfaces with original paint color. Protect machine-finish surfaces against corrosion.

4. Equipment and metal work installed as part of this Work which does not have special architectural finish and is exposed in hoistway.

5. Machine, motor generator, controller and selector.

6. Machine surfaces – Protect machine finished surfaces against corrosion.

7. Natural metals – stretcher leveled, re-squared sheets 0.063 inch minimum for door facings, and 0.074 inch minimum for entrance frames and front returns. Run grain of belting in direction of longest dimension. Satin finish – remove tool and die marks and then finish with No. 80, 100, and 120 grit sanding belts. Surfaces – smooth and without oil canning.

3.03 FIELD QUALITY CONTROL

A. Work will be checked during course of installation. Full cooperation with reviewing personnel is mandatory. Accomplish corrective work required prior to performing further installation.

B. Have governing code authority acceptance inspection performed and complete corrective work.

3.04 ADJUSTMENTS

A. Install hydraulic jack assembly and guide rails plumb and align vertically with tolerance of 1/16 inch in 100'-0". Secure guide rail joints without gaps and file any irregularities to a smooth surface.

B. Statically balance car to equalize pressure of guide shoes on guide rails.

C. Lubricate equipment in accordance with Manufacturer’s instructions.

D. Adjust motors, valves, controllers, leveling switches, limit switches, stopping switches, door operators, interlocks, and safety devices to achieve required performance levels.

E. Fabricate and assemble various parts in shop to greatest extent practicable; minimize field assembly. Parts which cannot be shop assembled and require close field fit – trial assemble in shop and mark for field erection.

3.05 CLEANUP

A. Keep work areas orderly and free from debris during progress of project. Remove packaging materials on a daily basis.

B. Remove loose materials and filings resulting from work.

C. Clean machine room equipment and floor. Paint machine room floor deck gray. Paint pit floor and walls deck gray.

D. Clean hoistways, car, car enclosure, entrances, operating and signal fixtures.

3.06 ACCEPTANCE REVIEW AND TESTS

A. Manufacturer shall perform review and evaluation of every aspect of its Work prior to requesting Metro or its designee's final review. Work shall be considered ready for Metro or its designee's final contract compliance review when Manufacturer's tests are complete per ASME A17.2 and elements of Work or a designated portion thereof are in place and elevators are deemed ready for service as intended.

B. Furnish labor, materials, and equipment necessary for review. Notify Metro or its designee a minimum of five working days in advance when ready for final review of elevator or group.

C. Metro or its designee's written list of observed deficiencies of materials, equipment and operating systems will be submitted to Manufacturer for corrective action. Metro or its designee's review shall include as a minimum:

1. Workmanship and equipment compliance with Contract Documents.

2. Contract speed, capacity, floor-to-floor, and door performance--comply with Contract Documents.

3. Performance of following is satisfactory:

a. Starting, accelerating, running

b. Decelerating, stopping accuracy

c. Door operation and closing force

d. Equipment noise levels

e. Signal fixture utility

f. Overall ride quality

g. Performance of door control devices

h. Operations of emergency two-way communication device

i. Operations of firefighters' service

j. Operation of SCADA/remote monitoring interface signals

4. Test Results:

a. In test conditions, obtain specified contract speed, performance times, stopping accuracy without re-leveling, and ride quality to satisfaction of Purchaser and Consultant. Tests shall be conducted under both no load and full load condition.

b. Temperature rise in motor windings limited to 50° Celsius above ambient. A full-capacity, one hour running test, stopping at each floor for ten seconds in up and down directions, may be required.

D. Performance Guarantee: Should Metro or its designee's review identify defects, poor workmanship, variance or noncompliance with requirements of specified Codes and/or ordinances, or variance or noncompliance with the requirements of Contract Documents, Manufacturer shall complete corrective work in an expedient manner to satisfaction of Metro or its designee at no cost as follows:

1. Replace equipment that does not meet Code or Contract Document requirements.

2. Perform work and furnish labor, materials, and equipment necessary to meet specified operation and performance.

3. Perform retesting required by Governing Code Authority, Metro or its designee.

E. A follow-up final contract compliance review shall be performed by Metro after notification by Manufacturer that deficiencies have been corrected. Provide Metro with copies of the initial deficiency report marked to indicate items which Manufacturer considers complete. If additional reviews are required due to the Manufacturer's gross non-compliance with initial and follow-up deficiency reports, Metro or its designee shall bill Manufacturer at normal billing rates plus expenses, and the Manufacturer acknowledges it will pay for additional compliance reviews.

3.07 PURCHASER'S INFORMATION

A. Non-Proprietary Equipment Design: Provide five sets of neatly bound written information necessary for proper maintenance and adjustment for equipment no less than fourteen days prior to substantial completion. Also provide an electronic version of data on a CD or other acceptable media. Final retention will be withheld until data is received and reviewed by Metro or its designee. Include the following as minimums:

1. Straight-line wiring diagrams of "as-installed" elevator circuits, with index of location and function of components. Provide one set reproducible master. Mount one set wiring diagrams on panels, racked or similarly protected, in

each elevator machine room. Provide remaining set rolled and in a protective drawing tube. Maintain drawing sets with addition of subsequent changes. These diagrams are Metro's property. A legend sheet shall be furnished with each set of drawings to provide the following information:

a. Name and symbol of each relay, switch or other apparatus.

b. Location on drawings, drawing sheet number and area and location of contacts.

c. Location of apparatus, whether on controller or on car.

2. Printed instructions explaining operating features.

3. Complete software documentation for installed equipment.

4. Lubrication instructions, including recommended grade of lubricants.

5. Parts catalogs listing replaceable parts including Manufacturer's identifying numbers and ordering instructions.

6. Four sets of keys for switches and control features properly tagged and marked.

7. Diagnostic test devices together with comprehensive supporting information necessary for interpretation of test data and troubleshooting of elevator system and performance of routine safety tests.

8. The elevator installation shall be a design that can be maintained by any licensed elevator maintenance company employing journeymen mechanics, without the need to purchase or lease additional diagnostic devices, special tools or instructions from the original equipment Manufacturer.

   a. Provide on site capability to diagnose faults to the level of individual circuit boards and individual discrete components for the solid state elevator controller.

   b. Provide a separate, detachable device, as required to Metro as part of this installation if the equipment for fault diagnosis is not completely self-contained within the controller. Such device shall be in possession of and become property of Metro.

   c. Installed equipment not meeting this requirement shall be removed and replaced with conforming equipment at no cost to Metro.

9. Provide upgrades and revisions of software during the progress of the Work, warranty period, the term of the ongoing maintenance agreement between Metro and Manufacturer and for a 60 month period following expiration of any warranty or ongoing maintenance agreement between Metro and the manufacturer/installer.

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SECTION 14 31 00

ESCALATORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Designing, furnishing and installing Heavy Duty Transit Escalators in Stations.

B. Engineering, equipment, labor, hoisting equipment, tests and permits required to satisfactorily complete escalator installation required by Contract Documents and approval of escalators by jurisdictional agencies.

C. Preventive maintenance as described herein.

1.02 RELATED SECTIONS

A.	Section 01 33 00	Submittal Procedures
B.	Section 01 43 10	Project Quality Program Requirements - Design/Build
C.	Section 01 43 38	Field Samples and Mock-Ups
D.	Section 01 66 00	Product Storage and Handling Requirements
E.	Section 01 78 43	Spare Parts, Illustrated Parts Catalog and Replacement Materials
F.	Section 05 05 33	Basic Welding Requirements
G.	Section 05 08 00	Stainless Steel Escalator Cladding
H.	Section 09 91 00	Painting
I.	Section 21 00 00	Fire Protection Systems
J.	Section 28 40 00	Communications Supervisory Control and Data Acquisition System Remote Terminal Unit (SCADA RTU)

1.03 REFERENCES

A. American Bearing Manufacturers Association (ABMA):

1. Bearing Basic Rating Life L_{10}

B. American Institute of Steel Construction (AISC):

1. AISC Specifications for Design, Fabrication, and Erection of Structural Steel for Buildings

C. American National Standards Institute (ANSI) Publications:

1. ASME A17.1 Safety Code for Elevators and Escalators

2. ASME A17.2.3 Escalators and Moving Walks Inspection and Maintenance Evaluation

3. ASME A17.5 Committee on Elevator and Escalator Electrical Equipment

D. ASTM International (ASTM):

1. ASTM A36 Carbon Structural Steel

2. ASTM A240 Chromium and Chromium-Nickel Stainless Steel Plate Sheet, and Strip for Pressure Vessels and for General Applications

3. ASTM A276 Stainless Steel Bars and Shapes

4. ASTM A480 General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

5. ASTM A554 Welded Stainless Steel Mechanical Tubing

6. ASTM A568 Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for

7. ASTM A1008 Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

8. ASTM B209 Aluminum and Aluminum-Alloy Sheet and Plate

9. ASTM B221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

E. American Public Transportation Association (APTA):

1. APTA Heavy Duty Transportation System Escalator Design Guidelines

F. American Welding Society (AWS)

1. AWS D1.1 Structural Welding Code – Steel

G. California Code of Regulations (CCR):

1. Title 8 – Industrial Relations

a. Chapter 4 Division of Industrial Safety; Subchapter 6 - Elevator Safety Orders, including Article 13, Escalators

b. Division of Occupational Safety and Health – Cal/OSHA

2. Title 19 – Public Safety Code

3. Title 24 – Building Standards Code

    a. Part 2 – California Building Code (CBC)

    b. Part 3 – California Electrical Code (CEC)

H. Metro Rail Design Criteria (MRDC)

I. National Fire Protection Association (NFPA):

1. NFPA 70 (ANSI C1) National Electric Code

2. NFPA 130 Fixed Guideway Transit and Passenger Rail System

J. Supervisory Control and Data Acquisition (SCADA)

K. Underwriters Laboratories, Inc. (UL)

L. U.S. Department of Transportation (USDOT):

1. Federal Transit Administration (FTA) – ADA Standards for Transportation Facilities

M. South Coast Air Quality Management District (SCAQMD):

1. SCAQMD Rule 1113 – Architectural Coatings

1.04 QUALITY ASSURANCE

A. Comply with Project Quality Program Requirements (see 1.02 above).

B. Manufacturer and Applicator/Installer Qualifications:

1. Manufacturer's Qualifications: Minimum of five (5) years experience in manufacturing of specified materials/products, with record of successful in-service performance.

2. Applicator/Installer Qualifications: Engage applicator/installer with minimum 5 years experience in installation of materials/products similar in material, design, and to extent indicated for this Project.

    a. Installer Certification: Obtain written certification from manufacturer, certifying that installer is approved by, licensed, or certified by manufacturer for installation of specified materials/products or systems.

    b. Provide list of minimum 5 projects similar in nature and size to that of this Project, where specified materials/products have been successfully installed/used.

    c. Other Parts and Appurtenances - By escalator manufacturer or firms specializing in types of components required and acceptable to escalator manufacturer.

C. Perform welding in accordance with the requirements of the American Welding Society (AWS). Provide evidence of Welders current certification by the AWS.

D. Escalator Contractor - Currently C-11 licensed.

E. Safety - Conform to requirements of ASME A17.1 and Supplements and ASME A17.2 and Supplements for safety devices, running clearance, testing and maintenance methods.

F. Corrosion Protection

1. Design escalator assemblies to prevent corrosion by galvanic action due to physical contact between dissimilar metals or other causes.

2. Where use of adjoining dissimilar metal is required, submit description of protective measure to be employed to prevent corrosive damage.

G. Hours of operation: 24 hours per day, seven days per week

H. Design, fabricate and install escalator parts subject to repair and replacement to be readily and easily removable and replaceable without requiring modification of truss structure, equipment space or escalator equipment.

I. Precisely identify replacement parts, whether produced in Contractor's factories or secured from commercial factories and distributors. Make replacement parts, maintenance methods, technical information, wiring diagrams, testing procedures, design and performance criteria, and other publications related to escalator equipment provided available to Metro or its designee without prejudice or delay. Required quantities, uniform price and delivery time of replacement parts - On same basis as Contractor's most favored maintenance consumer.

J. Reliability/Maintainability

1. Escalator - Capable of operating at full load under normal modes of operation with Mean-Time-Between-Failure (MTBF) of 350 hours, where MTBF is determined by following formula:

$$\text{MTBF} = \frac{\text{Operating Time "T" (all escalators)}}{\text{Number of failures in time "T"}}$$

2. Escalator - Mean-Time-To-Repair (MTTR) of two hours, where MTTR is defined as average time required to repair escalator to operate after failure occurs and is calculated as follows:

$$\text{MTTR} = \frac{T(t)}{f(t)}$$

Where $T(t)$ = total active repair time to repair failures occurring in time (t)

$f(t)$ = the total number of failures occurring in time (t)

3. In lieu of demonstrating MTBF, Contractor may elect to demonstrate compliance with reliability criteria by Mean-Cycles-Between-Failures (MCBF). One operating cycle will be considered as consisting of 44 seconds of travel

time, in UP and DOWN directions, plus two door open/close cycles. MCBF: 30,000 cycles.

K. Store critical spare repair parts on-site or in a Metro designated location.

L. The escalator specifications are intended to cover the complete installation of the escalator and to outline broadly the equipment required, but not to cover the details of construction. Such details are recognized to be the exclusive responsibility of the Manufacturer and Installer. It is hereby recognized that Metro or its designee did not invent or develop any part of the escalator systems, but has only made selections of capacities, speeds, control systems, materials, from choices made available by the manufacturers.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures, for submittal requirements and procedures.

B. ~~Within 60~~**No less than 180** calendar days ~~after award of contract and before~~**prior to** beginning equipment fabrication, submit shop drawings and required materials for review as outlined in Section 01 33 00, Submittal Procedures, and per Metro requirements. Allow 30 calendar days for response to initial submittal.

1. Fully Dimensioned Layout: Plan of pit, wellway, machine room and remote controller with associated equipment, indicating equipment arrangement, and elevation section of wellway.

2. Design Information: Indicate equipment lists, reactions and design information on layouts including ventilation requirements.

3. Power Confirmation Information: Include motor horsepower, code letter, starting current, full-load running current, and demand factor.

4. Fixtures: Cuts, samples, and shop drawings, including but not limited to key switch, stop button, handrail, balustrade panel, cladding.

5. Finish Material: Submit samples of actual finished material for Metro review of color, pattern, and texture. Include other submittals as requested by Metro, including but not limited to signal fixtures, lights, graphics, and details of mounting provisions.

C. Contractor shall provide six hard copies and one electronic copy of the shop drawings.

1. Drawings shall include but not be limited to:

a. Outline of escalator truss in profile and plan

b. Elevation of escalator balustrade

c. Vertical section through balustrade

d. Truss midway between working points

2. Drawings shall show:

    a. Truss stanchion

    b. Track system and supports

    c. Drive system

    d. Step nosing radius at upper and lower ends

    e. Drive chain and gear trim

    f. Step chain or step links (including chain pitch, step and trailer wheels)

    g. Step assembly (including axle, step tread, frame and riser)

    h. Handrail system (including profile, guides, drive and tension device)

    i. Support details (including upper, lower, intermediate and slip joint) balustrade deck cover, interior panels, skirt panels and their moldings and skirt brush details

    j. Safety switches and operating devices

    k. Motor and emergency brake

    l. Floor plates

    m. Speed governor

    n. Metal gauges

    o. Radial, vertical and horizontal dimensions required for manufacture, and positions of lower and upper working points

    p. Attachment of truss to structure

    q. Major mechanical and electrical components within truss

    r. Drainage and electrical interfaces

    s. Hand and finger guards

    t. Passenger instruction signs

    u. Emergency stop button

    v. Operating panel in upper and lower balustrades (including stop button, start and direction selection switches, and fault finder receptacle)

    w. Details of remotely located controller cabinet and equipment. Note: control, drives and related equipment and accessories to be contained in a single cabinet enclosure.

x. Truss cladding attachment provision details

y. Details and schematics of SCADA interface.

3. Bearings ratings, identification and catalog numbers shall be provided

4. A complete schematic diagram shall be provided for the controller and electrical devices

5. Test certificates for step chain shall be provided

6. Seismic calculations signed and sealed by Registered Professional Engineer licensed in State of California.

D. Acknowledge and/or respond to submittal review comments within 14 calendar days of return. Promptly incorporate required changes due to inaccurate data or incomplete definition so that delivery and installation schedules are not affected. Provider's revision response time is not justification for equipment delivery or installation delay.

E. Prior to commencing installation of the first escalator, Contractor shall submit six draft hard copy sets of Operation and Maintenance manuals to Metro or its designees for approval.

F. Material Safety Data Sheets (MSDS): Manufacturers Material Safety Data Sheets for each used in Work type of material.

G. ~~Within sixty~~**No less than 180 calendar** days ~~after Notice to Proceed, and~~ prior to ~~installation~~**Substantial Completion**, Contractor shall submit detailed Preventive and Warranty Maintenance Control Programs, showing functions to be performed and their scheduled frequency.

H. As-built drawings shall include:

1. Control and schematic electrical wiring diagrams of controller, including wiring of safety devices to connections with remote indication and control panels for each escalator.

2. Electrical layout showing placement of lighting, light switches, receptacles, light fixtures, disconnect switches and convenience outlets in machine rooms and pits.

3. Complete detailed drawings and wiring diagram of escalator fault finding device and connection to annunciator panel.

4. Electronic and hard copies of ladder diagrams, logic and program.

1.06 DEFINITIONS

A. Terms used are defined in the latest edition of the Safety Code for Elevators and Escalators, ASME A17.1.

B. Reference to a device or a part of the equipment applies to the number of devices or parts required to complete the installation.

C. Defective is defined to include, but not limited to; operation or control system failures, performance below required minimum, excessive wear, unusual deterioration or aging of materials or finishes, unsafe conditions, the need for excessive maintenance, abnormal noise or vibration, and similar unsatisfactory conditions.

D. VOC: Volatile Organic Compound, as defined in SCAQMD Rule 102 – Definition of Terms:

1. Any volatile compound of carbon, excluding methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, and exempt compounds.

E. SCAQMD: South Coast Air Quality Management District.

F. ~~Substantial Completion – Elevators and Escalators. Substantial Completion for elevators and escalators will occur no earlier than the date of commencement of revenue service.~~**NOT USED**

G. The Preventive Maintenance Period is defined as the twelve month period commencing on the date of Substantial Completion~~ – Elevators and Escalators~~**.**

1.07 ADMINISTRATIVE REQUIREMENTS

A. Temporary Use: Do not use escalators during construction period, unless permitted in writing by Metro.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 01 66 00, Product Storage and Handling Requirements, for general requirements for product delivery, storage, and handling procedures.

B. Deliver material/product in manufacturer's original, unopened protective packaging.

C. Store material in original protective packaging. Prevent soiling, physical damage, or moisture damage.

D. Protect equipment and exposed finishes from damage and stains during transportation, erection, and construction. Chains exhibiting rust shall be replaced.

E. Coordinate/cooperate with other trades performing tasks at the Worksite.

1.09 RELATED WORK PROVIDED UNDER OTHER SECTIONS

A. Wellway and Pit:

1. Clear, plumb, wellway with variations not to exceed one inch at any point.

2. Floor pockets and structural beams for support of escalator truss at each end as shown on Contract Drawings. Steel supports, if used, shall meet deflection

requirements of AISC Specifications for Design, Fabrication, and Erection of Structural Steel for Buildings. Seismic supports shall meet the requirements of California Code of Regulations (CCR), Title 8.

3. Fire rated enclosure of escalator truss including ends, sides and bottom in ceiling plenum.

4. Patching and finishing around escalator landing plates after installation. Filler piece at lower end slide attachment.

5. Cladding and finishing of exposed truss surfaces. Truss cladding shall not exceed ten pounds per square foot. Cladding shall be per Metro's Architectural Standards.

6. Waterproof Pit. Sump pit with flush grate and pump or indirect waste drain with oil separator. Liquids cannot be directed to sewer. Pump and/or drain must be easily accessible for maintenance from outside of the escalator pit. Install drain cleanout outside of escalator pit.

7. Protect exposed exterior escalators with weatherproof canopy entire length of truss per ASME A17.1, Section 6.1.8.

8. Protect open wellways during construction per Cal/OSHA Regulations.

9. Protect escalator truss, steps, chains, landing plates, balustrades, handrails, and special metal finishes from damage, deterioration and environmental conditions during construction and until escalator system is fully operative.

10. Access route to escalator wellway, clear and free of construction materials and debris, provided to permit delivery of escalator truss, related equipment and rigging equipment to wellway.

11. Area around escalator wellway, clean and free from construction materials and debris, to permit unloading and installation of escalator truss, related equipment and rigging required to install truss sections.

12. Venting or other means to prevent accumulation of smoke and gas in escalator truss as required by Local Building Code.

13. Fire sprinklers per local Fire Authority and Code requirements, with protective guards.

B. Electrical Service, Conductors and Devices:

1. Light with guard and GFCI convenience outlet in each pit and machine room space.

2. Three-phase mainline copper power feeder to terminals of each escalator controller in the remote controller cabinet with protected, lockable "open", disconnect switch.

3. Wiring and conduit from escalator controller to remote monitoring panels, interface panels or consoles as required.

4. Fire alarm initiating devices in each escalator pit. Provide alarm initiating signal wiring from connection point to escalator controller terminals. Device to provide signal for general alarm Temporary power and illumination to install, test, and adjust escalator equipment. Temporary power shall have the same characteristics as the permanent power.

5. Conduit from the closest wellway of each escalator group or single escalator to the Emergency Management Panel. Coordinate size, number and location of conduits with Metro and escalator contractor.

6. Escalator Illumination: Provide a minimum of 10 footcandles of consistent illumination over the entire escalator.

1.10 WARRANTIES

A. Material and workmanship of installation shall comply in every respect with Contract Documents. Correct defective material or workmanship to satisfaction of Metro or its designee at no additional cost, unless due to ordinary wear and tear, or improper use or care by Metro.

B. Make modifications, requirements, adjustments and improvements to meet performance requirements in Parts 2 and 3 of this specification.

~~B.~~**C. The Warranty on the Escalators shall commence on the date of the issuance of the Certificate of Substantial Completion and shall remain in effect for one year after that date.**

1.11 DOCUMENT AND SITE VERIFICATION

A. In addition to other Representations, Warranties, and Covenants made by Contractor in the Contract Documents, General Conditions, to discover, avoid, and/or resolve conflicts or lack of definition which might create problems during the performance of the Work, Contractor is responsible for reviewing, and warrants that it has reviewed, site conditions and of the requirements in the Contract Documents to ensure compatibility of the selected product prior to submittal of its bid. Metro shall not be liable for any costs, impacts or changes to structural, mechanical, electrical, or other systems to accommodate the product selected by Contractor to provide for this Contract.

1.12 PERMIT, TEST AND INSPECTION

A. Obtain and pay for permit, license, and inspection fee necessary to complete installation.

B. Perform test required by Governing Authority in accordance with procedure described in ASME A17.2 Guide for Inspection of Elevators, Escalators, and Moving Walks in the presence of Metro or its designee.

C. Supply personnel and equipment for test and final review by Metro Consultant, as required in Part 3 of this specification.

1.13 PREVENTIVE MAINTENANCE

A. ~~Within 60 days after Notice to Proceed, and~~**Not less than 180 calendar days** prior to ~~installation~~**Substantial Completion**, Contractor shall submit detailed Preventive Maintenance Control Programs, showing functions to be performed and their scheduled frequency. The Preventive Maintenance Period is defined as the twelve month period following Substantial Completion~~ – Elevators and Escalators~~.

1. Program shall reflect requirements for Heavy Duty Transit Escalators for use in an exterior location at the job specific location.

B. Perform preventive maintenance and 24-hour emergency callback service during the ~~Interim~~ **Preventive** Maintenance period. Callback service shall be provided at no additional cost to Metro. All callbacks are included.

C. The preventive maintenance agreement shall also cover repairs and damage above and beyond regular maintenance including vandalism and nuisance calls for the period of the agreement. The preventive maintenance period is to be paid under the ~~bid item for Preventive Maintenance~~**lump sum Bid Item for Escalators** in Schedule A of the Schedule of Quantities and Prices. Repairs to damage from vandalism and the cost of nuisance calls will be paid under the provisional sum ~~established by Metro~~**in Schedule B of the Schedule of Quantities and Prices**.

D. Provide backup documentation of all labor hours and parts costs with the submission of Provisional Sum invoices. Provisional Sum invoices will only be considered for payment for services rendered due to vandalism or abuse or shutdowns caused by forces outside of the normal operation of the escalators. Provisional Sum payment will not be rendered for shutdowns due to defective equipment, software imperfections, component failure, poor workmanship or any condition covered by Preventive Maintenance or pertaining to an item on the Metro punch list.

E. Preventive Maintenance

1. Provide preventive maintenance and 24-hour emergency callback service for the Preventive Maintenance Period (as defined above). Required maintenance shall be of the same standard as other Metro transit escalators and shall include Metro's standard maintenance check chart and manufacturers O&M criteria. Systematically examine, adjust, clean and lubricate equipment. Repair and replace defective parts using parts produced by the manufacturer of installed equipment.

2. Use competent personnel, acceptable to Metro, supervised and employed by Contractor.

3. Repair or replace defective parts using parts produced by the manufacturer of installed equipment.

4. Perform preventive maintenance in compliance with Title 8 and ASME A17.1. Provide a minimum of eight mechanic hours per unit, per month of preventive maintenance. Required testing, major repairs exceeding one and one half (1.5) hours, and callbacks shall not be considered a part of the eight hours of

preventive maintenance. Equipment shall be adjusted to meet specified performance criteria.

5. Provide support for State Inspector and Metro or its designee's annual inspection.

6. Respond to trouble calls, first, with onsite personnel. If Contractor personnel are not on site, response between 6:00am and 9:00 pm shall be within 45 minutes, 90 minutes between 9:00 pm and 6:00 am. Coordinate maintenance work with Metro and Metro's ROC. Escalators shall not be removed from service for maintenance between the hours of 6:00 am and 9:00 am or 3:00 pm and 7:00 pm (peak hours).

7. During the Preventive Maintenance Periods, no escalator shall be out of service for more than 12 hours during weekdays or more than 24 hours during weekends.

8. The Preventive Maintenance Period specified in Item 1 above shall be extended according to the Escalator Performance Condition at no additional cost to Metro.

F. Escalator Performance Condition:

1. During the final 30 days of the Preventive Maintenance Period, the escalators shall run reliably and safely with no more than three similar trouble calls within a 96-hour period; and there shall be no failure of any component that causes the escalators to be out of service for more than 24 consecutive hours during the 30 day observation period (the "Escalator Performance Condition"). If at the end of the 30 day observation period, and the escalators have operated as provided in and above, then the "Escalator Performance Condition" shall be deemed satisfied. However, if at any time during the 30 day observation period the escalators do not meet the Escalator Performance Condition, Metro shall provide contractor with written or electronic notice of the escalator's failure and a request for immediate repair and written confirmation of the repair. Once the repairs are made, the 30 day observation period shall reset and the repaired escalator must then meet the Escalator Performance Conditions in the next 30 days. This process shall be repeated until the Escalator Performance Condition has been met.

1.14 REGULATORY REQUIREMENTS

A. Compliance with Regulatory Agencies:

1. Comply with most stringent applicable provisions of Codes, laws, and local Authorities having jurisdiction, including revisions and changes in effect as of the Invitation for Bid issue date.

1.15 OPERATION AND MAINTENANCE MANUALS

A. After Metro approval of Operation and Maintenance Manuals, three final hard copy sets of the approved manuals and one electronic copy shall be provided to Metro

by the Contractor. The manuals are due no less than fourteen days prior to Substantial Completion – Elevators and Escalators and shall include the following:

1. Complete table of contents.

2. Complete instructions regarding operation and maintenance of equipment, including disassembly and assembly of drive system, handrail drive assembly, and track system. Included will be a complete, illustrated, exploded view of assemblies, and a complete, illustrated, exploded view of identifying system parts.

3. Maintenance Control Program per ASME A17.1.

4. Complete nomenclature of replaceable parts, part numbers, current cost, and warehouse location. If product source is other than the Contractor, Contractor shall include name and address of the vendor.

5. Sample copies of preventive maintenance chart.

6. Descriptions of safety devices.

7. Safety rules, tests, and procedures, including testing of systems and subsystems.

8. Procedures for adjusting brake, handrail tension, handrail chain drive tension, step chain tension, track system, and mechanical components including pictorials.

9. Instructions for removing floor plate, replacing comb segments, and installing steps, and interior panels.

10. Troubleshooting techniques.

11. Detailed lubrication and cleaning schedule indicating weekly, monthly, quarterly, semiannual, and annual lubrication; and a description of each lubrication point, lubrication type, and specification.

12. Control and schematic electrical wiring diagrams of controller, including wiring of safety devices to connections with remote indication and control panels for each escalator.

13. Electrical layout showing placement of lighting, light switches, receptacles, light fixtures, disconnect switches, and convenience outlets in machinery room, controller, truss envelope, and pits.

14. Complete detailed drawings and wiring diagram of escalator fault finding device and connection to annunciator panel.

15. Provide material on CD-ROM in a format approved by Metro.

16. Comprehensive list of error and fault codes with explanation of the fault and procedures to resolve the problem.

17. Diagram of escalator showing all safety devices.

B. Certification

1. The OEM shall provide certification that Metro or its designee has been provided with copies of all documents related to maintenance, safety, operations, design changes, modifications, retrofits, and like items, which relate to any part, component, equipment, system, subsystem, or material and services applicable to the escalator provided.

2. All of the above referenced shall be provided by the installer as it pertains to the original installation through the end of the warranty period.

3. The referenced material shall be provided within thirty days of publication or internal distribution by the OEM of any safety related updates or changes to the equipment provided in this contract. The material, even if labeled "proprietary" shall be delivered to Metro without prejudice or delay and at no additional cost.

1.16 SPARE PARTS AND REPLACEMENT MATERIALS

A. Refer to Section 01 78 43, Spare Parts, Illustrated Parts Catalog and Replacement Materials **for requirements**.

~~B.~~ Provide adequate spare parts on-site to ensure minimal downtime of the escalators during the **Preventive Maintenance and Warranty**~~warranty~~ period. **The Contractor may draw~~g~~ spare parts from Metro Warehouse for maintenance but shall restock such parts within two weeks of their use at no additional cost to Metro.**~~Spare parts shall include the list below at a minimum.~~

~~1. Spare Parts and Maintenance Material: The Contractor shall provide to Metro's designated location, the following spare parts. The parts shall become Metro's property. Parts may be used by the Contractor for maintenance but shall be restocked within two weeks of their use at no additional cost to Metro. The parts shall be delivered prior to Substantial Completion of the escalators.~~

~~a. Comb Plate/Demarcation Strips: 50 pieces, plus 10 left and 10 right, if different.~~

~~b. Steps: complete including demarcation and tread plates. 20 total.~~

~~c. Handrail Drive: One set for each particular assembly (left and right) including gears/chains and sprockets wheels.~~

~~d. Chain Rollers: Complete (two per axle) for highest rise unit.~~

~~e. Step rollers: Complete (two per step) for highest rise unit.~~

~~f. Brake Assembly: One for each size including actuator, drum and bearings, plus two sets of each size brake shoe/banks.~~

~~g. Demarcation lamps/fixture and ballast: Two complete units.~~

~~h. Drive sprockets (bullgear) – including sprockets for drive chain bullgear and handrail drive: One set (left and right) for each size drive.~~

~~i. Drive motor and gear box assembly: One set for each size drive.~~

~~j. Electrical contactors (up and down) relays, electronic starters, (control and isolation), coils and auxiliary contacts and control transformer: One set of each particular size for each escalator.~~

~~k. Switches (micro/safety), modules and sensors: One set for each escalator, total of three sets.~~

~~l. Fuses/lamps: One dozen for each size used.~~

~~m. Printed circuit board (Plug-in or hardwire): One for each type used.~~

~~n. Start switch/stop button assembly: Two sets of each type used.~~

~~o. Balustrade lighting lamps/fixture and ballasts. Two complete sets.~~

~~p. One complete handrail of each size.~~

~~C. Provide six sets of each key for key switches that match existing Metro escalators.~~

~~D.~~**B.** ~~Diagnostic equipment complete with access codes, adjusters manuals and set-up manuals for adjustment, diagnosis and troubleshooting of escalator system, and performance of routine safety tests.~~

PART 2 - PRODUCTS

2.01 ESCALATORS

A. Approved Manufacturers:

1. KONE, Otis, Schindler, ThyssenKrupp.

2. Alternate Providers must receive approval of Metro at least 14 calendar days prior to bid date.

B. Heavy Duty Metro Compliant Transit Escalators for use in an Exterior Environment as indicated on Project Definition Drawings.

1. Number: Per Project Definition Drawings

2. Size: 48-inch Wide (40-inch Step)

3. Speed:

   a. 90 feet per minute (fpm)

   b. 22.5 fpm Maximum Maintenance Speed

4. Flat Steps: Three minimum for less than 32-foot, 10-inch (10 m) rise; four minimum for greater than 32-foot,10-inch. rise

5. Rise: Per Project Definition Drawings
6. Floors Served: Per Project Definition Drawings
7. Configuration: Linear
8. Arrangement: Per Project Definition Drawings
9. Angle of Inclination: 30 degrees
10. Upper Track Radius 8 feet 6 inches (2.6 m)
11. Lower Track Radius 6 feet 6.75 inches (2 m)
12. Static Brake Load 674 lbs, based on a 40-inch (1000 mm) step width
13. Dynamic Brake Load 320 lbs, based on a 40-inch (1000 mm) step width)
14. Motor Duty Load 320 lbs, based on a 40-inch (1000 mm) step width
15. Step Chain Load 320 lbs (based on step load)
16. Operation:
    a. Reversible
    b. Full-time regenerating variable frequency drive (vfd) capable of full speed control for maintenance and future 'sleep mode' operation
17. Drive Motor Gear Box: Worm, Planetary or Helical
18. Balustrades: Perpendicular to Decking
19. Balustrade Finish: Stainless Steel Satin No. 4 Finish
20. Deck Configuration: High
21. Deck Finish: Stainless Steel Satin No. 4 Finish
22. Molding and Trim: Match Deck Finish
23. Skirt Panels: Match Deck Material and Finish with Polytetrafluoroethylene (FTFE) Impregnated Panels or Approved Equivalent
24. Handrail Color: Black
25. Step Tread and Riser:
    a. Cleated and meshed with adjacent step with tread demarcation lines on sides and rear.
    b. Demarcation Color Yellow per ASME A17.1

26. Power Supply: 480 volts, 3 phase, 60 hertz

27. Additional requirements:

    a. Complies with APTA Heavy Duty Transportation System Escalator Design Guidelines

    b. Room Storage Cabinets as indicated on drawings

    c. Galvanized steel truss and truss extensions/reductions as required

    d. LED lighting

    e. Enhanced Remote Monitoring and System Interface with Metro/ROC control center

    f. Provide key switch to match existing Metro escalators (Allen Bradley #d018 keyswitch key)

2.02 MATERIALS

A. Steel:

1. Sheet Steel for Exposed Work: Stretcher-leveled, cold-rolled, commercial quality carbon steel, complying with ASTM A1008, matte finish.

2. Sheet Steel for Unexposed Work: Hot-rolled, commercial quality carbon steel, pickled and oiled, complying with ASTM A568.

3. Structural Steel Shapes and Plates: ASTM A36.

B. Stainless Steel Plate, Sheet and Strip: Type 316 complying with ASTM A240, with standard tempers and hardness required for fabrication, strength and durability. Apply mechanical finish on fabricated work in the locations shown or specified, conforming to NAAMM nomenclature, with texture and reflectivity required to match Metro's sample. Protect with adhesive paper covering.

1. Finish: Satin No. 4 finish (ASTM A-480): Graining directions as shown or, if not shown, in longest dimension.

C. Stainless Steel Shapes and Bars: Type 316 complying with ASTM A276 and A554 for tubes.

D. Aluminum: Extrusions per ASTM B221: sheet and plate per ASTM B209.

E. Paint: Clean exposed metal parts and assemblies of oil, grease, scale, and other foreign matter and factory paint one shop coat of standard rust-resistant primer. After erection, provide one finish coat of industrial enamel paint. Galvanized metal surfaces shall be neatly touched-up with Galvacon™ or approved equivalent.

F. Prime Finish: Clean metal surfaces indicated to receive a baked enamel paint finish of oil, grease, and scale. Apply one coat of rust-resistant primer followed by a

filler coat over uneven surfaces. Sand smooth and apply final coat of primer complying with requirements of Section 09 91 00 - Painting.

G. Baked Enamel Finish: Prime finish per above. Unless specified “prime finish” only, apply and bake three additional coats of enamel in the selected solid color.

2.03 OPERATION

A. Each unit shall be capable of operating smoothly and quietly at rated speed with synchronized step and handrail operation and speed in either direction of travel.

B. Handrail Speed: Consistent with step speed under any loading condition in either direction of travel.

C. Ride Quality: Measured vibration during riding and operating conditions.

1. Handrail Vibration: Not more than 15 mg peak to peak in the 1-10 Hz range.

2. Step Vibration: Not more than 10 mg peak to peak (adjacent peaks) in the 1-10 Hz range.

D. Noise and Vibration Control: Provide sound isolation within truss as required to limit noise levels relating to escalator equipment and its operation to no more than 55 dBA, measured 3'-0" above escalator at any point of its length.

E. Provide full-time regenerating variable frequency drive (VFD) capable of full speed control for maintenance and future ‘sleep mode’ operation.

2.04 MACHINE ROOM EQUIPMENT

A. Provide equipment for operation in an exterior environment.

B. Motor and Drive Mechanism: Shall be mounted within the truss envelope at the upper end. Shafts shall be designed for ease of assembly or disassembly. Provide NEMA 4X enclosures.

C. Driving Machine: Worm geared, planetary or helical spur gear reduction unit coupled directly to AC induction or Permanent Magnetic Synchronous Motors (PMSM) drive motor. Handrail drive shall be directly coupled to drive machine.

1. Gear box requirements:

a. Gear bearings shall be rated with an American Bearing Manufacturers Association (ABMA) L10 life of 200,000 hours and housed in an oil-tight, dust-proof case. The case shall provide a convenient method of draining the oil.

b. Synthetic lubricants shall be used, subject to approval of Metro or its designee.

c. Rotating parts shall be provided with a means for lubrication and retention of lubricants.

d. Sealed bearings shall be used.

e. Exposed, moving drive elevator shall be protected by metal housings, which shall provide access for lubrication of components.

f. A low-oil sensor shall be provided to prohibit starting of the escalator on automatic operation with low oil in the gearcase.

2. Other:

a. V-belt and tooth belt drives shall not be considered acceptable.

b. Head shaft bearings shall be rated for ABMA L10, 200,000 hours.

D. Drive Motor: Shall be totally enclosed with external cooling fans. Three phase, operating at no greater than 1800 revolutions per minute (rpm). Motors shall be designed to operate in confined unvented spaces. Motor insulation class “F” or greater. Motor starting shall incorporate a WYE Delta reduced voltage starter or a SCR soft start with closed transition.

E. Brake:

1. Electromechanical brake to safely decelerate, stop and hold rated load per Code requirements. Brake shall stop escalator operating in the down direction at a relatively constant rate not greater than three feet/second^2.

2. The brake shall be capable of stopping and holding a descending escalator with a 320 lb load per step running in the down direction on exposed steps on the incline.

3. The brake coil shall be insulated to Class F.

4. A monitor shall be provided, and if brake lining becomes insufficient for safe usage, restart of the escalator shall be prevented.

F. Step Band Lock:

1. A step band lock shall be manually applied and mechanically engaged to prevent movement of linkages while the escalator is disconnected from its power supply.

2. An electrical interlock that shall prevent escalator drive motors from starting while the step band lock is engaged shall be provided.

G. Step Drive Assembly: Direct or indirect drive. Machine sprockets at each side over which step chains, step chain rollers, or steel cord reinforced polyurethane cog belt shall pass and transmit motion from machine to steps. If indirect chain drive is used between machine and drive sprocket, provide emergency brake on drive assembly to automatically set if drive chain fails. Provide roller-type sealed bearings.

H. Stop Switch: Per ASME A17.1 and CCR, Title 8.

2.05 CONTROLLER

A. Controller: UL/CSA labeled.

1. Provide Programmable Logic Controller (PLC) or approved equivalent, to control and monitor escalator.

2. Compartment:

a. New controller to be located remote from the escalator as shown on Contract Drawings. Controller cabinet shall be Type 316 stainless steel and shall contain control, drives and related equipment and accessories in a single cabinet.

b. Securely mount assemblies, power supplies, chassis switches, relays, etc., in a substantial steel cabinet, permitting ease of access to controls and wiring. Include mainline circuit breaker, phase, and overload protection.

3. Equipment:

a. The escalator control equipment shall contain diagnostic capabilities as required for the ease of complete maintenance. The diagnostic system shall be an integral part of the controller and provide user-friendly interaction between the service person and the controls. Such systems shall be free from decaying circuits that must be periodically reprogrammed by the manufacturer.

b. The main controller shall use a programmable logic controller (PLC) to control and monitor the status of the escalator. The PLC shall be designed to communicate over Ethernet or approved equal.

c. The PLC racks shall provide space for two future single-slot modules.

d. The PLC in the remote control panel shall also have hardware and firmware provisions to communicate with interactive operating interface (monitor).

e. The PLC shall store the last 99 safety device faults, accessible via laptop connection, panel view or remote communications.

f. A copy of working programs on approved computer medium, as well as a printed program listing, shall be provided.

g. The PLC shall have one dedicated serial port, which supports RS-232-C signals. It shall be accessible in ladder logic and provide support for point-to-point and slave SCADA communication protocol systems. Alternatively, it must be usable for programming purposes or for access to remote programmers via modems.

4. Microprocessor-Related Hardware:

a. Provide built-in noise suppression devices which provide a high level of noise immunity on solid-state hardware and devices.

b. Provide power supplies with noise suppression devices.

c. Isolate inputs from external devices (such as safety switches) with opto-isolation modules.

d. Design control circuits with one leg of power supply grounded.

e. Safety circuits shall not be affected by accidental grounding of any part of the system.

f. System fault log memory shall be retained in the event of power failure or activation of any safety device.

g. Equipment shall be provided with Electro Magnetic Interference (EMI) shielding within FCC guidelines.

5. Wiring: UL/CSA labeled copper for factory wiring. Neatly route wiring interconnections and securely attach wiring connections to studs or terminals.

6. Permanently mark components (relays, fuses, PC boards) with symbols shown on wiring diagrams.

7. Interface requirements:

a. Provide remote monitoring and control contacts in the controller of escalator.

b. Provide normally open dry electrical contacts to indicate status of escalators to Metro/ROC station emergency management Programmable Logic Controller. The following minimum indications are required:

1) Escalator “Up” Direction

2) Escalator “Down” Direction

3) Escalator “Out of Service” Indication

4) Escalator “Trouble” Alarm

5) Escalator Pit water high level indication (where applicable)

6) Escalator sump trouble indication (where applicable)

c. Provide inputs for two terminations: Normally Open (NO) and Common (C) in the escalator controller for each indication contact. All remote monitoring terminals shall be in adjacent terminal block locations so that it shall be possible to insert a jumper to connect the common (C) terminals.

d. Provide easily accessible switch to disable alarms during maintenance activity or automatic disabling when escalator is in maintenance mode.

When in the maintenance position, the trouble contact shall be continuously closed and all other indication contacts shall not change state.

e. Indication dry contacts shall have a minimum rating 48VDC @ 2A.

8. Enhanced Remote Monitoring:

a. The escalator controller shall support Ethernet based monitoring for service maintenance personnel.

b. The monitoring shall not allow any remote control or configuration.

c. The monitoring shall provide detailed system status, diagnostic and performance information including event logs as required for efficient and effective preventative, predictive and unplanned maintenance.

d. The monitoring shall only require network connection and a standard web browser.

1) No special client software shall be required.

e. It shall be possible to set a password to prevent unauthorized access.

f. The Contractor shall provide an industrial firewall (Phoenix Contact MGUARD-RS or Metro approved equivalent to block all outside traffic except valid HTTP/HTTPS requests from authorized networks/clients.

g. Network connection and configuration will be performed by Metro.

2.06 WELLWAY EQUIPMENT

A. Provide equipment for operation in an exterior environment

B. Truss:

1. Hot dipped galvanized steel truss to safely carry entire load of escalator, including components, full-capacity load and weight of exterior truss and balustrade covering material; (not to exceed 10 lbs./sq. ft.). Exterior cladding material per Section 05 08 00, Stainless Steel Escalator Cladding. Provide factor of safety per ASME A17.1 and CCR Title 8. Provide clearly identified exterior cladding support attachment locations on exposed sides and bottom of the entire length of truss and cooperate with cladding installer as required. Provide structural truss reinforcement as required for support to eliminate need for additional intermediate building supports beyond the existing support. Field verify existing conditions.

2. The deflection of the loaded truss shall not exceed one-thousandth of the span under a live load of 320 lb. per 40-inch step.

3. The slip joint slide bearings shall not use grease for lubrication.

4. A permanent identification shall be provided on the truss for the centerline at both ends of the escalator and in both transition curves.

5. Permanent mark reflecting track system working point distances shall be provided at both ends of the escalator trusses.

6. Field splices shall be rigid and non-deforming, and shall maintain alignment.

7. Field modification shall not compromise the paint and corrosion protection specified in Article 2.02.

8. All shims shall be Type 316 stainless steel.

9. Support shims shall not exceed 2 inches.

C. Truss Extensions: Provide truss and access cover extensions or reductions at upper and/or lower landings as required to suit existing structural support locations. Field verify existing conditions.

D. Upper and lower pits shall have adequate space for a technician to stand in the pit to work without first removing any components from the escalator. The space shall allow for one person to stand in the pit and remove steps from the escalator.

E. Drip Pans:

1. Galvanized, 3 mm steel, watertight drip pans for the entire length and width of trusses shall be provided with sufficient strength to withstand weight of workmen. They shall also be sloped for proper drainage and collection of lubricants, as well as any moisture or water that may enter the escalator. They shall be constructed to prevent oil from leaking below the truss.

2. Drip pans of sufficient size to collect and maintain, within truss areas, oil and grease drippings from step linkage and forms of loose debris that maybe deposited from steps at turnaround points at the upper and lower portions of truss shall be provided. This system shall be separate from the water drain in order to prevent the discharge of lubricants into the drainage system.

3. Access to drip pans at lower landings of escalators shall be provided for the purpose of cleaning drain.

F. Oil/Water Separator: Provide an oil/water separator and drainage in the lower pit. Coordinate with existing drainage. Field verify.

G. Step Tracks:

1. Fabrication of tracks shall retain steps and running gear safely under load requirements and at the highest speed specified.

2. Installer shall assemble and secure sections of track together for easy removal and replacement of defective sections. The system shall be adjustable, and connecting of the track section by welding is not acceptable.

3. Design of the mechanical components shall provide for easy installation and removal without the dismantling of parts of the structure.

4. Tracks shall be properly supported on trusses to provide correct alignment and smooth transition to return stations. The rolling surface of the passenger side track shall be a minimum thickness of 3 mm. Return side track shall be a minimum thickness of 2 mm.

5. The guiding system for the step chains and step wheels shall be zinc plated or galvanized steel profiles with smooth are even running surfaces and with the joints cut diagonally to the running direction. The guide profiles shall not be welded together at the joints.

6. A second, continuous guiding profile shall be provided above the step chain rollers so that the step chains are positively guided in the area of the escalator open to passengers.

H. Step Chain:

1. Chain shall be endless, roller-type step chains with one on each side of the step.

2. Step chains shall be of heat-treated steel construction, supported at intervals by linkage wheels.

3. A means to prevent steps from coming into physical contact with one another and to prevent chains from sagging or buckling shall be provided.

4. A means to maintain constant distance between step axles shall be provided.

5. An automatic tensioning device to maintain tension under load and to compensate for wear shall be provided. The device shall be located within the truss at the lower end.

6. A means for individual fine adjustment of tension for each linkage shall be provided.

7. Step chains shall be constructed to permit removal of segments as may be required for replacement purposes at a minimum of every six-axle section. Each escalator shall have at least two one-axle sections.

8. Support wheels spaced to distribute load and guide linkage throughout the run shall be provided. Rollers shall be constructed of polyurethane material, with a diameter sufficient to provide reliability, maintainability, smoothness of motion to operate within the noise level requirements specified. The chain rollers shall have polyurethane tires, sealed bearings and diameters of not less than 4". They shall require no additional lubrication and be mounted outside chain link. The wheels, hubs and bearings shall have an L10 rating of 100,000 hours.

9. Wheels shall be affixed to permit rapid replacement.

10. Each pair of step chains shall be matched set within manufacturing tolerances. Only precision, roller fishplate chains of high-grade heat-treated steel shall be used as step chains. The pins, axles, bushing and rollers shall be hardened and ground.

11. Step chain and chain pins shall have a surface pressure at engaging points that shall not exceed 30 N/mm² (3,420 lbs./sq.in.). Step chain load is to be based on step loads of 320 lbs per 40-inch wide step.

12. The safety factor shall be at least six.

13. A test certificate for the chain-breaking load shall be provided.

14. A shielding device shall be provided to protect chain, track guides and rollers against water, dirt and debris.

I. Step Chain Tensioning Device:

1. The step chain tensioning device shall be of a design that keeps the step chains at the correct tension.

2. A pointer and scale shall be provided to gauge step chain tensioning and wear.

3. Bearings, if used, shall be rated ABMA L10, 200,000.

J. Truss Wiring and Conduit

1. Galvanized rigid pipe and/or liquid tight flexible metal conduit shall be used in the truss.

2. In Class 2 circuits, SO cord may be used in lengths not to exceed three feet.

3. Liquid tight flexible metal conduit must be UL/CSA approved.

4. Galvanized rigid pipe shall be used between the truss and the remote controller cabinet.

K. Steps:

1. The entire step assembly shall be treated with not less than one coat of zinc chromate primer or iron phosphate and one coat of powder-coated enamel for corrosion resistance.

2. Steps and their various attachments shall permit removal of steps without disturbing balustrades.

3. The design shall permit the running of the device without steps for convenience in cleaning and inspection.

4. Step rollers shall have polyurethane tires on hubs, sealed roller bearings, and a diameter of no less than 3". Step roller bearings shall have an L10 rating of 100,000 hours.

5. Steps shall be constructed so as to be driven by step linkages to step or step rollers.

6. Washers and nuts shall be provided as follows:

   a. Tap bolts: Lock washers.

   b. Through bolts: Lock nuts or owner-approved equal.

7. Design the steps for a minimum load of 320 lb. per 40 inch step, with an ultimate strength safety factor of 8, in addition to the minimum requirements given in ASME A17.1 and CCR Title 8,

8. Steps shall carry the load under maximum concentric and eccentric loading conditions without failure.

9. Die-cast aluminum steps shall not have more 0.3 percent copper content.

L. Safety Devices: Provide step and handrail safety devices to function per ASME A17.1 and CCR, Title 8.

1. Broken drive train/step chain

2. Broken drive chain/drive belt

3. Skirt obstruction

4. Missing bridge (if required)

5. Reversal stop

6. Step up-thrust

7. Handrail speed

8. Missing step

9. Step level

10. Handrail entry

11. Combplate impact

    a. A separate switch for vertical and horizontal detection.

12. Step Demarcation Lights

13. Missing floor plate

14. Lockable stop switch in the upper and lower pits

2.07 HANDRAILS

A. Provide equipment for operation in an exterior environment:

1. Handrails shall receive their motion from the main escalator drive through direct gearing and drive shaft or chain drives, so that the handrail and steps operate at the same speed in each direction of travel. Driving and guide wheels shall have a groove to accept the wedge on the underside of the handrail. The handrail shall have a V-shape wedge. Submit specifications and a sample prior to ordering equipment.

2. A means to take up the slack using a tensioning device shall be located within the escalator. In addition, an approved method of releasing the device for repair or removal shall be provided. Pre-tensioning of the handrail shall be considered unacceptable.

3. Handrail gearbox, if provided, shall have bearings rated at ABMA L10, 200,000 hours.

B. Construction: Reinforced laminated synthetic rubber running on metal guides. Handrail shall be spliced and vulcanized rubber with smooth joint. Handrail shall be driven at the same speed as the steps. Provide tensioning device and slack-tension switch.

C. Newels:

1. Newels meeting the following requirements shall be provided:

a. Newels shall be designed and constructed so that the handrail will return into the newel end at a point inconspicuous and difficult for passengers to reach.

b. Newel sheaves shall be provided at the upper and lower newels.

c. Handrails, the handrail drive system and guides shall be so designed and installed that the handrail cannot be thrown off or disengaged while running and special design attention shall be given to the area where the handrail passes from the drive system to the guides.

d. Handrail rollers shall have sealed bearings rated at ABMA L10, 100,000 hours.

e. Friction drive sheaves and idlers shall be designed and positioned so that lubricant cannot reach the surface of the handrail. Marking and spotting of the handrail by drive equipment shall not be permitted. Provide sealed bearings rated at ABMA L10, 100,000 hours.

f. The handrail shall be composite of either vulcanized rubber or an approved equal with a synthetic fabric slider and shall be constructed with a steel cable tension member providing a minimum strength of 25 kN over the splice area.

g. Handrail guides shall be continuous on the exposed portion of handrails, constructed of Type 316 stainless steel, shall not be subject to corrosion nor pitting, and shall have a polished or specially coated permanent finish to minimize frictional wear to the under surface of the handrail. On the

unexposed portion, guiding shall be by adjustable rollers having sealed bearings and set in a way so as not to cause wear on the handrail.

2.08 BALUSTRADES AND SKIRT PANELS

A. Construction:

1. Panels shall be a minimum of 3 mm solid Type 316 stainless steel and backing panels or “sandwich material”, where used, shall be noncombustible. Submit sample to Metro for approval.

2. Panels shall be constructed, when practical, in equal lengths for interchangeability.

3. Panels shall be attached to permit easy removal for inspection, lubrication and adjustment of safety devices.

4. Panels shall be sized so that no more than two people are required to remove a panel and without the aid of special handling equipment.

5. Requirements for exposed panel fasteners (where used): Panels shall be fastened to their respective supports or mating portions with tamperproof flathead machine screws.

6. When the framework to which panels are fastened is less 0.25 inch thick, steel backup plates with a minimum 0.25 inch thickness shall be added. These plates shall have tapped holes or clearance holes where necessary.

7. Decking shall be a minimum of 2 mm thick solid Type 316 stainless steel, identical in finish to balustrade.

8. Decking between escalators shall be designed to support a live load of 175 lb./ft² without permanent deformation.

9. Paneling, decking and other enclosures shall be reinforced and supported on a steel frame.

B. Skirt Panels: Reinforced 14 gauge metal, if required by Manufacturer’s own design. Install to maintain loaded step gap clearance per code. Provide panels with skirt brushes with aluminum or stainless steel brush holder extrusions. Extend skirt panel beyond combplates and wrap around base of newel. Align brush extrusion joints with skirt panel joints.

C. Deck Boards: Reinforced 14 gauge stainless steel metal. Deck section joints shall abut to provide a smooth surface to surface connection with butt joint transition, top and bottom, horizontal to incline sections.

D. Newel Ends: Continuous stainless steel metal guides at upper and lower end of the balustrade, matching profile of handrail guides. Newel end shall include a multi-roller bearing system to minimize friction and provide smooth return of handrail.

E. Finishes:

1. Interior Panels

    a. Stainless steel, Type 316, Satin No. 4 finish.

2. Skirt Panels: Manufacturer's standard polytetrafluorethylene-impregnated.

3. Inner and Outer Deck: Stainless steel, Type 316, Satin No. 4 finish.

F. Trim and Moldings: Match deck finish.

G. Anti-Slide Knobs: Provide outer high deck configuration of immediately adjacent units with anti-slide knobs, if required. Finish of knobs to match deck finish.

H. Floor Intersection Guards: Provide stainless steel intersection guards at floor penetrations as required per ASME A17.1 and CCR Title 8. Guards shall be a minimum of 1 inch thick pan construction with rounded leading edge.

I. Deck Guards: Provide clear plexiglass guards between adjacent units at top and bottom of trusses as required per ASME A17.1 and CCR Title 8.

J. Extended Newels: Newels of adjacent escalators shall align at upper and lower landings

K. Balustrade Lighting (if required)

1. Balustrade lighting should only be used as a last resort if it is not possible to provide adequate light levels on the escalator steps with overhead ambient lighting. Provide built-in balustrade lighting fixtures as required to maintain average illumination levels of 15 foot candles throughout the length of the escalator and 30 foot-candles at transitions. Provide heavy duty easy to maintain lighting fixtures suitable for a wet location complete with conduits, wiring and accessories. Fixture shall be of Type 316 stainless steel. Lighting shall be of an energy efficient LED design. Submit sample for approval prior to ordering equipment.

2.09 LANDINGS

A. Flat Steps: Provide a minimum of three contiguous level steps at upper and lower landings.

B. Step Demarcation Lighting: Provide a minimum of two green LED step demarcation lights within the step band at upper and lower landings. Locate within a maximum of 16" from combplates. Provide weather resistant enclosure.

C. Combplate Assemblies:

1. Complete assemblies of wear-resisting, noncorrosive metal material with exposed anti-slip surfaces shall be fabricated.

2. A separate switch for vertical and horizontal detection shall be provided.

3. Combplate sections meeting the following requirements shall be provided:

a. Shall be removable to permit ease of replacement

b. Shall be yellow in color for safety/demarcation.

c. Provisions for lateral and vertical fine adjustments shall be provided so that cleats of step treads pass between combteeth with minimum clearances.

D. Combplate Lighting: Provide LED combplate lighting in skirt panel on both sides of units at both upper and lower landings. Provide NEMA 4 or equivalent enclosure.

E. Floor Plates:

1. Shall have Type 316 stainless steel frames at floor openings, designed to be supported on truss heads.

2. Shall be designed to cover entire area of upper and lower landings.

3. Shall be reinforced, as necessary, to be rigid and able to withstand a live load of 250 lb./ft² with zero permanent deformation.

4. Shall be extruded or die-cast aluminum in a ribbed pattern transverse to the escalator axis. Ribs shaft be designed to provide maximum traction, and will be finished in the same manner as the combplates. Top and bottom floor plates of outdoor escalators shall have an applied anti-skid coating.

5. Shall have exposed portions constructed of material and finish to harmonize with steps and combplates.

6. Shall not have visible manufacturers name or logo.

7. Finished flooring should slope away from the escalator landing.

2.10 SIGNAL AND CONTROL FIXTURES

A. Operating Station: Provide upper and lower newel operating stations. Mount on right side when facing unit. Match deck finish. Function and operating positions of switches and buttons shall be identified with engraved characters which are readily visible from a standing position. Each station shall contain the following:

1. Red “emergency stop” button. The button shall be covered with a transparent cover which can be readily lifted or pushed aside. When the cover is moved, an audible warning signal shall be activated. The signal shall have a minimum sound intensity of 80 dBA at the button location.

2. The cover shall be engraved “EMERGENCY STOP”; “MOVE COVER” or equivalent legend (i.e. “LIFT COVER”, “SLIDE COVER”); and “PUSH BUTTON.” “EMERGENCY STOP” shall be in letters not less than 1/2 inch high. Other required wording shall be in letters not less than 3/16 inch high. The cover shall be self-resetting.

3. Key switch to “start” unit shall match other escalators in the Metro Station. (Allen Bradley key #D018). Locate so steps are visible while operating key switch.

4. Key directional control switch.

5. Locate key switch to provide full visibility of escalator steps when operating.

B. Fault Indicator: Provide upper and lower end of truss with fault indicator to display source of fault without removal of equipment access plate. Locate indicator in handrail inlet box or deck board visible from landing plate.

C. Diagnostic Access Port: Provide upper and lower landings with RJ-11 diagnostic access port.

2.11 SIGNS AND INDICATORS

A. Landing Signs: Provide caution signs at top and bottom landings per ASME A17.1 and CCR, Title 8. Provide engraved plate to meet code and Metro requirements, with material and finish to match decking. Fill engraving in colors mandated by ASME A17.1.

B. Indicators:

1. Escalators users shall be informed by means of highly visible LED indicator lights of the predetermined running direction of the escalator.

2. A green LED indicator light shall be illuminated at the entrance for escalator running direction, and a red LED indicator light shall have a horizontal white stripe and shall be illuminated at the exiting end. No incandescent lamps shall be permitted.

2.12 EXTERIOR WEATHERPROOFING

A. Provide exterior weatherproofing package

1. Handrails: The handrail shall be vulcanized rubber, or approved equivalent, with synthetic fiber slider, and shall be constructed with a steel cable tension member providing a minimum strength of 25kN over the splice area.

2. Handrail Guides: Stainless steel.

3. Truss: Hot dipped galvanized or approved equivalent including drip pans, turnarounds, and tension carriage.

4. Step Tracks, Sprockets, Axles, and Mountings: Zinc chromate or cadmium plated.

5. Hardware: Hardware and fastenings to be stainless steel. With substitution approval, zinc chromate or cadmium plated may be accepted.

6. Motor: Drip proof type with moisture resistant class “B” PMR (premium moisture resistant) insulation.

7. Exposed Materials:

   a. All balustrades, skirt panels, trim, deck boards and exposed hardware to be Type 316 stainless steel.

   b. Balustrade and skirt panel backing, if used, shall not be of wood products and shall be sealed against moisture penetration at joints with caulking.

   c. Powder coat steps and combplates to resist corrosion. Each step shall be provided with yellow painted demarcation lines on each side adjacent to the skirt panel and at the rear of the step tread, conforming to ASME A17.1.

8. Factory paint drive unit, step tracks, sprockets, axles, and mountings with two coats zinc-rich primer followed by two coats of weather-resistant enamel complying with requirements of Section 09 91 00 - Painting.

9. Water Diverting:

   a. Provide landing plate and equipment access plate framing with stainless steel water channels and drain.

   b. Install galvanized or stainless sheet steel gutters and drip covers over, machine, drive sprockets, main drive chain, handrail drive, handrail drive chain and maintenance control stations.

   c. Provide galvanized drip pans with drains in bottom of truss.

10. Conduit, boxes and fittings shall be of watertight construction. Operating controls and switches shall be provided in NEMA 4 enclosures. Safety solenoids and switches shall be approved moisture-proof type.

11. Wiring:

    a. Install weatherproof gaskets under emergency stop button covers.

    b. Safety solenoids approved moisture-proof type.

    c. Electrical material, controller cabinet and installation to meet NEMA 4 criteria.

12. Fasteners: Cotter and replaceable pins to be stainless steel.

2.13 LUBRICATION SYSTEM REQUIREMENTS

A. Step Chain:

1. Parts, other than sealed items, requiring lubrication shall be designed for an automatic or remote lubricating system. The system shall operate only when the escalator is running, and the amount of lubrication shall be fully adjustable. A reservoir with a low-oil signal to the controller, and a minimum capacity capable of providing the manufacturer's required lubrication for one month of

operation based on the specific operating hours for this installation shall be provided.

2. System shall be positive acting, located in the escalator pit.

3. A reservoir level indication shall be provided where lubricants are contained within housings, supply tanks and larger filler cups.

4. A means to maintain lubricant viscosity shall be provided where required.

B. Miscellaneous Lubrication:

1. The installer shall furnish and mount on the controller cabinet a laminated lubrication chart for each escalator. The chart shall show the location of each lubrication point, the type of lubricant to be used and the frequency of lubrication.

C. Bearings:

1. Sealed bearings shall be used where possible.

2. Bearings requiring manual lubrication shall be furnished with fittings to accommodate the use of a pressure gun for lubrication.

D. Manual Lubrication:

1. Manual lubrication points shall easily accessible, available and clearly identified.

2.14 SEISMIC OPERATIONS AND EQUIPMENT

A. Provide design, components and operation per California Code of Regulations, Title 8 and ASME A17.1. Design shall include seismic restraint provisions to accommodate the required and specified number of inches of story drift indicated on structural drawings.

B. Structural Requirements:

1. The installer shall provide escalator truss mounting angles and intermediate truss supports with attachments, sized as required to install escalators into the wellway structural support system shown on the contract drawing.

2. Escalator intermediate support points shall be provided by the installer where indicated on drawings. Details and calculations shall be submitted by the escalator installer for approval by Metro or its designee.

3. Reaction loads shall be indicated on contract drawings.

4. Seismic designs must be based on actual story drift data from the building's structural engineer.

5. Seismic calculations shall be based on the APTA design loadings as indicated.

2.15 PERFORMANCE

A. Performance Criteria

1. The escalator specifications are intended to cover the complete installation of the escalators and to outline broadly the equipment required, but not to cover details of construction. Such details are recognized to be the exclusive responsibility of the Manufacturer and Installer. It is hereby recognized that Metro or its designee did not invent or develop any part of the escalator systems, but has only made selections of capacities, speeds, control systems, materials, from choices made available by the Manufacturers.

2. Exterior installation of escalator shall be designed to operate while exposed to the natural elements of weather, including sunlight, rain, slush, snow and ice; conditions of relative humidity while exposed to salt, deicing chemicals, airborne dust and debris, corrosive elements; in a dry-bulb temperature range of 25°F to 105°F.

3. No wood or wood products shall be used in the escalator.

4. Escalators shall be designed with provisions for thermal expansion and contraction of complete escalator assemblies and for any movement of the facility caused by trains braking when fully loaded.

5. Operational Requirements:

   a. Hours of operation shall be considered as 24 hours per day, seven days per week.

   b. Direction of travel shall be considered as either direction, or unit shall be up and down reversible.

   c. Rated speed shall not exceed 100 feet per minute (FPM). The no load to full load speed shall not exceed 4 percent of the rated speed.

   d. Escalator components shall be designed based on the design loads as defined in Section 2 of this document, following applied duty cycle during operation:

      1) Three hours with 100 percent design load

      2) Six hours with 50 percent design load

      3) Fifteen hours with 25 percent design load

6. Provide Contractor project management support for Metro Authorized Representatives to visit the factory where the escalator is being manufactured. At this Metro visit, the escalator shall be tested with the actual control to be shipped with the escalator. The steps and step chain shall be operational to test selected devices. The Contractor shall not ship the escalator without approval from Metro or its designee after conclusion of successful testing during the factory visit.

PART 3 - EXECUTION

3.01 SITE CONDITION INSPECTION

A. Prior to beginning installation of equipment, examine wellway and pit areas. Verify that no irregularities exist which affect execution of Work specified.

B. Do not proceed with installation until Work in place conforms to project requirements.

C. Coordination Requirements:

1. Alterations: The installer shall coordinate any alterations required to accommodate escalators with the Contractor.

2. Cladding: The installer shall review appropriate contract drawings dealing with proposed methods of securing cladding to truss. The installer shall coordinate with other appropriate contractors prior to any such actual work.

3. Floor Finish at Landing Plates and Newels: The installer shall coordinate with other appropriate contractors and/or trades.

4. Lock and Key Requirements: Coordinate with Metro.

5. Pit Drainage: Provide a means to prevent water from accumulating in the pit. Drain and/or sump pump shall be accessible from outside of the escalator pit for maintenance and cleaning.

6. Rigging Plan: The installer shall supply a rigging plan that is approved by the Contractor.

7. Safety Training: The installer shall attend appropriate safety training programs provided by Metro at no extra cost, if required.

8. As-built drawings: The installer is responsible for providing revised contract drawings to reflect the actual as-built condition, including structural, architectural, electrical, mechanical and plumbing connections to the escalators.

9. Methodology: The installer shall meet with the Contractor and provide a written method of installation for approval.

3.02 INSTALLATION

A. Install equipment in accordance with Manufacturer's instructions, referenced Codes, specification and approved submittals.

B. Install equipment so it may be easily removed for maintenance and repair.

C. Install equipment for ease of maintenance.

D. Install equipment to afford maximum accessibility, safety and continuity of operation.

E. Remove oil, grease, scale and other foreign matter from the following equipment and apply one coat of field-applied machinery enamel.

1. Exposed equipment and metal work installed as part of this work which does not have architectural finish.

2. Machine room equipment truss.

F. Neatly touch up damaged factory-painted surfaces with original paint color. Protect machine-finish surfaces against corrosion.

3.03 FIELD QUALITY CONTROL

A. Work will be checked during course of installation. Full cooperation with reviewing personnel is mandatory. Accomplish corrective work required prior to performing further installation.

B. Have governing code authority acceptance inspection performed and complete corrective work.

3.04 ADJUSTMENTS

A. Track Alignment: Re-align factory installed tracks if required to ensure continuous 4-point contact with step and chain rollers. Secure joints without gaps and file any irregularities to a smooth surface.

B. Lubricate equipment in accordance with Manufacturer's instructions.

C. Adjust motors, brakes, controllers, stopping switches and safety devices to achieve required performance levels.

D. Adjust brakes and controlled descent devices to stop escalator with variable load. Drive machine brakes shall stop the down running escalator at a rate no greater than three feet/second^2.

E. Adjust handrail speed to coincide with step speed.

3.05 CLEANUP

A. Keep work areas orderly and free from debris during progress of project. Remove packaging materials on a daily basis.

B. Remove loose materials and filings resulting from Work.

C. Clean machine room equipment, truss interior and pit.

D. Clean balustrades, deck boards, skirt panels, operating and signal fixtures and trim.

3.06 ACCEPTANCE REVIEW AND TESTS

A. Review procedure shall apply for individual escalators, accepted on an interim basis or completed, accepted and placed into operation.

B. Contractor shall perform review and evaluation of every aspect of its Work prior to requesting Metro's final review. Work shall be considered ready for Metro's final contract compliance review when Contractor's tests are complete and elements of Work or a designated portion thereof are in place and escalators are deemed ready for service as intended.

C. Furnish labor, materials and equipment necessary for Metro's review. Notify Metro a minimum of five working days in advance when ready for final review of escalator or group. Review will include testing of remote monitoring (SCADA) with Metro Personnel present.

D. Equipment and Instruments: Furnish equipment and instruments to perform required tests. The following instruments may be necessary to complete the tests:

1. Multi meter
2. 500 Volt Megger
3. Alternating-current voltmeter and ammeter
4. Celsius-calibrated thermometers (two minimum)
5. Precision tachometer
6. Decibel meter for noise test

E. Metro's written list of observed deficiencies of materials, equipment and operating systems will be submitted to Contractor for corrective action. Metro's review shall include as a minimum:

1. Workmanship and equipment compliance with Contract Documents.
2. Contract speed and performance comply with Contract Documents.
3. Performance of following is satisfactory:
    a. Starting and running
    b. Stopping
    c. Controlled descent
    d. Equipment noise levels
    e. Signal and operating devices
    f. Overall ride quality
    g. Handrail speed
    h. Operations of safety devices
4. Operating Tests:

a. Overspeed Protection Device: Test by operating at rated speed, tripping overspeed device manually.

b. Handrail-Tension Device: Test manually.

c. Broken Drive Chain Devices: Test by operating at rated speed, tripping broken chain device manually.

5. Test Results

a. In test conditions, obtain specified contract speed, handrail speed, controlled descent, performance, stopping, ride quality and operation noise levels to satisfaction of Metro.

b. Temperature rise in motor windings limited to 50° Celsius above ambient.

F. Performance Guarantee: Should Metro or its designee review identify defects, poor workmanship, variance or noncompliance with requirements of specified Codes and/or ordinances, or variance or noncompliance with the requirements of Contract Documents, Provider shall complete corrective work in an expedient manner to satisfaction of Metro or its designee at no cost as follows:

1. Replace equipment that does not meet Code or Contract Document requirements.

2. Perform Work and furnish labor, materials and equipment necessary to meet specified operation and performance.

3. Perform retesting required by Governing Code Authority, Metro or its designee.

G. A follow-up final contract compliance review shall be performed by Metro or its designee after notification by Manufacturer that deficiencies have been corrected. Provide Metro or its designee with copies of the initial deficiency report marked to indicate items which Provider considers complete. If additional reviews are required due to by Manufacturer's gross non-compliance with initial and follow-up deficiency reports, Metro or its designee shall bill the Manufacturer at normal billing rates plus expenses, and the Manufacturer acknowledges it will pay for additional compliance reviews.

3.07 INFORMATION AND MATERIAL

A. Provide information and maintenance materials as described in Article 1.05 - Submittals, of this specification.

B. Final retention will be withheld until data is received and reviewed by Metro.

3.08 PURCHASER'S INFORMATION

A. Non-Proprietary Equipment Design: Provide three sets of neatly bound written information necessary for proper maintenance and adjustment for equipment no less than fourteen days prior to substantial completion. Also provide an electronic version of data on a CD or other acceptable media. Final retention will be withheld

until data is received and reviewed by Metro or its designee. Include the following as minimums:

1. Straight-line wiring diagrams of “as-installed” escalator circuits, with index of location and function of components. Maintain drawing sets with addition of subsequent changes. These diagrams are Metro’s property. A legend sheet shall be furnished with each set of drawings to provide the following information:

    a. Name and symbol of each relay, switch, or other apparatus.

    b. Location on drawings, drawing sheet number and area, and location of contacts.

    c. Location of apparatus, whether on controller or on car.

2. Printed instructions explaining operating features.

3. Complete software documentation for installed equipment.

4. Lubrication instructions, including recommended grade of lubricants.

5. Parts catalogs listing replaceable parts including Manufacturer’s identifying numbers and ordering instructions.

6. Four sets of keys for switches and control features properly tagged and marked.

7. Diagnostic test devices together with comprehensive supporting information necessary for interpretation of test data and troubleshooting of escalator system, and performance of routine safety tests.

8. The escalator installation shall be a design that can be maintained by any licensed escalator maintenance company employing journeymen mechanics, without the need to purchase or lease additional diagnostic devices, special tools, or instructions from the original equipment Manufacturer.

    a. Provide onsite capability to diagnose faults to the level of individual circuit boards and individual discrete components for the solid state escalator controller.

    b. Provide a separate, detachable device, as required to Metro as part of this installation if the equipment for fault diagnosis is not completely self-contained within the controller. Such device shall be in possession of and become property of Metro.

    c. Installed equipment not meeting this requirement shall be removed and replaced with conforming equipment at no cost to Metro.

B. Provide upgrades and revisions of software during the progress of the Work, warranty period, the term of the ongoing maintenance agreement between Metro and the Manufacturer and for a 60 month period following expiration of any

warranty or ongoing maintenance agreement between Metro and the manufacturer/installer.

3.09 TRAINING

A. Instruct Metro's maintenance personnel in proper use, operation and daily maintenance of escalators. Review emergency provisions and procedures to be followed in checking source of operational failure or malfunction. Upon final acceptance, Contractor shall provide training to Metro personnel for proper response to escalator outages. Two sessions of one hour each at a date and time to be determined will be provided. Training will cover proper procedures for safely restarting escalators.

END OF SECTION 14 31 00

SECTION 21 00 00

FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Designing, furnishing, installing, testing and placing in service fire protection systems.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 23 Operation and Maintenance Data

D. Section 01 78 43 Spare Parts, Illustrated Parts Catalog, and Replacement Materials

~~D.~~**E.** Section 05 05 33 Basic Welding Requirements

~~E.~~**F.** Section 09 91 00 Painting

~~F.~~**G.** Section 10 44 13 Stainless Steel Cabinetwork and Fire Extinguishers

~~G.~~**H.** Section 22 05 10 Plumbing Piping Design (Design Build) Requirements

~~H.~~**I.** Section 23 05 10 Basic Mechanical Requirements

~~I.~~**J.** Section 26 42 13 Cathodic Protection for Water Distribution Facilities

~~J.~~**K.** Section 33 00 01 Pipe Utilities

1.03 REFERENCES

A. American National Standards Institute (ANSI)

1. ASME/ANSI B31.9 Building Services Piping

B. American Society of Mechanical Engineers (ASME)

1. ASME/ANSI BPVX-IX ASME Boiler and Pressure Vessel Code (BPVC), Section IX: Welding and Brazing Qualifications.

C. National Fire Protection Association (NFPA)

1. NFPA 13 Standard for the Installation of Sprinkler Systems

2. NFPA 14 Standard for the Installation of Standpipes and Hose Systems

3. NFPA 15 — Standard for Water Spray Fixed Systems for Fire Protection

4. NFPA 72 — National Fire Alarm and Signaling Code

D. Underwriters Laboratories Inc. (UL)

1. UL 346 — Standard for Waterflow Indicators for Fire Protective Signaling Systems

E. Metro Rail Design Criteria

1.04 QUALITY ASSURANCE

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

B. Perform installation of Fire Protection Systems using a State of California C-16 licensed installer. Perform calibration, adjusting and setting of instruments in accordance with manufacturers, NFPA and system requirements.

C. Perform welding operations in accordance with requirements as specified in ANSI B31.1, NFPA 13 and Section 05 05 33, Basic Welding Requirements.

D. Coordinate Fire Protection Subcontractor's Design with Communications System Contractor and Electrical Subcontractor to ensure systems are properly interfaced, supervised and controlled.

E. Provide Seismic Restraints as specified in NFPA and Section 23 05 10, Basic Mechanical Requirements.

F. Perform pipe coating inspections and electrical tests on insulating flanges as specified in Section 26 42 13, Cathodic Protection for Water Distribution Facilities.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Manufacturer's Literature and Product Data.

C. Shop Drawings.

D. Operation and Maintenance Data for Equipment and System, as specified in Section 01 78 23, Operation and Maintenance Data.

E. Welder Certifications and Qualified Welding Procedures.

F. Certificates of Compliance for Sprinklers and Standpipe Systems, and verification that flange bolts are properly torqued.

G. Manufacturer's Product Data, including catalog cuts and specifications for corrosion control materials.

H. As-Built Drawings - Maintain up-to-date, legible, accurate, dimensioned reproducible record of As-Built location of work as installed under this Contract.

I. Calibration Certificates for Instruments.

J. Test Plan, Notification and Report.

K. Pipe Flushing Plan.

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 WET SPRINKLER SYSTEM (WSP)

A. Provide automatic type, conforming to requirements and recommendations of NFPA 13, for Ordinary Hazard, Group 1 in emergency exits and ancillary areas, except auxiliary power transformer rooms, and train control and communication rooms. In public areas, provide automatic type conforming to requirements and recommendations of NFPA 13 for Ordinary Hazard, Group 1 in platform and concourse high bay areas, and Ordinary Hazard Group 2 in Station entrance and concourse footprint areas. Design systems hydraulically. Provide California State Fire Marshal approved devices. Extended coverage systems may be provided where allowed by NFPA 13.

2.02 WET STANDPIPE SYSTEM (WSP)

Install WSP from and including the Fire Protection Valve Pit into and including the station. Install six inch WSP in trainway and other WSP. Provide devices approved by the California State Fire Marshal. WSP to conform to requirements and recommendations of NFPA 14, except calculate required flow as 500 gpm at 65 psi (250 gpm from each of two adjacent fire hose valves), and as follows:

A. Space fire hose valves in trainway at 250 foot maximum intervals, measured from a hose valve inside the crosspassages.

B. Fire Hose Valves Not in Fire Hose Cabinets: 2 1/2 inch, 90 degree lever actuated ball valve with slow closing device.

C. Check Valves - Provide iron body, brass seat with rubber faced discs, clearway swinging and drip connections and designed for 175 psi water working pressure. Non-metallic components - Withstand temperatures up to 300°F for one hour.

D. Isolation Valves - At every other crosspassage, but not farther apart than 1600 feet. Isolation valves - Handwheel operated, full lug or grooved type butterfly valves, UL listed and Factory Mutual (FM) approved, rated at 175 psi water working pressure. Equip valves with built-in supervisory switches to indicate valve open or closed position. Non-metallic components - Withstand temperatures up to 300°F for a period of one hour.

E. Supply trainway WSP system from tunnel valve rooms.

F. Make provisions to compensate for expansion and contraction of pipe lines. Use grooved type couplings with proper anchoring guides and supports designed for the following:

1. Pipe and gasket pressure and temperature rating: 450 psi at 230°F for one hour.

2. Thermal expansion: 0.8 inch per 100 feet.

3. Movement - Combination of axial and lateral.

4. Alleviate expansion and contraction of pipe lines in trainways; use piping cut to 15 feet sections, with a grooved flexible coupling 15 feet on center and cut grooves.

2.03 UNDERCAR DELUGE SYSTEM (U/C DLG)

Install undercar deluge system in underground station trackway conforming to requirements and recommendations of NFPA 15, with devices approved by California State Fire Marshal and as follows:

A. Undercar Deluge System - One zone per track, hydraulically designed to provide a minimum design density of 0.16 gpm per square foot for the entire length of the passenger loading platform

B. Provide system with remote manual activation.

C. Provide a 24 VDC, 0.5 amp or less normally closed solenoid control valves to actuate the under car deluge systems.

D. Provide each of the undercar deluge system zones with a valve supervisory switch and a water flow alarm pressure switch. Valve supervisory and water flow alarm pressure switches shall have form "C" contacts rated for 15 amp 120 Vac service.

2.04 PRE-ACTION SPRINKLER SYSTEM (PSP)

A. In Train Control and Communication Room - Provide hydraulically designed, single interlock, fully supervised pre-action sprinkler system, with electrically activated cross zoned smoke detectors, devices approved by the California State Fire Marshal and conforming to NFPA 13. Provide system with a design density for Ordinary Hazard, Group 1 occupancies.

B. Provide a 24V DC, 0.5 amp or less normally closed solenoid control valve to actuate the PSP system that allows the system piping to fill with water before the fusing of a sprinkler, permitting a more rapid fire attack.

C. Provide the PSP system with pneumatically pressurized piping for supervisory purposes only, and include a high/low air pressure supervisory switch. The high/low air pressure switch shall have double Form "C" contacts rated for 15 amp 120 Vac Service.

D. Provide the PSP system with a valve supervisory switch and a water flow alarm pressure switch. Valve supervisory and water flow alarm pressure switches shall have Form "C" contacts rated for 15 amp 120 Vac service.

2.05 VALVES

A. Furnish valves as required. Valves - UL listed and FM approved for fire protection service. Indicate open or closed position to water flow. When required, provide valves with valve supervisory switch positioned by valve stem so that open or closed position of valve can be remotely monitored.

B. Deluge Valve - Quick opening.

C. Preaction Valve - Quick opening type.

D. Alarm Check Valve may be used instead of check valve and water flow indicating switch. Provide valve with trim for variable pressure installation and with alarm pressure switch.

E. Provide outside screw and yoke type gate valves designed for 175 psi water working pressure, having iron body and brass trim in Fire Protection Valve Pits, lock valves open with chain having breakable lock, instead of using valve-supervisory switch.

F. Ball Drips - Cast brass automatic drip connections, which close at approximately 7 to 10 psi, UL listed.

2.06 SPRINKLER HEADS

California State Fire Marshal approved.

A. Sprinkler heads - Fusible link or strut type of style as required for particular application, nominal 1/2 inch discharge orifice, ordinary temperature range, unless otherwise required, and chrome-plated head and escutcheon if exposed in public areas.

B. Trackway Spray Nozzles - Wide-angle spray type, 160 degree spray pattern, capable of spraying 20 gpm with discharge coefficient of K=4.08, and 1/2 inch male NPT connection equipped with dust cap and stainless steel wire attached between nozzle and dust cap.

2.07 FIRE HOSE CABINETS

A. Free-standing fire hose cabinets on platforms and concourses shall comply with the requirements of Section 10 44 13 - Stainless Steel Cabinetwork and Fire Extinguishers.

B. Recessed fire hose cabinets in public areas shall be of similar construction to the cabinets in Section 10 44 13 – Stainless Steel Cabinetwork and Fire Extinguishers. In non-public area recessed fire hose cabinets shall be 18 gage, type 304 stainless steel construction with solid door with continuous stainless steel hinge. Provide No. 4 finish on all visible exterior surfaces.

C. In non-public areas surface mounted fire hoses cabinets may be used. Surface mounted fire hose cabinets shall be 18 gage, type 304 stainless steel construction with solid door and continuous stainless steel hinge. Provide No. 4 finish on all visible exterior surfaces. Fire hose cabinet doors shall be 12 gage 304 stainless steel, positive latch device and labeled “Fire Hose” and “Fire Extinguisher” using upper and lower case Universe 65 San Serf, or Helvetica typeface with a capital letter height of 1 inch. Submit Shop Drawings for layout approval.

D. Each cabinet shall contain a 1-1/2 inch cast-brass angle hose valve with 100 feet of 1-1/2 inch polyurethane lined, synthetic jacketed hose, mildew and rot-resistant, complete with cast-brass nipple and coupling, 1-1/2 inch red body with black bumper polycarbonate fog nozzle, hose rack, 2-1/2 inch cast-brass angle-hose valve body with 2-1/2 inch or 3 inch outlet (depending upon requirements of local fire department) with fire department hose thread end and cap with chain, escutcheon plates and spanner wrench and fire extinguisher. Hose Rack: Steel with polished chrome finished, swivel type with pins and water stop. The outlet of the 2-1/2 inch hose valve shall have a brass reducer with 2-1/2 inch female to 1-1/2 inch male, National Standard Thread (NST) for fire hose, and a 1-1/2 inch brass cap and chain. Provide minimum 1 1/2 inch clearance between valve and cabinet.

2.08 ESCUTCHEON

A. Provide split-hinged, locking type escutcheon held in place by internal tension spring or setscrew where exposed to public.

2.09 METAL SIGNS

A. Conform to NFPA 13. Attach metal sign to each valve required to be identified. Provide a sign with hydraulic design data.

2.10 SPARES

A. Provide each system with sprinkler cabinet and six sprinkler heads of each type and rating installed, one sprinkler wrench, and one pair of sprinkler tongs. **See Section 01 78 43, Spare Parts, Illustrated Parts Catalog, and Replacement Materials, for details.**

2.11 INSPECTOR'S TEST VALVE

A. Supply for highest and most remote part of each system in relation to riser assembly and as required by NFPA and City of Los Angeles Fire Code.

2.12 WATERFLOW INDICATING SWITCH

A. Provide waterflow indicating switches where required conforming to UL 346 and California State Fire Marshal approved.

2.13 GAUGES

A. 3½ inch dial type, conforming to NFPA 13.

2.14 PIPING AND FITTINGS

UL listed or Factory Mutual approved.

A. Piping

1. Embedded and exposed piping - Class S as specified in Section 22 05 10, Plumbing Piping Design (Design Build) Requirements, welded pipe for embedded, and grooved pipe with cut grooved ends for exposed.

2. Buried piping - Class K as specified in Section 22 05 10, Plumbing Piping Design (Design Build) Requirements with an exterior protective coating.

B. Provide flexible grooved coupling connections at locations between embedded and non-embedded piping.

C. Provide protective coatings for pressurized buried ductile iron pipe and fittings, steel pipe and fittings, and ferrous fittings in pressurized buried nonmetallic pipe as specified in Section 22 05 10, Plumbing Piping Design (Design Build) Requirements.

D. Provide insulating connections, pipe joint bonds and corrosion control test facilities for pressurized buried pipe as specified in Section 22 05 10, Plumbing Piping Design (Design Build) Requirements.

E. Provide cathodic protection corrosion control materials for pressurized buried ductile iron and steel piping systems and ferrous fittings in pressurized buried non-metallic piping systems as specified in Section 26 42 13, Cathodic Protection for Water Distribution Facilities.

F. Provide watertight insulating wall sleeves where pressurized buried metallic piping systems penetrate exterior below-grade walls, floors, ceilings, vault walls, and at-grade floor slabs as specified in Section 22 05 10, Plumbing Piping Design (Design Build) Requirements.

G. Casings For Buried Pipe - Steel casings; nonmetallic casings; casing sleeves and casing end seals for carrier pipes as specified in Section 22 05 10, Plumbing Piping Design (Design Build) Requirements.

H. Provide protective coatings for buried insulating flanges and flexible expansion joints as specified in Section 22 05 10, Plumbing Piping Design (Design Build) Requirements.

2.15 SEISMIC RESTRAINTS

A. Provide seismic restraints on all piping in accordance with NFPA-13, 14 and as specified in Section 22 05 10, Plumbing Piping Design (Design Build) Requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

Install products and in accordance with NFPA 13, 14 and 15.

A. Install pipe and fittings without springing or forcing. Install flanged, grooved and threaded joints as specified in Section 22 05 10, Plumbing Piping Design (Design Build) Requirements.

B. Install piping true to line and grade; support and guide piping to ensure alignment under all conditions. Installed piping to Clear obstructions. Conceal piping above ceiling panels and wall cladding in public areas except where approved in advance by Metro or its' designee.

C. Joints To Be Welded - Fusion weld in accordance with ANSI B31.9 and NFPA 13. Make changes in direction of piping with welded pipe fittings. Do not use mitered joints. Provide branch connections with welding tees or forged welding branch outlets.

D. Embedded piping (in concrete) shall be avoid; wherever feasible, piping should be run through areas which will not be filled with concrete.

3.02 SEISMIC RESTRAINTS

A. As specified in Section 22 05 10, Plumbing Piping Design (Design Build) Requirements and as required by NFPA 13.

3.03 PAINTING

A. Make piping system free from grease, oil, rust and scale, and ready for application of paint as specified in Section 09 91 00, Painting. Paint exposed fire protection system piping red in non-public areas. Paint piping to match adjacent surfaces if exposed in public areas.

3.04 TESTING AND FLUSHING

A. Testing - Hydrostatically test with water in accordance with NFPA 13, 14 and local regulations. Test fire alarm devices in accordance with NFPA 72 and adjust to meet system requirements. Tests - Witnessed by Metro's Fire/Life Safety Committee representative, local Fire Department representative and Metro; correct defects and retest. Calibrate instruments in accordance with manufacturer's procedure before testing. Testing of tunnel standpipe may be completed separately and before testing fire water piping in station box. Submit test plan, and report. Provide notification at least 16 days before test.

B. Flushing - Flush piping in accordance with NFPA, local codes and ordinances.

3.05 ADJUSTING AND CLEANING

A. Eliminate leaks and remove foreign material from installed products. Adjust and set instruments (pressure gauges, flow switches and the like), for a properly functioning system.

3.06 CORROSION CONTROL MEASURES FOR PRESSURIZED BURIED METALLIC PIPING SYSTEMS AND METALLIC FITTINGS IN NON-METALLIC PIPE

A. In accordance with Section 22 05 10, Plumbing Piping Design (Design Build) Requirements and as indicated in Section 26 42 13, Cathodic Protection Control for Water Distribution Facilities.

END OF SECTION 21 00 00

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SECTION 23 34 40

STATION AND TUNNEL EMERGENCY VENTILATION FANS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Designing, furnishing, installing and testing Station and Tunnel Emergency Ventilation Fan-Motor Units and appurtenances as shown on the Contract Drawings, or as required for proper operation. Contractor shall furnish all labor, materials, tools, and equipment, and perform all operations necessary for installing and testing the Emergency Ventilation Fan-Motor Units and accessories. All work shall comply with the current NFPA 130 Standard and Metro Fire/Life Safety Design Criteria.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 23 Operation and Maintenance Data

D. Section 01 78 43 Spare Parts, Illustrated Parts Catalog, and Replacement Materials

~~D.~~**E.** Section 23 33 60 Emergency Ventilation Sound Attenuators

~~E.~~**F.** Section 26 09 16 Controls, Instrumentation, Control Panels, and Interface Cabinets

~~F.~~**G.** Section 26 09 19 Motor Starters and Contactors

~~G.~~**H.** Section 26 24 19 Motor Control Centers

~~H.~~**I.** Section 28 40 00 Communications Supervisory Control and Data Acquisition Remote Terminal Unit (SCADA RTU)

1.03 REFERENCES

A. Air Moving and Control Association (AMCA):

1. ANSI/AMCA 210-07 Laboratory Methods of Testing Fans for Certified Aerodynamic

B. American Bearings Manufacturers Association (ABMA):

1. ANSI/ABMA 9 Load Ratings and Fatigue Life for Ball Bearings.

2. ANSI/ABMA 11 Load Ratings and Fatigue Life for Roller Bearings.

C. American Iron and Steel Institute (AISI)

D. American National Standards Institute (ANSI):

1.	ANSI/ASQC C1	Specification of General Requirements for a Quality Program.
2.	ANSI/ASA S12.56 / ISO 3746	Acoustics-Determination of Sound Power Levels and sound energy levels of Noise Sources Using Sound Pressure.

E. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1.	ANSI/ASHRAE149	Laboratory Methods of Testing Fans used to Exhaust Smoke in Smoke Management Systems
2.	ASHRAE	HVAC Applications Handbook

F. American Society of Mechanical Engineers (ASME):

1.	ASME B18.21.1	Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series).

G. American Society for Non-Destructive Testing (ASNT):

H. ASTM International (ASTM):

1.	ASTM A36-08	Standard Specification for Carbon Structural Steel.
2.	ASTM A193-12b	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and other Special Purpose Applications.
3.	ASTM A194-12a	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
4.	ASTM A388-11	Standard Practice for Ultrasonic Examination of Steel Forgings
5.	ASTM B117-11	Standard Practice for Operating Salt Spray (Fog) Apparatus.
6.	ASTM B247-09	Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings and Rolled Ring Forgings.

I. American Welding Society (AWS):

1.	AWS B5.1	Specification for the Qualification of Welding Inspectors
2.	AWS D1.1	Structural Welding Code - Steel.

3. AWS D1.3 Structural Welding Code - Sheet Steel.

4. AWS QC1 Standard for AWS Certification of Welding Inspectors

J. Code of Federal Regulations (CFR)

1. 29 CFR 1910 Occupational Safety and Health Standards

2. 29 CFR 1926 Safety and Health Regulations for Construction

K. FM Global (FM):

1. Approval Guide.

L. Institute of Electrical and Electronic Engineers (IEEE):

1. IEEE 112 IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.

M. International Organization for Standardization (ISO)

1. ISO 9001 Quality Management Systems - Requirements

N. Military Specifications (MIL)

1. MIL P-24441 Paint – Epoxy-Polyamide Exterior Topcoat, haze gray, formula 151

O. National Electrical Manufacturer's Association (NEMA):

1. NEMA MG-1 Motors and Generators.

2. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).

P. National Fire Protection Association (NFPA):

1. NFPA 70 National Electrical Code (NEC).

2. NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Systems.

Q. Steel Structures Painting Council (SSPC):

1. SSPC PA 1 Shop, Field and Maintenance Painting of Steel.

2. SSPC PA 2 Measurement of Dry Coating Thickness with Magnetic Gauges.

3. SSPC SP-3 Power Tool Cleaning.

4. SSPC SP-10 Near White Blast Cleaning.

R. Underwriters Laboratories (UL):

1. UL 508 Industrial Control Equipment.

1.04 QUALITY ASSURANCE

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

B. Equipment: Fan-motor units shall be the product of a single manufacturer whose name shall appear on the theoretical fan-motor unit performance curves and all other data submitted. The equipment covered under this Contract shall be standard equipment of proven performance for the Project environment. Equipment shall be designed, constructed and installed with the best practices of the trade, and shall operate satisfactorily upon installation.

C. Manufacturer's Qualifications: The manufacturer of the fan-motor units to be provided under this Contract shall have regularly engaged in the production of fan-motor units, of size and performance comparable to those specified herein, for a period of not less than five years. The manufacturer shall have previously furnished fan-motor units to Metro, or other rail transit agencies. The fan-motor unit manufacturer shall submit documents to show continuous and current experience in the design, assembly, and testing of axial-flow tunnel ventilation fans and experience in the design and fabrication of units capable of operating in an airstream at an air temperature of not less than 482 degrees Fahrenheit for not less than 90 minutes.

D. Submittals: The calculations and shop drawings submitted under this Contract shall be prepared in accordance with ISO 9001 procedures for quality assurance and quality control. Each calculation and shop drawing submitted shall have a "designed by" and "checked by" title block. All calculations and shop drawings submitted under this Contract shall be signed and sealed by a Professional Engineer licensed in the State of California.

E. Surfaces: The surfaces and structures to which the equipment provided under this Contract will be affixed, placed or mounted shall be inspected by the Contractor before installation begins. Surfaces that will be concealed by the equipment shall be identified to the Construction Manager prior to installation.

F. Clearance Limitations: Personnel access space provisions are required for equipment operation and maintenance. The fan-motor unit sizes and mounting arrangements shall be such that they do not encroach into the personnel access space required for this equipment.

G. Temporary Supports: Except where permanent equipment conveying provisions are already available, equipment shall be lifted into place using Contractor-supplied conveying provisions. Provide temporary supports and bracing as required during shipping, handling and installation.

H. Supervision of Fan-Motor Unit Installation: Provide the services of a qualified superintendant who is competent and experienced with the work of installing fan-motor units. At the Work Site, the superintendant shall supervise the fan-motor unit installation and shall verify that the equipment is performing properly.

I. Welding: All shop and field welding shall conform to the requirements of Section 05 05 33, Basic Welding Requirements. The welding process employed on the equipment furnished under this Contract shall be the shielded-metal arc process in accordance with Section 05 05 33, Basic Welding Requirements. All welders working on the equipment covered by this Contract shall be qualified in accordance with Section 05 05 33, Basic Welding Requirements.

J. Welding Inspections: All welds shall be visually-examined; the quality of the welds and the standards of acceptance shall be in accordance with Section 05 05 33, Basic Welding Requirements. Inspections shall be made prior to galvanizing, painting or other finishing of the welded surface. Welding inspections shall be conducted or approved by an independent inspection or testing laboratory, or by a competent technical consultant. The inspector shall be an independent Certified Welding Inspector (CWI) who has met the qualification and program requirements in accordance with Section 05 05 33, Basic Welding Requirements. The CWI shall file an inspection results report with the Construction Manager, who may inspect and test welds at random. When inspections indicate defects in the welding process, the welds shall be repaired and re-inspected.

K. Starter Compatibility: The fan-motor unit manufacturer shall coordinate with the manufacturer of the starters to confirm compatibility of the starters with the fan-motor units. The fan-motor unit manufacturer shall provide written certification that the equipment is compatible. Fan-motor unit performance testing shall be conducted with the actual starters being provided under this Contract. Refer to Section 26 09 19, Motor Starters and Contactors.

L. Alternate Industry Standards: Contractor may propose for approval alternate standards to those listed herein, provided that the standards are submitted in the English language, with a point-by-point comparison between the specified and alternate standards included in the submittal. If the original language of the proposed alternate industry standard is not English, the Contractor shall provide certification that the English translation is accurate. The requirements of proposed alternate standards shall be at least as stringent as the specified standards.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Prior to Award of Contract, submit a complete list of projects on which similar fan-motor units to those specified herein for rail or transit tunnel applications, with high temperature requirements in compliance with NFPA 130, have been furnished or installed. List shall include:

1. Name of Authority or User (include Metro installations, if any)

2. Contract Number(s)

3. Original installation date(s)

4. Number and Size of fan-motor units, including voltage and horsepower of motors

5. Current condition of equipment, including estimate of remaining useful life

6. A list of all known failures for the past 10 years, including their apparent causes, corrective work affected (including design changes), and a description of equipment service and operating conditions

    a. Prior to Notice to Proceed, submit any proposed alternate standards to those listed herein.

    b. Within 15 days after Notice to Proceed, submit qualifications; qualification statement shall include, but not be limited to, the following data:

7. Theoretical fan-motor unit composite performance curves for equipment proposed to be furnished under this Contract. Performance curves shall be plotted to scales and with a grid that will make it possible to read the data accurately.

    a. Fan-motor unit performance curves from shut-off to free delivery shall have the following data, at air density of 0.075 lbs/cu ft, plotted as ordinates versus airflow rate, in cubic feet per minute, as abscissa:

        1) Fan total pressure, in inches of water

        2) Fan static pressure, in inches of water

        3) Fan velocity pressure, in inches of water

        4) Total efficiency, in percent

        5) Static efficiency, in percent

        6) Horsepower input to fan impeller

        7) Kilowatt input to the motor

    b. Separate curves shall be furnished for forward and reverse directions at both full and half speed operation. Each curve shall be identified.

    c. The system resistance curve shall be plotted on each curve. The point of operation shall be indicated.

    d. In addition, furnish the following data:

        1) Theoretical performance curves for each rotational direction shall be plotted for fan-motor units for the installed motor horsepower for the following blade pitch angles:

            a) Maximum blade pitch angle for installed motor horsepower.

            b) Minimum blade pitch angle.

            c) Design blade pitch angle.

d) A minimum of four intermediate pitch angles between maximum and minimum blade pitch angle other than design pitch angle.

e. The following information shall be imprinted on each theoretical and actual performance curve (performance data shall be recorded at the operating point):

1) Project Title

2) Name and Address of fan manufacturer

3) Name and Address of motor manufacturer

4) Metro fan-motor unit designation number

5) Fan housing diameter, in inches

6) Fan outlet area, in square feet

7) Fan rotor hub diameter, in inches

8) Fan speed, in revolutions per minute

9) Number of fan blades

10) Design blade pitch angle

11) Rotational moment of inertia of fan rotor assembly, in pounds-foot squared

12) Maximum acceleration time required to start axial fan-motor unit from rest and accelerate it to full-operating speed against the design duty resistance, in seconds, at rated voltage

13) Air density, 0.075 pounds per cubic foot

14) Direction of airflow (forward or reverse)

15) The following data at the design operating point:

a) Quantity of air delivered, in cubic feet per minute

b) Fan static pressure, in inches of water

c) Fan total pressure, in inches of water

d) Fan outlet velocity pressure, in inches of water

e) Fan outlet velocity, in feet per minute

f) Fan total efficiency, in percent

g) Motor efficiency at operating point, in percent

h) Fan-motor unit total efficiency, in percent

i) Horsepower input to fan impeller

j) Kilowatt input to motor

8. Theoretical fan motor performance curves shall cover the entire range of load conditions from no load, to not less than 115 percent of full load at 110 percent, 100 percent, 90 percent, and 85 percent of motor rated voltages.

   a. Composite curve for each motor's horsepower size plotted with abscissa as horsepower output, and ordinates as:

      1) Motor current, in amperes

      2) Speed, in revolutions per minute

      3) Efficiency, in percent

      4) Power factor, in percent

      5) Torque, in pounds-feet

   b. Composite curve for each motor's horsepower size plotted with abscissa as speed in revolutions per minute and ordinates as:

      1) Motor current, in amperes

      2) Power factor, in percent

      3) Motor torque, in pounds-feet and, in percent of full load torque

      4) Fan torque, in pounds-feet

      5) Motor acceleration from standstill to half-operating speed, in seconds

      6) Motor acceleration from standstill to full-operating speed, in seconds

   c. Time, in minutes, as abscissa versus motor winding and bearing temperature rise in degrees Fahrenheit as ordinates when operated at full voltage and speed.

   d. Separate curves shall be furnished for both full and half speed operation. Each curve shall be identified.

   e. Insulation resistance values as logarithmic ordinates and the temperature values as uniform abscissa on semi-logarithmic graphs.

   f. In addition, for comparison purposes, a curve indicating the safe operating value of insulation resistance shall be plotted on the same sheet with the insulation resistance temperature test curve.

g. The following information shall be stated on each motor theoretical and actual performance curve and data sheet:

1) Project Title

2) Name and Address of motor manufacturer

3) Metro fan-motor unit designation number

4) Motor type and serial number

5) Motor frame size

6) Motor nameplate and horsepower rating

7) Electrical characteristics (voltage-phase-frequency)

8) Full-load, half-load, and no-load current in amperes

9) Locked-rotor current in amperes and in percent of rated motor current

10) Motor torque in pounds-feet including locked rotor torque, pull-up and breakdown torque

11) Full-load slip

12) Direction of rotation of motor

13) Speed in revolutions per minute

14) Service Factor

15) Rotational moment of inertia of fan rotating assembly in pounds-foot squared

16) Rotational moment of inertia of fan motor in pounds-foot squared

17) Power factor at 100, 75, and 50 percent load

18) Motor torque and fan load torque curves indicating net torque margin

19) Motor efficiency at 100, 75, and 50 percent load

20) Electrical characteristics of space heater, including voltage and kilowatt input

9. Axial fan-motor unit sound levels in decibels (re: db 10-12 watts) shall be submitted as specified herein (for both directions of airflow for reversible fan-motor units at full speed and half speed).

10. Fan-motor unit manufacturer and Contractor quality assurance program in accordance with ANSI C1.

11. Names of independent testing firms proposed to do work under this Contract.

12. Manufacturer's Certificate of Compliance signifying that the equipment to be furnished under this Contract meets the requirements specified herein.

13. List of Components proposed to be purchased from other manufacturers, giving name of manufacturer, type and characteristic of each item and applicable data requested herein.

C. Within 90 days after Design Approval, submit the following:

1. Certified Shop Drawings including Bill of Materials for fans, motors, fan-motor unit bases, installation drawings, installation instructions, dimensioned drawings for anchor bolt locations, and any additional data required to demonstrate compliance with the Contract Documents. Shop drawings shall indicate operating and shipping weights of each component and fully-assembled unit.

2. Comprehensive General Arrangement Drawings of fan-motor unit assembly including transition and straight ductwork, flexible connections, sound attenuators, dampers, etc.

3. Drawing of fan blades and hub identifying index marks for setting blade angles.

4. Dimensioned Drawings including mounting details of the fan and fan-motor unit monitoring instrument panel.

5. Working Drawings indicating the size and location of each foundation for the fan-motor units in the ventilation structure, reinforcing bar requirements for these foundations and the expected static and dynamic forces and moments generated by the equipment.

6. Basis and justification for material selection for fan blades and hub. Submit data on mechanical properties of the fan blades and hub and data on fan blade and hub yield strength at 482 degrees Fahrenheit. Submit analysis to confirm that the blade and hub stress does not exceed 75 percent of the component material yield strength at 482 degrees Fahrenheit.

7. An analysis taking into account the differential rates of expansion of dissimilar materials, showing the clearance of the blade tips to the fan housing. The fan-motor unit manufacturer shall submit a table showing the maximum and minimum blade tip clearance at 0, 60, 100 and 482 degrees Fahrenheit.

8. Material Safety Data Sheet (MSDS) on motor bearing lubricant, frequency of lubrication and amount of lubricant to be supplied during lubrication, and temperature of lubrication material.

9. Motor Terminal and Auxiliary Box Drawings indicating adequate box sizes for cable bending as required in the NFPA 70, including electrical wiring diagram of motor and monitoring device connections.

10. Paint Manufacturer's printed paint application instructions. Submit four samples of the specified primer paint and top coat paint coats applied together on light-gauge carbon steel sheet. The paint coats shall be applied in shingle fashion to expose each representative coat. The samples shall be 12-inches square and shall be marked with manufacturer's type and color designation.

11. Complete Nameplate Drawings for the fans and motors.

12. List of Technical Support Items specified and list of any additional support items required.

13. Factory Test Procedures: Not less than 30 days before actual testing begins on any fan-motor unit to be furnished, submit full details of all test procedures including the sequence in which they are to be run and the expected duration of the test, samples of all test report forms, and full details of the methods by which the raw test data is to be reduced for submittal.

    a. Test details shall also include a list of test instrumentation, containing name of manufacturer, model type, serial number, and calibration date. Documentation shall be furnished to verify that test instrumentation has been calibrated not more than 12 months before the tests.

    b. The Test Report shall include a list of attendees.

    c. Submit Shop Drawings and the Test Procedures for the pre-production units as a package.

    d. Submit detailed Test Reports for independent motor factory tests. Include the raw data as recorded during each test.

14. Complete Field Test Procedures with diagrams showing test set-up arrangements, proposed measurement points, sample test forms, Test Report format and pass/fail criteria.

    a. Submit written instructions for testing of the fan-motor units in the field. The test program shall contain, as a minimum, the resumes of key personnel participating in the testing, the specific make and model of test equipment to be used, sample data collection forms, and a specific and detailed procedure to be followed for the setup of equipment and for the sampling, recording and reduction of the test data. The test program shall be jointly prepared by Contractor and a field service engineer, and contain a certified letter from the fan-motor unit manufacturer indicating review and acceptance of the test program.

D. Within 14 days after successful completion of the tests specified herein and of any additional tests conducted at Contractor's own option, provide the following:

1. All records and results of non-destructive examinations made at completion of each examination.

2. Radiographic Inspection Films.

3. Drawings of each fan impeller indicating the fan blade number and weight of each fan blade and x-ray numbers for each blade and hub with the factory test report.

4. Certified Factory Test results for the fan-motor units. No equipment shall be released for shipment until certified test data has been accepted. Copies of accepted test procedures, raw data measured results, calculations and all data derived from the tests shall be included as part of the report. All test data for the fan-motor units shall be bound in one report and shall be indexed and cross-referenced in an easily understood manner.

5. Fan-motor performance curves and test data that are developed from actual tests for performance developed in accordance with the requirements of AMCA 210.

6. Motor test curves and test data that are developed from actual performance tests by an independent motor testing agency in accordance with IEEE 112-B. Submit separate performance curves for the motor rotation in forward and reverse directions.

7. Narrative Test Reports for all field tests. Include the raw data and all observations recorded during each test. The Test Report shall identify the name of the manufacturer, the equipment model and serial numbers, and the last date of calibration for the testing instrumentation. The test report shall include a list of attendees. The attendees shall be listed with their title, contact information, affiliation and signature.

E. Operation and Maintenance Manuals in accordance with Section 01 78 23.

1. At least 30 days before shipment of the first fan-motor unit, submit the preliminary Operation and Maintenance Manual, which shall provide technical information for fan-motor unit maintenance. After approval of the preliminary submittal and having made all necessary corrections and amendments required, provide approved Operations and Maintenance Manuals. An electronic copy of Operation and Maintenance Manual text, drawings and catalog cut files shall also be provided. The manual shall provide a clear explanation of the theory, operation, and maintenance of the equipment accompanied by photos and schematic, wiring, and mechanical assembly diagrams, as required. The manual shall be indexed and cross-referenced in an easily understood manner. The manual shall be loose-leaf bound and shall include, but not necessarily be limited to, the following information:

   a. Description of Emergency Ventilation System and how the fan-motor units function in that system.

   b. Operating Procedures, including start-up and shut-down.

   c. Troubleshooting and fault-isolation procedures for on-site repair.

   d. Fan and motor removal and replacement procedures, including instructions on aligning motor and fan impeller within the fan housing.

e. Procedure for static and dynamic rebalancing of fan impeller in the field.

f. Fan and motor disassembly and re-assembly instructions.

g. A list of the components, which are replaceable at the three possible levels of maintenance: on-site, Metro's shops, and the fan-motor unit manufacturer's facility.

h. A Test Procedure to verify the adequacy of repair work for fan and motor.

i. A Preventive Maintenance Schedule and Instructions detailing lubrication of moving parts and monitoring of sound and vibration levels.

j. Procedures for separately removing and replacing, fan rotor and blades as well as procedures for removing a complete fan-motor unit without disassembly.

k. A List of Technical Support Items and Special Tools provided by the fan-motor unit manufacturer.

l. Metal Template for blade angle setting for each fan.

m. A List of Tools and Test Equipment required to perform all maintenance tasks.

n. Approved Shop Drawings.

o. Fan and motor Factory Test Reports.

p. Field Testing Procedures and list of required equipment.

q. Field Test Reports (to be inserted after completion of field tests)

r. A List of Parts to be replaced and/or testing procedures to determine parts to be replaced after a fan-motor unit has been exposed to 482 degrees Fahrenheit for a minimum of 90 minutes, as specified, to allow fan-motor unit to be put back in service safely and reliably.

s. The latest service bulletins with dates which describe service procedures.

t. Notification of any revision to service bulletins that are included in the maintenance manuals described herein for a period of 5 years from the date of equipment acceptance.

F. Technical Support Items: At least 30 days before shipment, submit the following:

1. Ten sets of special tools shall be provided in total. Special tools shall be those tools, which are required to specifically service or repair the fan-motor unit which is being supplied and that are not normally carried in a general machinist's toolbox.

2. Tabulation of Technical Support Items necessary to maintain the fan-motor units procured under this Contract. This table will become a working

document to be used in the procurement of support items, and shall be updated as changes occur. The Technical Support Items shall be grouped by equipment and components. This list for each item shall give complete ordering and procurement information for that item, including quantity required to maintain inventory for 2000 hours operation. Each item listed shall contain at least the following information:

a. Item Name

b. Description Rating

c. Estimated Operating Life

d. Current Price

e. Manufacturer's Name

f. Part Number and Name

g. Drawing Reference Number

3. Recommended Spare Parts List:

a. Provide a Spare Parts List in column format indicating (in separate columns): part name, part number, manufacturer's name, current price, drawing reference number, description, rating, estimated operating life and quantity.

b. A column, immediately after the columns indicating recommended spare quantities, shall indicate expected delivery time in excess of 60 days. Items that are common to more than one fan-motor unit shall be cross-referenced.

~~b.~~**c. Submit recommended spare parts list as part of Section 01 78 43 List B.**

G. Templates for Setting of Blade Angles: Submit at least two metal templates or other approved devices for each fan size provided to facilitate settings of blade angles in the field. One template shall be attached to each fan-motor unit in a location that is subject to approval. One template shall also be provided with each Operations and Maintenance Manual.

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 FAN-MOTOR UNITS

A. Description:

1. Fans shall be axial-flow type with reversible operation. Emergency ventilation fan-motor units shall be required to operate in the forward or reverse direction of airflow, with a capability of starting, stopping, or reversing the direction of

flow at any time in accordance with the ASHRAE HVAC Applications Handbook.

2. Fan-motor units shall be direct-driven by internally-mounted electric motors, with provision for manual adjustment of the pitch of the individual blades, i.e., blade angle setting or stagger angle. The design duty blade angle shall not be at its maximum or minimum setting. Fan-motor units and their supports shall be designed and constructed as per the Contractor's final arrangement of the equipment.

3. Motors shall be the product of a single manufacturer, whose name shall appear on the motor performance curves and all other data submitted. Motors shall conform to the requirements of NEMA MG 1; the motors shall not be provided with self-contained thermal protective devices.

B. Operating Environment – Fan-motor units and all parts thereof shall be capable of withstanding the effect of all stresses and loads under the starting, operating and reversing conditions specified herein. Fan-motor units and all components shall be capable of operating for not less than 90 minutes in an ambient temperature of not less than 482 degrees Fahrenheit. Fans, motors, and components shall be capable of withstanding sudden temperature changes because of fire between the extremes of 0 and 482 degrees Fahrenheit or vice versa. Submit the maximum design stress data of all rotating components at maximum speed and air temperature of 482 degrees Fahrenheit, and identify the types of materials to be used in the design by their ASTM designations, or approved equal.

C. Fan-Motor Unit Design Requirements:

1. Fan-motor units shall be designed and fabricated to serve an underground railroad environment, and to function under the environmental conditions specified herein.

2. Fan-motor unit performance shall be rated for the airflow and total pressure indicated at an air density of 0.075 pounds per cubic foot. The fan-motor units must meet or exceed the specified design duty point; no negative tolerances will be accepted. Performance that does not meet the requirements indicated herein shall be cause for rejection of the proposed equipment, which shall then be repaired or replaced at the Contractor's expense.

3. Fan-motor unit performance curves for either direction shall rise continuously with decreasing flow between free delivery and 60 percent of free air delivery, or to the maximum horsepower rating. Fan-motor units shall be capable of operating continuously at specified design points for forward and reverse flow. Forward flow shall be designated as exhaust mode (airflow from tunnel to atmosphere) and reverse flow shall be designated as supply mode (airflow from atmosphere to tunnel).

4. The design airflow quantity and total pressure indicated in the fan equipment schedule shall be achieved in both the forward (exhaust) and reverse (supply) directions without exceeding the nameplate motor horsepower.

5. Emergency ventilation fan-motor units shall have a total efficiency of not less than 60 percent when operating at the specified nominal flow rate.

6. Fan-motor units shall be capable of accelerating from a standstill to rated rotational speed, in either direction, in not more than 15 seconds and without failure of any part of the unit, when started across-the-line with rated voltage at the motor terminals before starting and a voltage dip of not more than 15 percent of the rated voltage during starting. Fan-motor units shall be capable of reversing to full speed from either direction of airflow and rotation within 15 seconds when started across the line with rated voltage at the motor terminals before starting and a voltage dip of not more than 15 percent of the rated voltage during starting, after a 10-second delay between power interruption and the energizing of the motor for the reversed rotation, without failure of any part of the unit.

7. Emergency ventilation fan-motor unit performance, when operating in the reverse direction of airflow at the design total pressure, shall not deviate by more than 10 percent in airflow quantity delivered from the fan-motor unit performance curves for operation in the forward direction of airflow at any point between 60 percent of the nominal airflow rate and free delivery.

8. Brake horsepower input to fan impeller shall not exceed the nameplate horsepower rating of the fan motor when operating in either direction of airflow.

9. Pressure variations of plus or minus 1.50 inches water gauge induced by external causes shall not result in movement of the fan operating point along the fan operating curve into the region of unstable operation. This requirement does not affect the horsepower requirement for the design operating point.

10. Fans shall not operate in stalling range of fan performance curve during parallel operation (forward or reverse direction).

11. Fans shall have a stable operating characteristic in both directions of free flow over the range from 60 percent nominal flow to free delivery.

12. No fan blade or fan wheel impeller assembly shall have a natural frequency within plus or minus 10 percent of two, three and four times the operating frequency nor at the blade pass frequency, defined as “number of blades multiplied by the natural operating frequency.”

2.02 FAN FABRICATION

A. Impeller Hub and Blades:

1. Impeller hub and blades shall be fabricated of aluminum alloy castings, aluminum alloy forgings or steel, suitable for the specified performance and environment. Aluminum forgings shall be in conformance with the requirements of ASTM B247.

2. Fan rotating components shall be designed such that no measured or calculated stress level shall exceed 75 percent of the components materials yield strength at design temperature of 482 degrees Fahrenheit for 90 minutes.

3. Fan blades shall not vary in weight by more than 1 percent. Blades shall be manufactured of a homogeneous material as specified herein and shall have no cast-in or embedded materials of any kind. Individual blades shall be secured to the hub by not less than four bolts per blade, or shall be clamped securely between the two halves of a split hub or between suitably designed and manufactured clamp plates.

4. Single stud blade fixing shall be permitted subject to the following conditions:

    a. Studs shall be screwed into the blade, or aluminum shall be cast around a steel frame structure or skeleton. For steel reinforced aluminum blade castings, x-rays of blades contained herein shall clearly show steel and aluminum interface for each blade and shall indicate no deficiencies in the casting process.

    b. In cases where contact between dissimilar metals exists among the blade, the stud, the hub assembly, or any combination of these, an assembly of the connections shall be submitted to 200 hours in a salt spray fog test, in accordance with ASTM B117. Upon completion of the test, the assembly shall show no signs of corrosion. The assembly shall then be subjected to loads equivalent to the maximum expected static and dynamic loadings of the assembly and shall not show any signs of weakening or failure.

    c. In addition to the test described above, the hub, stud and blade assembly shall be subjected to an elevated temperature test. The assembly shall be maintained in an environment of not less than 482 degrees Fahrenheit for 90 minutes. During the temperature test the blade shall be subjected to the maximum expected static and dynamic loadings of the assembly during operation and shall not show any signs of weakening or failure.

    d. Salt spray testing and elevated temperature testing shall be carried out before approval of the fans for manufacture.

    e. Locking nuts with positive locking devices shall be provided at each stud fixing.

    f. A torque wrench capable of producing and confirming the required torque to tighten the blade to the hub shall be provided.

5. Blade bolts, hub bolts or clamp plate bolts shall be readily accessible. The pitch of the blades shall be manually adjustable without removing impeller from fan-motor unit. Pitch is defined as the angle formed by the chord line of a blade root cross-section and a line parallel to the direction of rotation. The ratio of the hub diameter to the fan housing diameter shall not be less than 0.35. The hub shall have index marks embossed or engraved to show the design operating blade setting and the blade settings for a minimum of five

additional increments of stagger angle with not less than two on each side of design setting. Engraving shall be done at a low stress location on the hub.

6. Provide one spare impeller hub and one complete set of spare fan blades for each size fan-motor unit. Store spare hub and blades in secure storage containers with permanent labels identifying number, type, manufacturer and Metro's Construction Contract Number. **See Section 01 78 43 List A.**

B. Fan Housings:

1. Emergency ventilation fan housings, including motor mounts and motor supports shall be fabricated of hot-rolled steel not less than 1/2 inch thick. Clearance between housing inner diameter and blade tips shall be sufficient to allow for thermal growth difference between fan blades and fan housing at a temperature of 482 degrees Fahrenheit for 90 minutes. Fan housing shall be provided with split joints except for impeller section. Housing sections shall be bolted, and gasketed to facilitate disassembly and removal of motor, rotor, shaft and bearings without removal of entire fan-motor unit or any part of adjacent ductwork.

2. Welds located in the airstream shall be ground smooth. Flanged rings shall be continuously welded to the outer periphery at each end of the housings, or flanges may be rolled as part of the housing. Flanges shall be not less than 3 inches wide and not less than fan housing thickness. Flanges shall have punched or drilled holes equally spaced not more than 8 inches on centers to permit adjacent duct elements to be bolted to the housings.

3. Provide remote lubrication fittings for lubrication of motor bearings from easily accessible location, as approved by Metro.

C. The rotor assembly shall be fastened to the motor shaft by means of an approved keyed positive locking device that is fully effective for both directions of rotation, for all blade angle settings, and for all conditions of operation specified. The rotor assembly shaft shall be an extension of the drive motor shaft.

D. Motor mounts and motor supports shall be designed to support the entire weight of the impeller and the motor, and to maintain the alignment of the fan-motor unit assembly in the specified mounting position and to maintain vibration levels within the specified limits. Motor supports shall be sufficient in number to provide the required strength and rigidity and shall be continuously welded to the motor mount and to the fan housing. Fan motor and fan rotor assembly shall be totally enclosed within the fan housing and not protrude at either end of the fan housing.

E. Nosepiece cover plates, access doors, and aerodynamic separation plates, where provided, shall be secured by means of positive fastening devices which are fully effective for both directions of impeller rotation, for all blade settings, and for all conditions of operation specified herein.

F. Emergency ventilation fan-motor unit assembly supports shall be fabricated of carbon steel not less than 3/8 inch thick conforming to the requirements of ASTM A36. Supports shall include fan-motor unit structural steel base with vertical supports (for vertical fan orientation) extending from the base to the fan housing

centerline flange and with horizontal thrust plates (for horizontal fan orientation) extending over the full length of the fan housing. Vertical supports and thrust plates shall be welded continuously to the surfaces with which they come into contact.

G. Provide a 1/4-inch-thick silicone gasket between all adjacent companion flanges; width of gasket shall be same as flange width. Gaskets shall be capable of withstanding an ambient temperature of not less than 482 degrees Fahrenheit for not less than 90 minutes without degradation of sealing ability and without emitting toxic or noxious fumes.

H. Sufficient lifting eyes shall be provided on each fan assembly to facilitate on-site installation and removal of the fans.

2.03 MOTOR COMPONENTS AND CONSTRUCTION

A. General Requirements:

1. Motors shall be of the totally enclosed, air-over, cast iron or steel round frame, induction type, continuous duty, variable torque, and shall be flange, pad, or foot-mounted. Motor shall be two-speed, single winding. Motor nameplate rating shall be 460-volt, three-phase, 60 Hertz. Motor service factor shall be 1.15. Motors shall be suitable for operation with a 480-volt, three phase, 60 Hertz power distribution system. During continuous operation, motors shall be insensitive to line voltage variation of 10 percent above and below the rated motor voltage and to normal frequency variations described in NEMA MG-1. The motor shall be designed for accelerating the fan impeller from standstill to operating speed without exceeding the rated temperature rise.

2. Motors shall be rated in accordance with NEMA MG-1 for the locked-rotor input (kilovolt-amperes per horsepower) required for meeting the specified acceleration performance. Motor and shaft shall be designed for full plug reversal. Motors shall have a minimum of Type H insulation and shall be rated for Class F temperature rise when tested at the service factor load as a minimum requirement.

3. Nameplate horsepower shall be actual continuous brake horsepower developed without any consideration of the "air-over" factor.

4. The motors shall be designed for continuous operation for a period of not less than 90 minutes at an ambient temperature of not less than 482 degrees Fahrenheit.

5. All fan motors shall be new. Components from motors subjected to elevated temperature testing shall not be used in the fabrication of the new motors supplied for this project.

6. Motors shall be equipped with anti-condensation, factory-installed resistance space heaters within the motor enclosure to prevent condensation of moisture in the motor windings. The heaters shall be energized whenever the motor is not in operation and shall be automatically de-energized whenever the motor is in operation. Heaters shall be 120 volts, single phase. The heaters shall be

provided with leads terminated in the Power Junction Box contained herein, external to the fan housing. Motor space heaters shall be energized within 24 hours after the fan-motor unit is delivered to the storage facility and project construction site. The motor heaters shall also be energized while the motor is in storage awaiting the fabrication of the fan-motor units, in accordance with the manufacturer's instructions.

7. Motor horsepower shall be as indicated on the nameplate. Horsepower input required by the fans shall not exceed the nameplate horsepower of the motors for pressure variations of plus or minus 1.5 inches water gauge along the design fan performance curve in either direction of airflow. Motors shall have a minimum overall efficiency of 85.0 percent at the rated load. The locked-rotor torque shall not be less than 145 percent of the motor full-load torque in accordance with NEMA MG 1 for nameplate horsepower. Motor pull-up and breakdown torque percentage of full-load torque shall be in accordance with NEMA MG-1 for nameplate horsepower. The locked-rotor current shall not exceed 6.5 times the full-load current with rated voltage (460 volts) and frequency (60 Hertz) at the motor terminals.

8. Motors shall be capable of accelerating the fan impeller from standstill to rated rotational speed as described herein after being energized with rated voltage and frequency at the motor terminals. Motors shall be capable of decelerating the fan impeller after being de-energized and accelerating to the rated rotational speed in the opposite direction, as described herein, after being energized for reverse rotation.

9. Each motor bearing shall be provided with a shock pulse detector for continuous remote monitoring of bearing. The detector sensor shall be permanently encapsulated, coated electronics using microprocessor digital circuitry, with transducer wired through the Auxiliary Box described herein, external to the fan housing. The accuracy of the detector shall be a maximum of 20 percent of detector level within temperature range. The shock pulse monitor shall be installed in the Instrument Panel.

10. Each motor bearing shall be provided with a vibration detector for measuring bearing vibration. The detector sensor shall be permanently encapsulated, coated electronics using microprocessor digital circuitry, with transducer wired through the Auxiliary Box described herein, external to the fan housing. The accuracy of the detector shall be a minimum of plus / minus 20 percent of detector level within temperature range. The vibration monitor shall be installed in the Instrument Panel.

11. Shock pulse and vibration monitors shall be wired to a transducer device to provide a 4-20 ma signal from each detector to the fan-motor unit starter. Transducers shall be mounted in the Instrument Panel. The monitors shall incorporate a local digital display of shock pulse and vibration levels, and alarm and trip levels, and shall be equipped with alarm contacts to provide local audible and visual alarms of high vibration and shock pulse. Provide SPM Instruments Model MG4-22 and associated detectors, or an approved equal.

12. Motor windings shall be provided with six (two per phase) resistance temperature detectors (RTD's) wired to the Auxiliary Box described herein, external to the fan housing for remote indication of excessive running temperature during normal operation. These wires shall be taped and terminated in the Auxiliary Box and extended to a monitoring device located in the Instrument Panel. The temperature monitoring device shall incorporate a local digital display of temperature levels, alarm and trip levels, and shall be equipped with alarm contacts to provide local audible and visual alarms of high temperature. Alarm contacts shall also be wired back to the fan-motor unit starter.

13. Each motor bearing shall be provided with one RTD wired to the Auxiliary Box described herein, external to the fan housing for remote indication of excessive running temperature during normal operation. These wires shall be taped and terminated in the Auxiliary Box and extended to a monitoring device located in the Instrument Panel. The temperature monitoring device shall incorporate a local digital display of temperature levels, alarm and trip levels, and shall be equipped with alarm contacts to provide local audible and visual alarms of high temperature. Alarm contacts shall also be wired back to the fan-motor unit starter.

14. Motors shall be capable of acceleration from standstill to rated rotation speed at rated load in either direction, in not more than 15 seconds and without the failure of any part when started across-the-line with rated voltage (460 volts) at the motor terminals and a starting voltage (dip) of not more than 15-percent of the rated voltage of the motor during starting. Motors shall be capable of reversing to rated rotational load from either direction of airflow and rotation during an emergency within 15 seconds when started across-the-line with rated voltage (460 volt) at the motor terminals before starting and a voltage dip of not more than 15 percent of the rated voltage during starting, after a 10-second delay between power interruption and the energizing of the motor for the reversed rotation, without failure of any port.

15. Minimum power factor of motors shall be 85 percent of the winding at the rated load.

16. A two speed motor shall be provided. The lower speed shall be half of the full rated speed.

17. The motor shall be designed for accelerating fan impeller from standstill to operating speed a total of four times, in alternating airflow directions, within 15 minutes without exceeding the rated temperature rise.

18. The starting and accelerating torque on motor winding shall be sufficient to permit the motor rotor and fan impeller to attain full speed without tripping the motor controller overload relays, which shall be set at a current corresponding to 140 percent of the motor full-load current.

19. The motor shall be designed for a minimum of 2500 starts over its lifetime.

20. Provide Metro with one spare fan motor identical to the motors supplied for each unique fan-motor unit size. Store spare motor in secure storage

containers with permanent labels identifying number, type, manufacturer and Metro's Construction Contract Number. **See Section 01 78 43 List A.**

B. Motor Materials and Components:

1. Motor shafts shall be steel, designed and constructed to support and drive the fan impeller under all specified operating conditions.

2. Each motor shall have at least two ball or roller type grease-lubricated, electric motor grade, noise-tested bearings selected for the specified operating conditions of the fan-motor unit. The bearings shall be based on ABMA 9 or 11 and shall have a minimum L-10 life rating of 40,000 hours at maximum capacity and maximum speed based on the bearing load imposed by driven equipment.

3. Grease supply and relief lines shall be brought from each motor bearing to accessible lubrication fittings, external to the fan housing, accessible from the floor level of the fan room as approved by Metro. The lines shall not be less than 1/4 inch diameter and shall be fabricated of stainless steel or other corrosion resistant alloy, seamless metallic tubing. The tubing shall not be crushed or scored during installation and the lines shall have neither kinks nor sharp bends. Lines penetrating the housing shall be rigidly secured to the housings to prevent vibration of the lines and be provided with grommets. Grease supply lines shall terminate in straight lubrication fittings. Grease fittings shall only allow the proper amount of grease to each bearing. The bearing lubricant shall be capable of providing the lubrication properties specified by the bearing manufacturer under conditions of operation for not less than 90 minutes, with the lubricant at a temperature of not less than 482 degrees Fahrenheit, and also at a temperature of 0 degrees Fahrenheit.

4. Terminal Boxes: The motor leads for power, motor heater, monitoring and control shall be suitable for operation of not less than 90 minutes at a temperature not less than 482 degrees Fahrenheit, wired to separate power and auxiliary terminal boxes conforming to NEMA 250 requirements mounted externally to the fan housing. The Motor Terminal Box, Auxiliary Box and Instrument Panel shall have screw-type pressure terminal strips for terminating control wires, exterior mounting lugs, full cover gasket, hinged door, minimum inside dimension of 24 inches high by 24 inches wide by 12 inches in depth. Control terminal boxes shall be sized to provide device and wiring clearances conforming to NFPA 70. The Motor Terminal Box for power leads shall be at least one size larger than required by NEMA MG-1. The conduit and control terminal boxes shall be rigidly secured to the fan housing or separate channel frame in a manner which will prevent vibration and air leakage and shall be capable of withstanding a temperature of not less than 482 degrees Fahrenheit for not less than 90 minutes without causing fan failure. Terminal boxes shall be capable of being oriented as shown on the Contract Drawings, and shall also be capable of receiving the number and size of conduits required for the installation. Motor terminals and connectors shall be as described in Division 26. Sufficient cable slack shall be provided to permit testing of cables without disconnecting any connections. Vibration and shock pulse detector cables shall have sufficient length to reach monitors

installed in the Instrument Panel. Provide amplifiers for monitoring sensors as recommended by the manufacturer. An additional control terminal box shall be mounted on the motor casing and shall be located and sized properly such that motor cables originated from stator will have proper bending radius as per NFPA 70.

5. No jogging is permitted; no jog-buttons are to be provided.

6. Lifting lugs shall be provided on the exterior of motors.

2.04 SHOP FINISHES

A. After fabrication and before assembly, all inside and outside surfaces of all fan housings, fan housing extensions, supports, fan-motor unit bases and exterior of fan motors shall be prepared in conformity to the requirements of SSPC SP 10 and shall be given a rust-inhibiting coating, which may consist of an approved coating, or bonderizing, or phosphatizing, followed by the application of a suitable rust-inhibiting zinc-rich primer and finish epoxy and urethane paint that is resistant to abrasion and to exposure to elevated temperatures. Surface finish shall be capable of withstanding an ambient temperature of not less than 482 degrees Fahrenheit for not less than 90 minutes without degradation of its protective quality, and without emitting toxic or noxious fumes, and two hundred hours in salt spray fog test, in accordance with ASTM B117. Immediately upon removal of the panel from the test, the film shall not show any visible blistering or rust spots, and there shall not be over 1/8 inch of rust creepage on either side of the scratch mark.

B. Provide colors as directed by Metro.

C. Applied and cured paint shall be tested to ensure that the specified dry film thicknesses are achieved. The dry film thickness of each coat shall be measured in-place with a calibrated magnetic film thickness gauge. Measurement of dry film thickness shall be in accordance with the requirements of SSPC PA 2.

D. Machined surfaces not requiring painting shall be provided with a coating of anti-corrosion compound before leaving the place of manufacture.

E. Surface finishes damaged during transport or assembly shall be restored to their original condition and color by the Contractor to Metro's satisfaction.

F. Paint materials provided shall be from one source. Primer and top coat paint material shall conform to the requirements of MIL-P-24441.

G. The minimum height of profile after completion of blast cleaning shall be 1.5 mils. Surfaces to receive primer paint material shall be prepared in accordance with SSPC SP 3. Surfaces specified to receive paint shall receive one coat of primer paint material, two intermediate coats and one top coat of paint material. The intermediate and top coats shall be tinted to differentiate between coats.

H. The minimum dry film thickness of the primer coat shall be 3 mils Dry Film Thickness (DFT). Provide the manufacturer's recommended zinc-rich epoxy primer that is compatible with the substrate and finish materials indicated.

Products shall be one of the following: Ameron “Amercoat 68HS”, Carboline “858 Zinc-Rich Epoxy Primer” or Sherwin-Williams “Zinc-Clad IV”.

I. The minimum dry film thickness of each intermediate and top coat shall be 3 mils DFT. Two intermediate coats shall be high-build epoxy such as Ameron “Amerlock 400,” Carboline “893 Epoxy,” Sherwin-Williams “Epoxy Mastic Aluminum II,” or approved equal. Final top coat shall be urethane such as Ameron “Amerishield,” Carboline “133 HB Aliphatic Polyurethane,” Sherwin-Williams “Hi-Solids Polyurethane,” or approved equal, capable of resistance to weather abrasion and salt solutions, and having a wide selection of available colors.

J. Primer paint material and top coat paint material shall be applied in accordance with the requirements of the paint material manufacturer's printed application instructions and in accordance with the applicable requirements of SSPC PA 1.

2.05 HARDWARE

A. Fasteners:

1. In accessible areas, fasteners shall be hexagonal nuts, provided with heavy-duty lock washers.

2. In inaccessible areas, fasteners shall be hexagonal head-tap bolts, provided with heavy-duty lock washers.

3. Bolts shall not be less than 1/2-inch diameter unless otherwise indicated.

4. Bolts and head-tap bolts shall be stainless steel and shall conform to the requirements of ASTM A193, Grade B8M or B8MA, equivalent to AISI Type 316, with suitable lock washers.

5. Nuts shall be stainless steel and shall conform to the requirements of ASTM A194, Grade 2H, equivalent to AISI Type 316.

6. Lock washers shall be stainless steel, equivalent to AISI Type 316, and shall conform to the requirements of ASME B18.21.1.

B. Anchor Bolts:

1. Anchor bolts shall be stainless steel and shall conform to the requirements of ASTM A193, Grade B8M or Grade B8MA, equivalent to AISI Type 316, with suitable lock washers.

2. Anchor bolt nuts shall be stainless steel and shall conform to the requirements of ASTM A194, Grade 2H, equivalent to AISI Type 316.

2.06 NAMEPLATES

A. Each fan-motor unit shall be provided with a stainless steel nameplate permanently stamped with the name and address of the manufacturer, Contractor's identification number, fan type, Metro’s designated fan-motor unit number, shop order, serial number of fan-motor unit, year of manufacture, maximum safe operating speed of fan-motor unit in revolutions per minute, fan impeller diameter, maximum design

operating speed and corresponding quantity of air delivered and the fan total pressure at air density specified. The nameplate shall be securely screwed, or riveted, to the exterior of the fan housing in a conspicuous position.

B. Each fan-motor unit shall be provided with a stainless steel enamel plate which shall bear, in numerals not less than 3 inches high, Metro's fan-motor unit designation numbers. The plate shall be securely screwed or riveted to the exterior of the fan housing adjacent to the fan-motor unit nameplate.

C. Each motor shall be provided with two identical stainless steel nameplates each permanently stamped with the name and address of the motor manufacturer, the motor horsepower, motor frame number, voltage, phase, frequency, insulation type, full-load current, locked rotor indicating code letter, minimum overall efficiency, the design temperature rise over ambient of the motor, maximum ambient temperature, type of duty, the terminal connection chart for the motor, rating of space heater, speed in revolutions per minute, service factor, motor type and serial number, maximum starts per day, ABMA bearing code and shop order number. One nameplate shall be furnished on the motor and the other either riveted or screwed on the exterior of the fan housing immediately adjacent to the fan nameplate.

D. Each fan-motor unit shall be provided with a 10-inch-long by 1 1/2-inch-wide metallic arrow that shall indicate the direction of forward and reverse airflow. The arrows shall be rigidly and permanently attached to the fan housing, in a position that can be readily viewed when the fan-motor unit is in its final operating position. 3/4-inch high letters shall be engraved on the arrow to read as follows: "EXHAUST (FORWARD AIRFLOW)" and "SUPPLY (REVERSE AIRFLOW)".

E. Each fan-motor unit shall be provided with a 10-inch-long by 1-inch-wide stainless steel plate permanently stamped with the labels "Grease Line Supply Port" and "Grease Line Exit Port".

F. All the nameplates shall be Type 316 stainless steel not less than 10-gauge-thick and shall be placed so as to be readily conspicuous after installation.

2.07 DIRECTIONAL AIRFLOW SWITCHES

Emergency ventilation fan-motor units shall be provided with a two single-direction airflow sensors. The flow sensor shall have the capability to detect flow in one direction only. Two sensors shall be required, one for forward flow detection and one for reverse flow detection, per fan-motor unit.

A. The directional flow switch shall have no moving parts. It shall utilize thermal dispersion as a means for detecting the presence and direction of the airflow. The flow switch shall be capable of being field set from 1 to 100 feet per second air velocity. Repeatability shall be 1 percent of full signal range. Maximum sensor temperature rating shall be not less than 482 degrees Fahrenheit. Maximum electronics rating shall be 140 degrees Fahrenheit.

B. The flow sensor shall be Type 316 SS, all welded construction. The sensor shall have 1-inch MNPT process connection, a duct flange mounting assembly, and a 12-inch insertion length.

C. Remote electronics for reverse flow sensors shall be installed in the Instrument Panel. Provide sufficient interconnecting cable between sensor and Instrument Panel. The probe terminal strip enclosure mounted on the fan housing shall be NEMA 250 Type 4X. Two DPDT relays rated for 2 amps at 120 volts ac shall be provided, one for each flow direction.

D. The flow switch shall conform to FM Approval Guide or UL 508.

E. A factory authorized service technician shall verify installation and adjust flow sensor set points after installation is complete.

F. Flow sensor monitor shall be provided with Form "C" dry alarm contacts, two for each direction of airflow. Alarm contacts shall be wired to the fan-motor unit starters.

2.08 FACTORY TESTS AND INSPECTIONS

A. General

1. Perform factory tests as described below. The Construction Manager may witness any or all tests. Notify Metro and provide no less than 30 days notice before the factory tests. Metro FLSC shall be notified of all factory test and be given the opportunity to witness any tests.

2. Tests described herein shall not preclude additional standard tests normally performed by the manufacturers for similar equipment, in accordance with ASHRAE 149.

3. Pre-production fan-motor units used for testing may be furnished as production units after pre-production testing if the units satisfactorily pass all specified factory tests, except for fan-motor units subjected to the elevated temperature test. Motors, motor shafts, and fan rotating assembly components used in the elevated temperature test shall not be furnished in production fan-motor units.

4. The test procedures specified herein shall be performed for each size fan supplied and each unique fan-motor unit combination.

5. The test procedures shall be sequential in the order prescribed. Any fan-motor unit or component thereof that fails to satisfactorily perform any test as specified shall be considered unacceptable. Failing parts shall be replaced and the entire unit shall be re-tested as specified herein.

6. Except as required for the independent motor pre-production test, all tests shall be performed by Contractor at the fan-motor unit manufacturer's plant or other approved location.

7. All expenses in connection with, or incidental to, the factory testing shall be borne by Contractor.

B. Pre-Production Motor Tests

1. Motors shall be tested in accordance with the procedures specified in IEEE 112 and NEMA MG 1. Using full voltage option, motor tests shall be performed for one pre-production motor of each size by the approved independent testing company. Tests performed for the pre-production motor by the motor manufacturer will not be acceptable. This shall not preclude preparatory testing at the manufacturer's facility prior to conducting the independent factory test. Submit a certified test report and certified performance curves verifying the theoretical motor performance curves for all of the coordinates specified. Performance curves for each type and size of fan motor shall be plotted to a scale that will facilitate accurate readings.

2. One motor of each nameplate horsepower rating and service factor shall be tested for forward and reverse modes as follows:

    a. Full voltage tests to obtain actual fan motor performance curves from standstill to full speed verifying the theoretical fan motor performance curves at 110, 100, 90 and 85 percent rated voltage previously submitted and other data specified hereinafter:

        1) Full-load current, in amperes

        2) Half-load current, in amperes

        3) No-load current, in amperes

        4) Full-load input, in kilowatts

        5) Half-load input, in kilowatts

        6) No-load input, in kilowatts

        7) Locked-rotor current, in amperes

        8) Locked-rotor input, in kilovolt amperes

        9) Locked-rotor, pull-up and breakdown torque, in pounds-feet

        10) Power factor, in percent

    b. Tests to determine:

        1) Winding resistance

        2) Losses, no-load, full-load and half load

        3) Temperature rise – motor thermal curves

        4) Dielectric tests

        5) Visual bearing inspection

3. Heat Run Test

a. Each pre-production motor shall be connected to a dynamometer, loaded to design duty and operated continuously until winding and bearing temperatures stabilize.

b. Temperatures shall be considered stabilized when no more than a 1-degree Fahrenheit increase in temperature is observed over 1.5-hour period. Winding and bearing temperatures shall be recorded on 0.5-hour intervals throughout the test.

c. Separate heat run tests shall be performed for both half and full speed operation in both forward and reverse operation.

d. Temperatures shall be recorded; temperatures shall not exceed that allowable for the motor components.

4. Production motors and spare motors for each size specified shall not be released for manufacture until the pre-production test, the heat run test and the elevated temperature test are completed and approved.

5. The remaining motors shall be tested at their rated synchronous speed in one direction. Tests shall include the following:

a. Winding resistance

b. No-load current, in amperes

c. Dielectric tests

d. No-load speed

e. Visual bearing inspection

f. Locked-rotor current in amperes

6. The following data shall be plotted for each speed and direction as ordinates versus horsepower as abscissas from no load up to not less than 115 percent full load:

a. Current, in amperes

b. Efficiency, in percentage

c. Power factor, in percentage

7. The following data shall be potted for each motor frame size as ordinates versus revolutions per minute as abscissas from standstill to rated rotational speed:

a. Current, in amperes

b. Motor torque, in pounds-feet

c. Power factor, in percentage

d. Fan load torque, in pounds-feet

e. Acceleration time, in seconds

8. Test data for the certified performance curves shall be recorded at the rated voltage and frequency of the motor, and recorded continuously over the speed range from standstill to rated rotational speed of the motor.

C. Elevated Temperature Test

1. One pre-production fan-motor unit of each size provided shall be installed in an elevated temperature duct loop and subjected to a temperature of not less than 482 degrees Fahrenheit for a minimum period of 90 minutes. The fan-motor unit shall be operated at design airflow during the test; the duct loop shall have sufficient resistance to replicate the design pressure drop.

2. Air temperature in the elevated temperature duct loop shall be recorded continuously through the test.

3. Motor winding and bearing temperatures, phase voltages, currents, power factor and power shall be measured and recorded at a minimum of 5-minute time intervals throughout the test.

4. Each fan-motor unit shall still be operating at the design airflow at the end of the elevated temperature test with no rubbing of the fan blade tips against the interior of the fan casing. In the event that expansion of the fan blades due to the increased temperature results in any blades contacting the casing, the fan-motor unit manufacturer shall submit a remediation plan for approval.

D. Non-Destructive Inspection

1. Radiographic Inspection

a. Provide certification that, for all fan hubs and blades, x-rays have been taken by personnel certified in accordance with ASNT standards, and that fluorescent dye-penetrant examination has been performed. In addition, provide a complete list of the identification numbers for all hubs and blades actually installed in each fan-motor unit, with notation of their x-ray numbers.

b. Submit certification of visual acceptability, the x-ray procedure, the x-ray films and proof of traceability of conformance with alloy specifications of the metal used to cast the hub and blades. The identification number of the x-ray film shall be etched on each blade and hub at a location that will not create adverse stress concentrations to reduce the design safety factor at the point of critical stress.

c. The x-ray films shall be kept on file by the fan-motor unit manufacturer for a minimum of 5 years.

2. Ultrasonic Examination

a. Provide certification that, for all forged fan hubs and blades, ultrasonic examination has been performed in accordance with ASTM A388. In addition, provide a complete list of the identification numbers for all hubs and blades actually installed in each fan-motor unit.

b. Submit certification of visual acceptability, the ultrasonic examination procedure and proof of traceability of conformance with alloy specifications for the metal used to forge the hub and blades.

c. The ultrasonic examination results shall be kept on file by the fan-motor unit manufacturer for a minimum of 5 years.

E. Overspeed Tests

1. All fan rotor assemblies manufactured and furnished for this Contract shall be subjected to an over-speed test at the factory as specified herein before assembly of the complete fan-motor units.

2. After non-destructive inspection, and after static and dynamic balancing, each completely assembled fan impeller shall be overspeed tested in both directions. Spin testing of individual components, such as blades and rotors, in lieu of testing complete impellers, is not acceptable. Each fan impeller shall be spun from standstill up to 125 percent of the maximum design operating speed for a period of not less than 3 minutes. Following each spin test, perform a visual inspection for surface defects. Submit certificates of visual acceptability.

F. Vibration Tests

1. After assembly, each fan-motor unit shall be checked for bearing operation in both directions of rotation. Defective bearings shall be replaced, and the fan-motor unit shall be checked before further testing. Vibration shall be measured in two radial planes, 90 degrees apart, and in the axial direction. Measurements shall be made for each radial plane at the front and rear of the fan-motor unit. Measured maximum vibration shall not exceed peak-to-peak amplitudes of 1.2 mils (0.0012 inch) for fan-motor units operating at a nominal speed of 1,200 revolutions per minute or less, and 0.8 mils (0.0008-inch) for fan-motor units operating at a nominal speed greater than 1,200 revolutions per minute.

2. If measured vibration amplitude exceeds the specified maximum, or if the specified vibration measurements reveal unacceptable vibration at any frequency other than rated design operating speed, vibration amplitude shall be measured and recorded continuously as the fan-motor unit is accelerated from a standstill to rated design operating speed, and as the fan-motor unit coasts down from rated design operating speed to a standstill. The amplitude versus frequency chart shall be analyzed by the fan-motor unit manufacturer to determine the cause(s) of the unacceptable excessive vibration. Resonant frequencies shall be determined and shall be demonstrated as not to occur within fan operating ranges. Submit the analysis and correct the cause(s). Furnish the final vibration amplitude readings on all fan-motor unit bearings.

G. Fan-Motor Unit Performance Test

1. One pre-production fan-motor unit of each size provided which has satisfactorily passed the preceding test and inspections specified, shall be tested in accordance with the procedures specified in the AMCA 210, latest edition, using an approved test set-up.

2. Tests shall be performed with the starters furnished under this Contract.

3. Fan-motor units shall be tested without flow cones or any other static-regain devices. The fan-motor units shall be tested at the blade angle that produces the required volume of air at the required system pressure (this blade angle shall not be the maximum blade angle), and the minimum and maximum blade angle. Test data shall be recorded on AMCA data submittal forms, or the equivalent thereof. Submit certified test data and performance curves for all of the coordinates specified.

4. Performance tests shall cover the range of airflow rates from the no-flow condition to free air delivery. Performance tests of fan-motor units shall cover this range of airflow rates in both directions of airflow. Actual fan-motor unit performance shall not be less than specified in this Contract otherwise equipment shall not be approved.

5. Performance tests shall include starting the fan-motor unit from standstill against a system resistance that will result in the fan-motor unit operating at the airflow and pressure indicated on the fan schedule. Starting tests shall be performed for both forward and reverse airflow directions at rated voltage. A Hioki 3196 Power Quality Analyzer, Dranetz Power Explorer PX5, or approved equal, shall be used to measure and record current, voltage, power factor and power versus time during starting from standstill to a period of 5 minutes after fan-motor unit reaches rated speed, with the meter set to measure and record data on 1-second intervals.

6. The fan shall be calibrated for airflow capacity versus annulus velocity, using a laboratory-grade pitot tube in the annulus and mounted through the bushing in the fan housing during the performance test. Submit calibration data.

7. Tri-axial strain gauges shall be applied to two blades per impeller and to the hub of the unloaded impeller of each fan-motor unit. To accurately measure strains and stresses developed in each rotor, one strain gauge at the midpoint and one strain gauge at the tip of the blades on each side shall be applied on a minimum of two blades. In addition, one strain gauge shall be applied on the impeller hub for each strain-gauged blade. The strains developed during performance testing shall be continuously measured and monitored. The measured strains produced under the performance test load shall be used to calculate the corresponding stresses. Stresses found shall not exceed 75 percent of the material yield strength at 482 degrees Fahrenheit. Submit the methods of strain measurement and stress calculation. Submit the fan-motor unit manufacturer's notarized certification that the measured strains and the corresponding calculated stresses represent the strains and stresses developed in all other blades of the pre-production fan-motor unit being tested. Submit calculated maximum expected stresses, and the design properties of

the material used to fabricate the impeller blades and hub. Strain gauge testing shall be performed using the same testing set-up and operating conditions as the fan-motor unit full-scale performance test, and shall be performed at the design duty blade angle setting with the fan-motor units operating at the design duty airflow and pressure.

8. In the event that the tests show that the fan-motor units do not comply with the requirements as to characteristics and performance, or that the brake horsepower will exceed by 5 percent or more of the brake horsepower shown in the theoretical data submitted by Contractor, the fan-motor units shall be rejected unless changes are made therein and tests repeated until the specific requirements are met.

9. Upon the completion of the fan-motor unit performance tests, submit complete copies of all raw test data.

10. After the completion of fan-motor unit performance tests, submit for each fan-motor unit size, performance curves and tables of performance data calculated from shop test data, at each of the test points, and at each rotational direction and speed. The tables shall consist of numerical values at each of the test points for the following:

    a. Quantity of air delivery, in cubic feet per minute

    b. Fan static pressure, in inches of water

    c. Fan total pressure, in inches of water

    d. Fan outlet velocity pressure, in inches of water

    e. Fan total efficiency, in percent

    f. Horsepower input to fan impeller

    g. Fan speed, in revolutions per minute

    h. Current input, in amperes, versus time for fan-motor unit starts at: rated voltage, 110 percent of rated voltage, 90 percent of rated voltage and 85 percent of rated voltage

    i. Voltage, in volts, versus time for fan-motor unit starts at: rated voltage, 110 percent of rated voltage, 90 percent of rated voltage and 85 percent of rated voltage

    j. Power factor for fan-motor unit starts at: rated voltage, 110 percent of rated voltage, 90 percent of rated voltage and 85 percent of rated voltage

    k. Motor power input, in kilowatts, at: rated voltage, 110 percent of rated voltage, 90 percent of rated voltage and 85 percent of rated voltage

    l. Number of phases and frequency

11. Submit fan-motor unit performance curves verifying the theoretical performance curves previously submitted. Test points shall be indicated on the performance curves.

12. Submit all electrical curves for fan-motor unit starting tests.

H. Noise Test

1. Pre-production fan-motor unit for each size supplied which has satisfactorily passed all preceding tests and inspections specified shall be tested at the design duty on the performance test set-up in accordance with the test procedure of ANSI S12.56 to obtain sound power level data at eight octave band center frequencies from 63 Hertz to 8,000 Hertz.

2. Fan-motor units shall be tested at the design duty blade angle and setting with the fan-motor units operating at the specified nominal airflow in both forward and reverse directions. Test data shall be submitted in tabular form.

I. Reversal Test

1. One pre-production fan-motor unit for each size supplied which has satisfactorily passed all preceding tests and inspections specified shall be subjected to reversal tests. These tests shall require fan-motor unit operation at rated operating speed for approximately 4 hours, and shall require three cycles of rotation reversal. A cycle of rotation reversal is defined as reversal from one direction of motor impeller rotation to the other direction of rotation, and then back to the first direction of rotation.

2. The reversal test shall begin with the fan-motor unit operated in the forward direction of airflow for a period of 30 minutes.

3. At the end of the first 30-minute period of operation in the forward direction of airflow, the motor shall be electrically-reversed, with a 10-second time delay imposed between the interrupting of power and re-energizing of the motor for reversed rotation.

4. After the motor has been re-energized, the fan-motor unit shall be operated in the reverse direction of airflow for a period of 30 minutes.

5. The test shall be continued, with alternating 30-minute periods of operation in the forward and reverse directions of airflow, until six additional rotation reversals have been performed. At the end of each 30-minute period of operation, the fan-motor unit motor shall be electrically-reversed, with a 10-second time delay imposed between each change in direction until six rotation reversals have been performed.

6. After three additional cycles of rotational reversal or, after six additional reversals of the direction of motor and impeller rotation have been performed, the fan-motor unit shall be operated for an additional period of 30 minutes.

7. At the end of the last 30-minute period of operation, the fan-motor unit shall be de-energized, and permitted to coast to a standstill.

8. Resistance of the cold motor winding insulation shall be measured just before the start of the reversal test, and the resistance of the motor winding insulation shall be measured immediately after the end of the test. In addition, the temperature of the motor windings and of the motor frame shall be continuously recorded throughout the test and the acceleration time, speed, voltage, frequency, amps, and kilowatts shall be recorded during each reversal. Submit certification of successful performance of the reversal test and certified test data.

J. Run-In Test: Each fan-motor unit shall be operated continuously for a total of 24 hours, 12 hours in the forward (exhaust) mode and 12 hours in the reverse (supply) mode of rotation. During reversal, the fan-motor unit shall be allowed to coast for a period of 5 minutes before being restarted in the reverse direction. The following data shall be measured and recorded after each fan-motor unit reaches its rated speed and at 1-hour intervals thereafter:

1. Time, in minutes

2. Ambient temperature, in degrees Fahrenheit

3. Absolute barometric pressure, in inches of mercury

4. Motor winding temperature, in degrees Fahrenheit

5. Motor bearing temperature, in degrees Fahrenheit

6. Motor bearing vibration levels, in inches per second

7. Motor speed, in revolutions per minute

PART 3 - EXECUTION

3.01 GENERAL

A. INSTALLATION METHODS - All fan-motor units shall be furnished and installed in accordance with manufacturer’s instructions. All fan-motor units shall be furnished and installed as specified herein and as indicated on the Drawings. The manufacturer's rigging instructions shall be carefully followed. Ensure that the installation of all supports, gaskets, hardware, etc., are accomplished with precision and the exercise of extreme care so as to assure safe, accurate and trouble-free fan-motor unit installation.

B. Emergency ventilation equipment shall be carefully protected at the site in a manner to preclude the possibility of damage to the equipment.

C. The fan-motor unit installation shall be done in the presence of the Fan-Motor Unit Manufacturer’s Field Service Engineer (herein after referred to as the “Field Service Engineer”).

D. Emergency ventilation fan-motor assembly shall be mounted and leveled using stainless steel shim packs. Equipment shall be installed, leveled, and located so that working space is available for servicing, replacing, lubricating, and gaining access to controls.

E. Fan-motor units shall be connected to transition companion flanges with 1/4-inch-thick solid silicone gasket between; width of gaskets shall be same as flange width. Gaskets shall be capable of withstanding an ambient temperature of not less than 482 degrees Fahrenheit for minimum of 90 minutes without degradation of sealing ability and without emitting toxic or noxious fumes.

F. Apply anti-seizing compound to the threads of stainless steel bolts and studs.

G. When installed, the orientation of each fan-motor unit, as to motor end, shall be as indicated on the Contract Drawings. Fan-motor units that are improperly installed shall be removed and reinstalled at Contractor's expense.

H. After installation and before the start of testing, the equipment shall be lubricated. Equipment shall be checked for clearances and proper alignment.

I. All power and control wiring external to the emergency ventilation equipment shall be provided under Division 26. The permanent anti-condensation motor space heaters for the fan motors shall be energized with temporary power before and after installation until permanent power is available, as specified under Division 26. Fan motor assembly shall be installed in accordance with the requirements of NFPA 70.

J. Fan-motor units shall be allowed to free wheel until beneficial use is accepted. Protect openings to prevent unauthorized access.

3.02 FIELD SERVICE

A. Provide the fan-motor unit manufacturer’s field service engineering and inspection services to Metro to ensure that the fan-motor units supplied herein are properly installed and tested, and that all guarantees carry forward.

B. Field service shall be performed periodically as required during the construction and testing of Metro’s contracts. Field service shall not be less than 15 days.

C. Metro shall be advised in writing of the name, title and relevant experience of the proposed Field Service Engineer who, upon Metro approval, shall have complete authority to represent and to act for Contractor.

D. The duties, responsibilities, and qualifications of the Field Service Engineer shall be:

1. Responsible for advising the installation contractors on the proper procedures for the installation of the fan-motor unit equipment; must be present for all field installations.

2. To have a thorough knowledge of the emergency ventilation fan-motor units and the associated systems.

3. To have a thorough knowledge of the test results and performance requirements of all material and equipment supplied.

4. To prepare and submit to Metro a typewritten report on the activities and findings for each visit made within 15 working days of the visit.

3.03 FIELD TESTS

A. Upon completion of the installation of the emergency ventilation equipment at the fan rooms and the installation and verification of the power and local control wiring. Notify Metro and provide no less than 30 days notice before the factory tests. Metro FLSC shall be notified of all factory test and be given the opportunity to witness any tests. In addition, notify the Field Service Engineer for assistance in the performance of the tests.

B. Electricians to energize the emergency ventilation equipment and assist the Field Service Engineer during testing shall be provided by Contractor.

C. Acceptance field testing for the emergency ventilation equipment shall not commence until permanent electric service and local controls can be provided for testing, and after all construction and other work involving the air pathways for all fan-motor units has been completed.

D. Field tests shall be performed under the technical guidance and supervision of the Field Service Engineer. These tests shall be performed by qualified personnel (employees of Contractor or a subcontractor) who have been approved by Metro. The overall responsibility for this measurement program shall belong to Contractor.

E. Any defect that develops within the emergency ventilation equipment during the field tests shall be corrected by Contractor at no additional cost to Metro.

F. Vibration Test:

1. Each fan-motor unit shall be checked for obviously rough operation after the fan-motor units are installed. Defective bearings shall be replaced with new bearings and the fan-motor unit(s) shall be re-checked. Amplitude and frequency of radial and axial vibrations at the bearings shall be measured, recorded, and checked for conformity to the Specifications.

2. Each fan-motor unit on which the specified vibration tests have been successfully performed shall be proven operational in both directions of airflow, including one reversing of direction of rotation, in a two-hour run-in test.

G. Run-In Test:

1. All fan-motor units in the system shall be run simultaneously at high speed for a total of 2 hours; 1 hour in each direction, with 10-second time delay imposed between the interruption of power and re-energizing of the motors for reversed rotation. Where multiple fan-motor units are installed in the same room, all fan-motor units shall be operated simultaneously when determining and recording the electrical measurements.

2. A Hioki 3196 Power Quantity Analyzer, Dranetz Power Explorer PX5, or the approved equivalent, shall be used to measure and record current, voltage, power factor and power versus time for each fan-motor unit and simultaneously at the main switchboard during starting from standstill to a period of 5 minutes after the last fan-motor unit in the system reaches rated

speed, with meter set to measure and record data on 1-second intervals. Data shall be recorded on 5-minute intervals for the duration of the first hour. After the fan-motor units are shut down to perform the reversal, the power analyzer shall be used to record current, voltage, power factor and power versus time on 1-second intervals during starting from standstill to a period of 5 minutes after the last fan-motor unit in the system reaches rated speed in the reverse direction. Data shall be recorded on 5-minute intervals for the duration of the second hour.

H. Fan-Motor Unit Airflow Performance Test: After completion of the Vibration and Run-In Tests, a test to determine actual air output under operating conditions shall be made as specified below.

1. Airflow tests shall be performed by a certified testing agency approved by Metro with proven experience measuring airflows and performing field testing for fan-motor units of this type.

2. Each fan-motor unit shall be tested at the design blade angle while all fan-motor units in the system are operating simultaneously at high speed. For each fan-motor unit, while under both supply and exhaust operation, measure and record current, voltage, power factor and power versus time for each fan-motor unit and simultaneously at the main switchboard during starting from standstill to a period of 5 minutes after the last fan-motor unit in the system reaches rated speed, with meter set to measure and record data on 1-second intervals using a Hioki 3196 Power Quantity Analyzer, Dranetz Power Explorer PX5, or the approved equivalent. Simultaneously record the barometric pressure in inches Hg. with a precision barometer capable of measuring between 15 and 31 in. Hg. and the dry bulb (D.B.) temperature of the air passing through the fan-motor unit. In addition, use a pitot tube to measure velocity pressure though the calibration hole in the fan casing provided by the fan-motor unit manufacturer, using the same size pitot tube and insertion depth used by the fan-motor unit manufacturer for the calibration hole measurements taken during factory testing. Based on the recorded data and calibration hole measurements, and in conjunction with the certified operating fan and motor data and curves derived from the factory tests, the air delivery of each fan-motor unit under both supply and exhaust conditions shall be determined for each of the operating conditions specified above. BHP shall be corrected to the air density of 0.075 pounds per cubic foot before use with the fan-motor unit performance curves and all calculations shall be shown in the report. In addition, perform anemometer traverses for each of the operating conditions specified above, with all fan-motor units in the system operating, at locations determined by Metro before testing to confirm fan-motor unit airflow delivery. For each measurement location, a minimum of two air velocity traverses of the entire cross section shall be taken and averaged, and the averaged measurements shall not vary by more than 5 percent. If two sets of measurements vary by more than 5 percent, additional measurements shall be taken until two consecutive sets of measurements do not vary by more than 5 percent.

3. If the air delivery of the fan-motor units is equal to or greater than the design output stated in the Contract, no adjustment shall be made to the blade setting

of the fans, except when Metro directs that air delivery be reduced due to higher than desired brake horsepower. However, if air delivery is less than 95 percent of the design output, with approval of Metro and fan-motor unit manufacturer, adjust the fan blades in order to bring the air output of the fan-motor unit to the design level (or as close as possible to the design level) without increasing the design BHP to more than 5 percent above the design BHP indicated on the Contract Drawings, or to the BHP designated by Metro.

4. Following any change in air delivery of any fan-motor unit, repeat the tests to determine actual air output of each of the fan-motor units with all fans operating simultaneously at high speed, with the fan-motor units run under test for a minimum of 1 hour with 30 minutes each under supply and exhaust operation. A Representative of Metro shall be present at these tests.

5. Following any blade angle adjustment, replace fan-motor unit nameplates to reflect the latest blade angle setting and re-issue the Operations and Maintenance Manual for the fan-motor units.

I. Noise Test: Noise levels, measured in dB(A) shall be measured and recorded at the property line of the overbuild nearest the exhaust gratings above each exhaust plenum with each fan-motor unit operated individually at half speed. Noise levels, measured in dB(A) shall be measured and recorded at platform level near each fan room with all fan-motor units overbuild operating at high speed. Background noise levels shall be recorded before and after any fan noise measurement. Sound power levels shall be recorded in each octave band. The fan manufacturer shall coordinate with the sound attenuator manufacturer to confirm that the combined fan/attenuator noise (fan power level minus attenuator dynamic insertion loss) does not exceed NFPA 130 and 29 CFR 1910 levels. Refer to Section 23 33 60 for sound attenuator requirements.

J. Tunnel Airflow Performance Test: The last field test shall be the measurement of air movement produced by the emergency ventilation system within the tunnels. These measurements shall serve as verification versus the cold airflows predicted by computational analyses that the emergency ventilation system produces air velocities in the tunnel/train annular area during a fire in compliance with NFPA 130.

1. Select three locations for performing the testing and resulting air measurements. The exact location and placement of the trains for the test shall be determined by Metro in its sole discretion based on Contractor's submitted test procedure. Coordinate the associated testing conditions, including the emergency ventilation system equipment operating requirements and the location of the stopped train(s). Anemometer traverses of the entire tunnel cross section shall be constructed in order to measure the average airflow (in cubic feet per minute) through the cross section. For each measurement location, a minimum of two air velocity traverses of the entire tunnel cross section shall be taken and averaged, and the averaged measurements shall not vary by more than 5-percent. If two sets of measurements vary by more than 5 percent, additional measurements shall be taken until two consecutive sets of measurements do not vary by more than 5-percent. The measurements shall account for the effects of the tunnel

horizontal curvature and the distance from stopped train(s). Make the necessary arrangements with Metro to schedule the tests and to use stopped trains during the actual testing period. Provide field test procedures indicating the proposed train location(s), the associated tunnel emergency ventilation system operating mode and the proposed traverse locations prior to initiating the tests.

2. Provide the measured test results. Include the measured air velocities at each anemometer, the averaging technique utilized and the calculation for determining the average airflow. If the resulting tunnel air velocity is less than the required "cold" air velocity, Contractor shall be notified in writing to adjust the emergency ventilation system in order to produce the required tunnel air velocity. The field measurements shall then be repeated in order to verify that the required tunnel air velocity has been achieved. If the emergency ventilation system adjustments cause overloading of the fan motors, Contractor shall advise Metro in writing on the extent of the overload.

K. After completion of all field tests and after the final visit by the Field Service Engineer, submit a field test and inspection report. Field test report shall include copies of raw data, measured results, calculations, and all data derived from tests to confirm compliance with specified vibration performance, noise, and equipment efficiencies.

3.04 CONTROL SEQUENCING

A. Emergency Ventilation Fan-Motor Units: Fans shall be operable simultaneously at full speed in either the supply or exhaust mode for emergency ventilation from local control panels, central control, or the MCC. Fan-motor units shall also be operable at half-speed for tunnel maintenance or gas mitigation purposes. Fan-motor units will be capable of being tested (jogged), locally in either mode.

B. When multiple fans are to start, fan starting sequence shall be initially set with 15-second interval between successive starts, to be field-adjustable depending on actual acceleration times.

C. MCC control is described in Section 26 24 19, Motor Control Centers. Control modes are described in Section 26 09 16, Controls, Instrumentation, Control Panels, and Interface Cabinets and the Regional Connector “Ventilation Report”. SCADA as described in Section 28 40 00, Supervisory Control and Data Acquisition Remote Terminal Unit (SCADA RTU).

D. Emergency Ventilation Fan Dampers: The fan-motor unit and fan dampers shall be hardwire interlocked so that actuation of a fan-motor unit shall automatically activate opening the associated damper(s) after a field adjustable time delay as indicated in Section 26 09 16. Damper power off position will be fully open. A local test station will permit momentarily opening the damper while the fan-motor unit is off.

END OF SECTION 23 34 40

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SECTION 27 01 01

GENERAL COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work Includes:

1. This Section, in conjunction with details of the Work described in the subsystem specification sections, describes the Scope of Work included in the Contract. The Contractor shall be responsible for design, labor, materials, delivery, storage, installation, integration, testing, start-up and provide technical support and resources necessary to perform the Work specified herein.

2. Under the Contract, the Metro Purple Line Heavy Rail Transit System shall be extended west from the existing Wilshire/Western Station in downtown Los Angeles to Wilshire/La Cienega Station in Section 1 phase (and eventually to Westwood/VA Hospital Station – not in Contract).

3. All subsystem equipment furnished under this Contract shall be compatible at the time of installation with the existing Metro's equipment.

4. Contractor shall be responsible for the following subsystems:

   a. Uninterruptible Power Supply (UPS) System

   b. Facilities Emergency Management (FEM) System

   c. Seismic Event Detection System

   d. Cable Transmission System (CTS)

   e. Telephone System

   f. Radio System

   g. Transit Passenger Information System (TPIS)

   h. Intrusion Detection Access Controlled System (IDACS)

   i. Closed Circuit Television (CCTV) System

   j. Fire Alarm Detection System

   k. Gas Detection and Alarm System

   l. Supervisory Control and Data Acquisition System (SCADA)

   m. Universal Fare Collection System (UFCS) Interface

5. Contractor shall provide all interfaces, design and installation drawings, support documentation, manufacturers' literature, commissioning and testing documentation and As-Built drawings.

6. The design drawings included in this package do not represent complete final design and it is the contractor's responsibility to develop these drawings for completeness and constructability.

7. Contractor shall not procure any equipment prior to receiving approval of the submittals which includes product data, shop drawings and the sequence of operations.

8. Contractor shall identify all required interfaces within the communications subsystem and also with other non-communications systems such as Train Control, Traction Power Substations, Mechanical and Electrical Systems.

9. Contractor shall use the Metro's indefinite delivery indefinite quantity (IDIQ) equipment list attached as the reference for procurement of the communications equipment to ensure uniformity and compatibility at the time of installation with the existing rail communication system.

10. The Contractor shall ensure that the electrical, electronic, and communications systems design can perform in the Authority transit system EMI environments with vehicles and other equipment without being functionally affected by them; and without affecting the system operation, safety, or other car borne.

B. Other related work:

1. Wilshire/ Normandie Station

   a. Metro is responsible to upgrade the station SCADA F&EM to enable remote viewing/control of the ventilation system from the EMP at Wilshire/Western and Wilshire/ La Brea Stations. Likewise, the EMP at Wilshire/Western and Wilshire/La Brea station shall be able to communicate with the SCADA F&EM at Wilshire/ Normandie for remote viewing/control of the ventilation system.

2. Wilshire/Western Station

   a. Contractor shall be responsible to evaluate the existing conduits and cable runs and make changes necessary to accommodate the new communications equipment to be installed at the existing Wilshire/Western station TC&C room.

   b. Metro is responsible to ensure that the existing Wilshire Western Station's EMP is upgraded to be able to view the indications and control of the station emergency ventilation system from the two adjacent stations on each side.

   c. The existing OC-48 node at Wilshire/Western will be upgraded to OC-192 BLSR by Metro. The Contractor will be responsible to run and terminate the

fibers to the new contractor provided rack/FDP. Fiber slack enclosure and expose GRS conduits shall be provided for installation of the fiber cables in the TC&C room. Metro shall connect the fibers to the existing ADM to complete the SONET ring as depicted.

d. Extending of the existing radio Coverage

1) Contractor to provide the radio coverage from the existing tunnels at Wilshire/Western station to the end of the La Cienega tail tracks.

3. Wilshire/La Brea Station

a. Contractor shall coordinate with Metro to design of the station EMP to enable remote viewing/control of the ventilation system at Wilshire/Western Station and Wilshire/ Normandie Station.

4. Wilshire/Fairfax Station

a. Contractor shall coordinate with Metro to design of the station EMP to enable remote viewing/control of the ventilation system at Wilshire/Western.

5. Wilshire/ La Cienega Station

a. Contractor shall provide dedicated spare conduits from the west cable room to the interface junction boxes on both tunnels to accommodate the future CTS fibers, SCADA, radio, fire and gas detection system.

b. Contractor shall provide a dedicated rack, FDP and all associated equipment required to connect the fiber optical cables to the existing SONET node.

c. Contractor shall design the station EMP to enable remote viewing/control of the ventilation system for two future stations.

d. **Contractor shall provide conduits to the ~~Train Operating Supervisor's Booth at the east end of the platform from the nearest Communications Interface Cabinet. In addition, contractor shall furnish all labor and material for the installation of an administrative~~ telephone and a public address sytem~~microphone~~ for the train operating supervisor booth.**

C. Cutover plan:

1. Contractor shall submit a complete and detailed cutover plan for all subsystems for approval prior to start of any work.

2. The plan shall include but not limited to the following:

a. Cutover plan and procedure for each Subsystem:

1) Objective

2) Schedule time/dates

3) Rail Operations Control (ROC)

4) Identify impact and non-impact equipment/system

5) Contingency plans

6) Fire Watch

a) Security

b) Back-up emergency power for critical equipment

c) Communication equipment

d) Notify appropriate agencies: ROC, police, fire and department.

1.02 RELATED SECTIONS

A.	Section 01 33 00	Submittal Procedures
B.	Section 01 43 10	Project Quality Program Requirements – Design/Build
C.	**Section 01 78 43**	**Spare Parts, Spare Parts Catalog, and Replacement Materials**
~~C.~~**D.**	Section 27 05 56	Safety and System Assurance

1.03 REFERENCES

A.	METRO	Metro Rail Design Criteria, Metro Fire Life Safety Criteria and Metro Rail Standard and Directive Drawings
B.	NFPA	70 National Fire Prevention Association
C.	AREMA	Communications and Signals Manual
D.	CAC	Title 24 State Building Code
E.	CALTRANS	Section 12 California Transportation Department Standard Specifications
F.	ICBO	Uniform Building Code (UBC)

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, for Quality Assurance requirements.

C. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in subsection 1.03 - REFERENCES.

D. QA Program – Perform the work of the Contract in compliance with the approved Quality Assurance Program (QAP).

E. Codes – The Contractor shall be responsible for compliance with the latest issue of all applicable codes and shall obtain any permits necessary to complete the work.

F. Workmanship – Perform work in a workmanlike manner consistent with the highest industry standards.

G. Manufacturer Qualifications

1. Manufacturer acceptability shall be based on the manufacturer's experience, qualifications, and certifications such as ISO-9001, equipment reliability, compliance with standards specified herein and full compatibility with Metro's existing system. Manufacturer should have already supplied similar or identical equipment to at least one operating transit system in the U.S.

H. The Contractor shall perform the following:

1. Material qualification testing and certification for acceptance of materials, components and assemblies

2. Job control testing of in-progress work being performed in shops, factories and on-site

3. On-site inspection of specified work elements

4. Field Quality Control:

a. Comply with manufacturer's written instructions.

b. Inspect interiors of enclosures, including Integrity of mechanical and electrical connections, labeling, and ratings of installed components.

c. Inspect and test cameras and accessories in accordance with the NETA's acceptance testing specifications.

d. Test manual and automatic operational features and system protective and alarm functions.

e. Provide qualified staff to support the tests and inspections.

f. Wherever practical, all equipment including motors, dampers, fire smoke dampers (FSDs), ductwork, and penetrations in walls should be constructed so that they are accessible with an eight foot ladder. If this is not feasible, then provide an OSHA compliant service platform and access ladder.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. The Contractor shall be responsible for the content of all submittals, their completeness, their conformance with observable field conditions, their conformance with the schedule, and any delays resulting from rejection of submittals due to noncompliance with the requirements.

C. Design and submit final design documents, incorporating key elements of the Contract milestone schedule, demonstrating the ability to complete the Communications system design to function as intended, and the ability to deliver the Communications equipment in conjunction with the construction schedule.

D. Prepare test procedures, submit test reports, and perform factory testing of communications equipment prior to shipment, and perform testing of the installed systems per the communications subsystems specifications.

E. Provide as-built drawings that accurately depict the final status of all circuitry, identification labels and equipment as installed and placed in service.

F. ~~Provide~~ **Propose** spare parts and equipment sufficient for maintenance, testing and performing minor modifications to all equipment and circuitry provided as a part of this Contract. This shall include parts subject to normal wear or high probability of damage under normal use, and recommendations of the Manufacturer, or as obvious by definition, (such as sacrificial pieces) **as part of Section 01 78 43 List B submittal**.

G. Provide maintenance manuals, special test equipment and training sufficient to maintain, test and modify all equipment and circuitry provided as part of this Contract. This shall include routine maintenance and troubleshooting, specified or incidental testing, and minor modification as described in the Specifications, and/or as recommended by the Manufacturer.

H. Provide software licenses, software manuals and as-built software for each subsystem to Metro upon system final end to end acceptance test.

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL

A. Furnish materials necessary to provide a complete and operable Communications system. Equipment requirements are listed in the plans and specifications of the subsystems. Provisions shall be made to include any equipment not shown but is required for a complete operating system. Contractor shall include the software to enable Metro to program the equipment.

2.02 SYSTEM SUPPORT

A. ~~Provide~~ **Propose** recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract.

The Metro or its Designee will select such equipment as it requires. **Refer to Section 01 78 43 List B submittal.**

B. The Contractor shall provide technical support for the system integration test (SIT). Technical support shall include engineering, technical and installation staff as well as tools, appliances, fixtures, expendable materials, supplies, and test equipment as needed to perform the SIT procedures and or to develop and implement required corrective actions on the Contractor's elements.

C. The Contractor shall carry an allowance of 700 hours to support Metro's end to end system integration test.

PART 3 - EXECUTION

3.01 INSTALLATION

A. System installation shall be in accordance with the specification sections for subsystems.

B. Perform all tests as identified in the subsystem specification sections. The Contractor shall be responsible for materials, test equipment, and labor necessary to perform these tests and, if required by the Metro or its Designee for performing retesting.

ATTACHMENT A – ID/IQ LIST

Item No.	Subsystem	Description	Manufacturer	Manufacturers Part
1	CCTV	22" Widescreen LCD Monitor	Samsung	B2230
2	CCTV	2650-A Server	Dell Computer	PowerEdge A
3	CCTV	2850-3 Server to go in from CX300 Storage Array	Dell Computer	PowerEdge B
4	CCTV	Converter DC/DC. CCTV DVR. Rail. 150W	Schock Power Corporation	SDC144.1
5	CCTV	i=0 RX. 8V >-<> 2 RS422 and 2D. Digital. SN-V Monitor end 3 slots. Module	Infinova	N3759RA-M
6	CCTV	FO SM TRX 8V Out. 2D IO - 2RS-232 10 Module 12VDC24VAC	Infinova	3759RA-2D2B-M
7	CCTV	FO TRX. v>-<d (over the Coax). FM. SM. Camera end. 1 slot. Module	Infinova	N3S35TA-m
8	CCTV	FO TRX.v>+<D (over the Coaxi. FM. S'v1 Monitor end. 1 slot. Module	Infinova	N3S35RA-M
9	CCTV	Integrated Pan/Tilt Camera. 26X. d-n NTSC. w.-Wall Mount. 24VAC	Infinova	V1492-26A06
10	CCTV	Inverter. 150 W	Tripp Lite	PV150
11	CCTV	Long Wall Camera Mount	Infinova	v1 761 L
12	CCTV	Power Supply, 12VDC. ,2VA. Plug-In, 1 2CVAC	Infinova	N3921-12D-1
13	CCTV	PowerEdge 42"I0/216i	Dell Computer	KVM Server
14	CCTV	Lacie LaCie d2 DVD+RW 22x with LightScribe	Lacie	301484U
15	CCTV	Superdome. Outdoor. NTSC Day;0.1 Luxi Nightf0.02ujx). 480TVL 23x12, Smoke. Vandal Resistant PTZ Camera	Infinova	TV-v1747A-C0S3B5U
16	CCTV	Camera, Fixed. Camclosure (Elevator Camera)	Pelco	S210-DNV9
17	CCTV	IP PTZ Camera MPEG4/MJPEG18X, Color. NTSC. 480 TVLVR. Pendant. Outdoor Smoked, 24VAC	Infinova	V1745N-M0S3B
18	CCTV	IP PTZ Camera, MPEG4/MJPEG,26X, D/N, NTSC. 480TVL.VR. Pendant, Outdoor. Smoked, 24VAC	Infinova	V1748N-M0S3B6
19	CCTV	IP PTZCamera,MPEG4/MJPEG.36X,D/N,NTSC 480TVL. VR. Pendant. Outdoor Smoked,24VAC	Infinova	V1 743N-M0S3B
20	TPIS	Nexia TC Teleconference DSP	TransitVUE®	TV-DSP8
21	TPIS	PA Touch Screen	Two-Technologies	PSMTTVFDBPR2-H
22	TPIS	RS232/RS485 Isolation Hub	US Converters	MWE485-H4
23	TPIS	Assist Phone	Vandal-Proof Products	T2100
24	TPIS	Power Supply	Vandal-Proof Products	A705-8
25	CTS	ASA 5510 Security Appliance (Firewall)	Cisco	5510
26	CTS	Cable - Fiber Optic, 144 Strand, Single Mode, 8.3/125 um, core/cladding, (1310/1550 nm), Buffered Loose Tube, Gel Filled, Single Polyethylene jacket, length marhing in feet, 0.4 per kilometer attenuation, Operating Temp -40 to +50 degrees F, Max Tensile 119L	PRYSMIAN Cable & Systems	144GCS1LAFESJA
27	CTS	CABLE. FIBER OPTIC, ARMORED 48, FIBER SINGLE MODE LOOSE, TUBE, GEL	PRYSMIAN Cable & Systems	48GCS1 LAFESJA

Item No.	Subsystem	Description	Manufacturer	Manufacturers Part
		FILLED, OUTSIDE PLANT, 6,000 FT, PER REEL		
28	CTS	Cable, 6 Strand SM Riser Rated ISP Cable, In Feet, 1301 nm	AFL Telecommunications	CR0069441001
29	CTS	Cable, AX01-030N-SYMC/YMD-900-OFNR Simplex Singlemode Cable (ft)	Optical Cable Corporation	AX01-030N-SYMC/YMD-900-OFNR
30	CTS	Cable, Cat 5 Jumper - 3 meter	J.M Fiber Optics	05BC-3M-A-GY
31	CTS	Cable, CAT 5e - 110 Type RJ-45 Jack, Ivory	J.M Fiber Optics	JM-07B-I88-IV
32	CTS	Cable, CAT5 Jumper, 1 meter	J.M. Fiber Optics	05C-888-SA-5M-GY
33	CTS	Cable, CAT5E 5 Meter Jumper Gray	J.M, Fiber Optics	05BC-5M-A-GY
34	CTS	Cable, CAT5e Green, Plenum 4 Pair 24 AWG, Feet	J.M, Fiber Optics	803308
35	CTS	Cable, HDMI - HDMI Cable, 4 Feet	J.M, Fiber Optics	AV52300B04
36	CTS	Cable, LC-LC Duplex SM Zip cord 3 Meters	J.M, Fiber Optics	02Z-EE-10A-10A-3M
37	CTS	Cable, LC-LC Duplex SM Zip cord 20 Meters	J.M, Fiber Optics	02Z-EE-10A-10A-20M
38	CTS	Cable, SC SM Pigtail Assembly 3 meter	J.M, Fiber Optics	01-EE-7A-0-3M
39	CTS	Cable, SC-SC SM Simplex Assembly 3 meter	J.M, Fiber Optics	01-EE-900M-7A-7A-2M
40	CTS	Cable, ST SM Simplex Pigtail Cable Assembly 1 Meter (3mm jacket)	J.M, Fiber Optics	01-EE-4C-0-1M
41	CTS	Cable. Two-Strand DUAL-link SM Riser Rated ISP Cable	Draka Cable	DA0029481001
42	CTS	Cisco 3570 V2 10/100 POE Layer 3 Switch 48 POE and 4 SFP	Cisco	WS-C3750V2-48PS-E
43	CTS	Connector - Fiber Optic, SC MM Hot Melt	3M	6300-B5-12
44	CTS	Connector, LC MF UPC 1310/1550 10dB Attenuator	J.M. Fiber Optics	F18761C10
45	CTS	Connector, SC MF UPC 1310/1550 10dB Attenuator	J.M, Fiber Optics	F18731C10
46	CTS	Connector, SC SM	J.M, Fiber Optics	F13069
47	CTS	Connector, SC-SC SM Coupler	J.M, Fiber Optics	F13S10BC
48	CTS	Electrodes: Spare (Pair) for FSM-11 S	AFL Telecommunications	S014028
49	CTS	Electrodes; Spare (Pair) for FSM-50S/50R/17S	AFL Telecommunications	S013532
50	CTS	Fiber Optic Safety Kit	J M Fiber Optics	FS9500
51	CTS	Fiber. Splice Protection Sleeve -Quantity 50	J.M. Fiber Optics	FPS-60
52	CTS	Flashwave, F-LTH1A1 H-12-ES-024-E3 24 Fiber Armored, (ft)	Draka Cable	F-LTH1A1H-12-ES-024-E3
53	CTS	One Strand SM Riser Rated ISP Cable, Feet	AFL Telecommunications	SA0019301001
54	CTS	Panel. CAT5e RJ45 24 Port 110 Rack Mount Patch Panel 258A	J.M. Fiber Optics	01B-24-LA
55	CTS	Panel, CNS048P, 5U, 19/23" Rackmount fiber patch and splice panel, 048 APC/SC feed thru pre...	AFL Telecommunications	C210928-BL
56	CTS	Panel, CNS144P 5U 19/23" rackmount fiber patch and splice panel, 144 APC/SC feed thru prete...	AFL Telecommunications	C211021-BL
57	CTS	Panel, Fiber Optic Panel Loaded - with SC Single Mode Adapters	Corning Cable System	CCH-CP12-59
58	CTS	Panel, Fiber Patch and Splice Panel, Rackmount	AFL	CNS048P

Item No.	Subsystem	Description	Manufacturer	Manufacturers Part
59	CTS	Rack, Equipment Rack Cable Mgmt Trough, 6.5 ft. height, 6.0 inch wide, 6.38 inch Deep, Black in Color	Chatsworth Products, Inc.	Model # 11374-702 (Graybar # 96048006)
61	CTS	Rack, Equipment Rack Cable Mgmt Trough, 9.0 ft. height, 6.0 inch wide, 6.38 inch Deep, Black in Color	Chatsworth Products, Inc.	Model # 11374-708. (Graybar # 96048015)
62	CTS	Rack, Equipment Rack Isolation Kit, for 23 inch width self-supporting racks, Polyester Fiberglass Pad & Hardware	Chatsworth Products, Inc.	Model # 10605-023 (Graybar # 89027041)
63	CTS	Rack, Equipment Rack, 7-foot height, 45 RMU, 23 inch width, Open Floor Mount, Aluminum, Clear Grain Finish, Ships Unassembled	Chatsworth Products, Inc.	Model # 46383-503 (Graybar # 88084138)
64	CTS	Rack, Equipment Rack, 9-foot height, 58 RMU, 23 inch width, Open Floor Mount, Aluminum, Clear Grain Finish, Ships Unassembled	Chatsworth Products, Inc.	Model # 46383-508 (Graybar # 88084140)
65	CTS	Powerworx Power Dist. Panel	ADC	PWX-001RGCSD-10P-WDS
66	CTS	Flatpack 125A	Eltek	505811
67	CTS	FP 700W Rectifier	Eltek	241114.4
68	CTS	Powerware PW9125 6000g UPS	Powerware	103003635-5501
69	CTS	Powerware PW9125 240 EBM For 5000 & 6000 Models	Powerware	103003387-5501
70	CTS	Powerwave PowerPass Distribution Modules	Powerware	103003214-5505

END OF SECTION 27 01 01

SECTION 27 01 02

COMMUNICATIONS MANUALS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section specifies the description of and general requirements for providing technical manuals for all communications equipment and software including Metro furnished equipment and software

B. Technical manuals shall comprehensively address all phases of system configurations, operations, maintenance, repair and spare parts.

C. Support materials shall be provided to enable Metro personnel to operate and maintain all communications subsystems.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

~~C. Section 27 01 04 Spare Parts and Test Equipment~~

C. Section 01 78 34 Spare Parts, Illustrated Parts Catalog, and Replacement Materials

D. Section 27 05 56 Safety and System Assurance

1.03 REFERENCES (NOT USED)

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, for Quality Assurance requirements.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures

B. Submit a complete listing of the table of contents of the complete O&M manual. Submit a complete first draft of the O&M manual. Submit the O&M manual.

C. Submit manufacturer's operating and maintenance instructions for the complete communications system.

D. Course outlines for each of the end user training programs. The course outlines shall include the course duration, and a brief description of the subject matter.

E. Submit the operation and maintenance manuals for the following communications subsystems:

1. Uninterruptible Power Supply System
2. Emergency Management Panel
3. Seismic Event Detection System
4. Cable Transmission System
5. Telephone System
6. Radio System
7. Transit Passenger Information System
8. Intrusion Detection Access Controlled System
9. Tunnel Portal Surveillance and Alarm System
10. Closed Circuit Television System
11. Fire Detection System
12. Gas Detection and Alarm System
13. Supervisory Control and Data Acquisition
14. Universal Fare Collection System (UFCS) Interface

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. General

1. The manual shall consist of 8-1/2 inch by 11 inch sheets bound in loose-leaf-type binders. The binder holes shall be reinforced, unless a multiple-hole configuration with more than seven holes is used.

   a. Fold-out diagrams or illustrations may be employed, with a maximum size of 11 inches by 17 inches. The title shall be visible when the sheet is folded.

   b. Paper shall be white bond, at least 20 pound weight. Covers shall be oil-, grease, solvent, and wear-resistant, 40 to 50 mil thick.

c. The paper and ink shall resist smearing, fading and deterioration from age.

2. Manuals shall be written in English, to be understood by a high school graduate with two years of experience in a related field, but with minimal knowledge of railroad or transit operations. The writing shall be concise and free of ambiguities.

3. Manufacturer's standard manuals shall be acceptable, subject to the approval of Metro.

4. Revisions to a manual shall be reflected in a revision index included in each manual and revised with each manual update.

B. Maintenance and Repair Manuals

1. Prepare maintenance and repair manuals as specified herein. Additional instructional material shall be provided in the form of film transparencies, binders and DVDs. Include the following in each manual.

a. General Descriptions

b. Theory of Operation

c. Illustrated Parts Breakdown

d. Schematic Diagrams and reference drawings from the As-built and Shop drawings

e. Preventive maintenance tasks and procedures including recommended intervals

f. Troubleshooting and repair procedures

g. Dismantling and reassembly procedures

h. Spare parts requirements

i. Maintenance equipment tests

j. Any other information necessary to provide for proper maintenance and repair

k. Software configuration procedures

l. Software configuration backup and restore

C. Operation Manuals

1. Prepare operation manuals as specified herein. Include the following in each manual, as applicable.

a. Detailed operating instructions

b. Test procedures

c. Safety precautions

d. Functional relationship with other equipment or systems

e. Operational limits and restrictions

f. Other information necessary for proper and efficient operation

D. Installation Manuals

1. Prepare installation manuals as specified herein. Include the following in each manual, as applicable.

a. A description of equipment, including drawings and detail narrative of the function

b. Standard installation procedures

c. Safety procedures

d. List of special tools required to perform installation

e. Any other information necessary to provide for proper installation

PART 3 - EXECUTION

3.01 DELIVERY

A. All documentation shall be submitted in an electronically readable and editable format. Files shall be readable by MS Office Version 7 and AutoCAD Version 2009 or approved equivalent to provide view/edit software if not supported by current Metro applications. Documentation for standard, off-the-shelf components can take exception to these requirements.

The documentation content shall include:

1. Index of volumes, in each volume of multiple volume systems

2. Index for each volume. List and combine the literature for each system in sequence of operation.

3. Names, addresses and telephone numbers of Contractor, suppliers and installers

4. Names, addresses and telephone numbers of manufacturers' nearest service representatives

5. Names, addresses and telephone numbers of local parts vendor and service agency

6. Anticipated date Metro assumes responsibility for maintenance

7. Description of system and component parts
8. Pre-operation check or inspection list
9. Procedures for starting, operating and stopping equipment
10. Post-operation check or shutdown list
11. Inspection and adjustment procedures
12. Emergency operating instructions
13. Accepted test data
14. Maintenance schedules and procedures
15. One copy of each wiring diagram
16. One copy of each accepted Shop Drawing
17. Manufacturers' parts list with catalog names, numbers and illustrations
18. Exploded view of each piece of equipment with part designations
19. List of manufacturers' recommended spare parts, prices and quantities for two years of operation. The Contractor shall compare this to Section ~~27 01 04 Spare Parts and Test Equipment~~**01 78 34, Spare Parts, Illustrated Parts Catalog, and Replacement Materials**.
20. List of special tools and test equipment required for the operation, maintenance, adjustment, testing and repair of the equipment, instruments and components. If certain special tools or equipment are known to be difficult to locate or acquire, the Contractor shall include at least two suppliers for the product if possible.
21. Scale and corrosion control procedures
22. Dismantling and reassembly instructions
23. Troubleshooting and repair instructions
24. Calibration procedures
25. Ordering information

END OF SECTION 27 01 02

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SECTION 27 01 03

COMMUNICATIONS TRAINING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work of this Section includes the requirements for instruction and training of Metro Operations and Maintenance (O&M) personnel in the operations and maintenance and engineering staff in the software configuration of all installed equipment and systems, this also include the Metro furnished hardware and software.

B. The Work also includes provision of classroom(s), training aids and on-site instruction as most appropriate for the particular equipment or system or as specified in the Contract Documents.

C. The training courses shall utilize the approved O&M manuals in conjunction with the training aids, manuals and so forth, as specified in these Specifications.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

1.03 REFERENCES (NOT USED)

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, Section 1.04 for Quality Assurance requirements.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures

B. Training submittals shall include:

1. Training program outline and schedule
2. Training Session I
3. Training Session II
4. Training Session III
5. Outlines for User Education Training Classes

6. Training Materials

7. Trainer Résumés

C. The training course outline shall include, but not be limited to, a complete list of all training modules, duration of each module, module objectives and the instructor's resume.

D. Submit a training course outline and training manuals for all products, equipment and systems specified or indicated.

E. The training manuals shall include all materials that will be presented during the training courses.

F. Provide DVDs containing the entire initial training course.

G. Metro review time for each of the training and O&M submittals is expected to take up to five (5) weeks. It is also expected that there will be at least two re-submittals of the training and O&M manuals for the Metro approval process.

1.06 DEFINITIONS (NOT USED)

1.07 TRAINING COURSES

A. Provide instruction and training courses in the O&M of all equipment and systems for Metro personnel.

B. Training courses shall be conducted by the representatives of various equipment and product manufacturers and the Subcontractors responsible for the installation and acceptance testing of the affected equipment and systems. Training courses shall enable a qualified service technician to operate, troubleshoot, and maintain the equipment and systems.

C. Provide classroom facility or facilities, within 15 minutes of the Work site, for instruction and training sessions. Examples of acceptable classroom facilities include, but are not limited to, a local hotel conference room and a separate field office. Contents of the courses shall include demonstration and practical training on the communications system.

D. Training Materials – All printed training materials or audio-visual aids prepared as training aids shall become the unrestricted property of Metro upon completion of the training program at no additional compensation.

E. The training courses shall include, but not be limited to, the following topics:

1. Site O&M manual and design documentation familiarization

2. Communications subsystems operations

3. Familiarization with the systems software

4. Systems maintenance

5. Preventive maintenance and repairs

6. Safety/Emergency procedures

7. Troubleshooting

F. Metro personnel will attend the initial and final training courses.

G. Upon completion of the training courses, Metro personnel shall receive certification to operate and maintain the equipment.

H. Schedule the training courses at a time convenient to Metro

1.08 TRAINING MANUALS AND TRAINING AIDS

A. Provide O&M training manuals. Training manuals shall be prepared specifically for use as training aids. Training manuals shall also be provided in electronic format (MS Office) on a CD or DVD-ROM.

B. Provide each Metro O&M staff member with of pertinent training manuals and pertinent manuals before the start of training courses.

C. Provide all special tools, equipment, training aids, and other materials required for the training of Metro personnel. The number of special tools and other training equipment shall be adequate for the number of participants attending the training courses.

D. All printed, audio, and video training material used during the course of the training shall become the unrestricted property of Metro. These materials shall be provided at no extra cost to Metro.

E. Provide Metro with all revisions to the training manuals throughout the Contract and Warranty periods.

F. Metro reserves the right to copy all training manuals and training aids for use in Metro-conducted training courses.

1.09 SOFTWARE TRAINING

A. Training Materials – All printed training materials or audio-visual aids prepared as training aids shall become the unrestricted property of Metro upon completion of the training program at no additional compensation.

B. The training courses shall include but not be limited to, the following topics:

1. Metro applicable Systems overview

2. Software diagnostic and programming tools general usage

3. Software configuration backup and restore

4. Software configuration editing

5. Los Angeles Metro specific configuration

6. Simulation and testing

7. Software Security

C. ~~A.~~ Provide one instruction and training course in the software configuration of each equipment and systems where applicable for Metro engineering staff.

1.10 GENERAL TRAINING REQUIREMENTS

A. Provide training courses for Metro's personnel in the operation and maintenance of products, equipment, and systems provided under this Contract.

B. Training courses shall be conducted by qualified personnel to be approved by Metro at a location within 25 miles of the city of Los Angeles."

C. Training courses need to include 3 sessions:

1. Session I Training shall be provided for Metro's First Shift personnel between the hours of 06:30 and 14:30.

2. Session II shall be provided for Metro's Second Shift personnel between the hours of 14:00 and 22:30.

3. Session III shall be provided for Metro's Third Shift personnel between the hours of 22:00 and 06:30.

D. Submit a detailed course outline to Metro for review and approval. Furnish lists of course materials, training aids and equipment required, and names and qualifications of instructors proposed for the training.

E. Schedule personnel training courses after all field tests have been satisfactorily completed and O&M manuals delivered. Metro will direct the exact starting date and time for the training.

F. The Contractor may use spare parts and/or test equipment provided under this Contract as training aids, for demonstration, and for practical exercises in adjusting, testing, disassembly, and assembly of equipment. Ensure that the spare parts and test equipment so used are repackaged and returned to Metro's spare parts storage in their original condition.

G. Each course shall cover the subjects specified in these Specifications and elsewhere in the Contract Documents, and shall consist of the minimum hours indicated for each subject:

Subject	**Hours**
Theory and Operation of the Communications Subsystems	100
Maintenance, Repair, Servicing, Troubleshooting, and Installation of the Subsystems	50
system programming and administration training for any	50

software programming or configuration	
Safety and Emergency Procedures	50

H. Develop a comprehensive video record of the initial training course on a DVD to serve as a training aid. The instructor shall conduct training with a microphone to record the audio portion of the presentations. The video footage shall be edited to include the sequential presentation of the training course with non-relevant footage removed. Provide one copy of the final training video on DVDs, as well as the original video tapes. The DVDs shall be clearly identified with labels on the training material included on each DVD.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 27 01 03

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SECTION 27 01 06

COMMUNICATIONS UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes the detailed technical requirements for the uninterruptible power supply (UPS) and float battery power supply. The UPS system shall be designed to power all communications systems in the TC&C rooms, stations, cross passages in tunnels. The UPS units supplies shall be connected to the stations' vital power panels, and shall rectify incoming 120 V, 60 Hz AC power to DC, charge and maintain charge on their connected battery banks, invert the DC to 120 VAC/60 Hz, which shall be connected to an associated AC power panel for distribution to all connected subsystems. The UPS systems shall be connected to the supervisory control and data acquisition (SCADA) system. Float battery power supply shall be used to power the radio system in the station**s and cross-passages**.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 43 Spare Parts, Spare Parts Catalog, and Replacement Materials

D. Section 27 05 56 Safety and System Assurance

1.03 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI C62.41 Recommended practice on surge voltage in low voltage power circuit

B. FCC:

1. FCC Rules and Regulation 47, Part 15, subpart J, Class A-(Federal communication Commission certified compliance)

C. IEC:

1. IEC 60068-1, 2 International Electro technical Commission

2. IEC 801-2 Electrostatic discharge

D. Institute of Electrical and Electronic Engineers (IEEE):

1. IEEE 446 Recommended Practices for Emergency Standby system for Industrial and Commercial Applications

2. IEEE 110 Powering and Grounding Sensitive Electronic Equipment

E. National Electrical Manufacturers Association (NEMA):

1. NEMA PE-1 UPS system standard

F. National Fire Protection Association (NFPA):

1. NFPA 75 Standard for Protection of Electronic Computer/Data Processing Equipment

2. NFPA 70 National Electric Code (NEC)

G. Underwriters Laboratories, Inc. (UL):

1. UL 1778 Standards for Uninterruptible Power Supply Systems

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, for Quality Assurance requirements.

C. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in SUBSECTION 1.03.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures

B. Schematic diagram for the UPS components including, but not limited to the AC to DC converter, batteries and battery charger, inverter, transformer, static transfer switch, maintenance transfer switch and ground connections.

C. Submit rack layouts and elevations for UPS system equipment including assembly and installation drawings.

D. Single line power diagrams and electrical panel schedule showing the electrical circuit assignments and load required.

E. Submit manufacturer's technical product data for all devices furnished with certificates of compliance, dimensions, capacities, performance, electrical characteristics and start-up instructions.

F. Submit detailed installation work plans and procedures.

G. Submit detailed test plans and procedures for the following:

1. Factory acceptance tests (FAT)

2. Local field acceptance tests (LFAT)

3. Systemwide field acceptance tests (SFAT)

H. Submit test records.

I. Calculations and Certifications

1. Calculations as listed above

2. ISO certifications for all proposed manufacturers

J. As-Built Documentation

1. Submit Shop Drawings with the following information:

a. Wiring diagrams. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

K. Product Data: Submit approved manufacturer's technical product data

L. Submit manufacturer's operating and maintenance instructions for the complete system

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. Uninterruptible Power Systems (UPS)

1. Rectifiers, Battery Banks, and Inverters provided shall have sufficient capacity to support their connected loads plus 50% future load, for a power outage period of not less than 4 hours, while retaining 20% of full charge.

2. The rectifier/charger systems shall be capable of powering their connected loads while simultaneously bringing depleted charge batteries from 20% charge to 100% charge within a 16 hour period.

3. UPS shall be configured for automatic switchover to a bypass mode in the event of UPS battery system and/or inverter failure.

4. Manual bypass shall be provided for maintenance.

5. The UPS systems shall be connected to the SCADA system to implement the alarms via dry contact interface as specified in submittal 28 40 00.

B. Float Battery Systems

1. Float Battery Systems shall have sufficient capacity to support their connected loads plus 50% future load, for a power outage period of not less than 4 hours, while retaining 20% of full charge.

2. The battery system shall be absorbed glass mat (AGM) battery, which are sealed, non-outgassing gel cells and shall be designed such that the batteries shall be automatically disconnected from their associated load should capacity fall below 20% of full charge.

3. The rectifier/charger system, including batteries shall be alarmed via connection to the SCADA system.

4. Float Battery systems shall be connected to the SCADA system to implement the following alarms:

   a. Loss of incoming AC power

   b. Low Battery Reserve

   c. Rectifier Failure

C. DC Power Supplies

1. A -48V DC power shall be provided as indicated

2. Two power supplies shall be sized each to provide 100% of the maximum design load, with 125% of the actual load.

3. Each power supply arrangement shall include an alarm relay with two sets of Form C. The alarm shall activate if either of the shared power supplies fails to provide more than 45% of the load. The relay contacts will be monitored by the station RTU.

D. TC&C & Communications Panel Boards

1. Contractor shall provide the TC&C electrical panel boards and communications panel board as indicated.

2. The panel boards shall be appropriately sized and populated with 25% spare breakers.

2.02 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installations shall comply with NFPA, IBC, IFC, NEC and equipment manufacturers' requirements and procedures.

B. Install all wire and conduit in accordance with manufacturer's recommendations and applicable codes and standards.

C. Furnish and install clamps or other cable-restraining hardware in areas where support is required for cables entering or leaving conduit.

D. Furnish filling compound for cables entering or leaving conduit. The filling compound shall be applied in conformance with manufacturer's instructions.

E. Cable entrance openings in equipment enclosures and junction boxes shall be sealed with compression-type fittings or pliable sealing compound after cable is in place. Sealing compound shall be used to seal area around cable where it emerges from the end of a conduit or junction boxes.

F. Cable terminations shall have permanent cable tags identifying the cable number, the number of copper pairs in the cable.

G. Cable and conductors, which serve as communications links, shall have surge protection circuits installed at each end.

H. Each power supply, including batteries shall be provided and installed as indicated.

I. All equipment shall be grounded in accordance with manufacturer's installation instructions and any local or NEC standards.

3.02 EQUIPMENT MOUNTING

A. The batteries shall be mounted as recommended by the battery manufacturer.

B. Power plug mold strip – Equipment cabinets

C. Contractor shall provide the required sized and rated UL power plug mold strip in each equipment rack or cabinet. The power plug mold strip shall be powered from the UPS AC source as indicated. The plug mold shall be mounted vertically in the cabinet and contain a minimum of 10 power outlets.

D. Standard power source – equipment cabinets

E. Quad receptacles home run from the non UPS AC power source shall be installed in equipment racks or cabinets to provide access for non-critical or battery powered equipment such as test equipment or laptop computers.

3.03 TESTING

A. Field Test

1. Test shall verify the following:

a. Output power levels

b. Output quality

c. Transfer of load to standby source

d. DC equipment holdup in the event of single rectifier failure

e. Backup power holdup times under full load.

f. Accuracy of all meters

g. Proper grounding connections and levels

h. Functionality of all alarms, indications, and control

B. System Integration Test

1. System integration test (SIT) shall be performed after the completion of all individual system testing. Contractor shall submit a complete and detailed SIT plan and procedure for approval.

END OF SECTION 27 01 06

SECTION 27 01 07

COMMUNICATIONS FACILITIES EMERGENCY MANAGEMENT (FEM) SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes the detailed technical requirements for the facilities emergency management system which consist of the Emergency Management Panel (EMP), Auxiliary Emergency Management Panel (AEMP) and Remote CCTV jack box which the Contractor shall design, furnish, install and test under this contract. The Contractor shall furnish all labor, materials, tools, equipment and perform all operations necessary for installing and testing the FEM equipment and accessories.

B. EMP shall include a local SCADA HMI panel for indication and control of station ventilation, seismic detection and elevators, IDS annunciator panel for indication of intrusion alarms, local CCTV workstation and a remote graphic annunciator for fire alarm/gas alarms and trouble indications. Information shall be graphically overlaid on top of station schematics as well as in tabular data format.

C. The water flow and main control valve supervision of the sprinkler and wet standpipe systems at the station shall be established in separate zones.

D. Each vandal resistance EMP cabinet shall be equipped with communications circuits to allow access to local Public Address and SCADA systems.

E. EMP shall be located in the vicinity of the station entrance at concourse or ancillary level from which the fire department will respond. **In addition, the EMP shall be provided at the mid-vent structure.** Locations shall be approved by the FLSC.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 43 Spare Parts, Spare Parts Catalog, and Replacement Materials

D. Section 27 05 56 Safety and System Assurance

1.03 REFERENCES

A. American Society for Quality (ASQ):

1. ASQ Z1.11 Quality Assurance Standards

B. California Building Code

C. Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits 2002

D. National Fire Protection Association (NFPA):

1. NFPA 70 National Electric Code

2. NFPA 72 National Fire Alarm Code

3. NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail.

E. Underwriters Laboratories, Inc. (UL):

1. UL 268 Standard for Safety Smoke Detectors for Fire Protective Signaling Systems

2. UL 864 Control Units and Accessories for Fire Alarm Systems

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, for Quality Assurance requirements.

C. Regulatory Agency Approvals - California State Fire Marshal (CSFM) approval/listing letters

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Complete engineered drawings indicating:

1. Standby Battery Calculations

2. Voltage Drop Calculations

3. Sequence of Operations

C. Interfaces with all connected sub-systems

D. Submit termination and interconnection diagrams for all cable to each component furnished and installed in the EMP.

E. Submit manufacturer's technical product data for all devices furnished with certificates of compliance, dimensions, capacities, performance, electrical characteristics and start-up instructions.

F. Submit detailed installation work plans and procedures

G. Submit detailed test plans and procedures for the following:

1. Local field acceptance tests (LFAT)

2. Systemwide field acceptance tests (SFAT)

H. Submit test records

I. Calculations and Certifications

1. Calculations as listed above

2. Certifications: ISO certification for all proposed manufacturers.

J. EMP zone summaries for all stations; graphically on the station plan views, tabular on the zone alarm display screen, and in tables.

K. Certificate of Completion per NFPA 72

L. As-Built Documentation

1. Shop Drawings with the following information:

a. Wiring diagrams. Clearly differentiate between portions of wiring which is factory-installed and portions to be field-installed.

b. Logic diagrams showing sequence of events and their relationship.

M. Product Data: Submit approved manufacturer's technical product data.

N. Submit Record of Completion per NFPA 72 requirements

O. Submit manufacturer's operating and maintenance instructions for the complete system.

P. Submit complete set of screen shots

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. All equipment and components shall be new and the manufacturer's current model. The materials, appliances, equipment, and devices shall be tested and listed by a nationally recognized approvals agency. The authorized representative of the manufacturer of the major equipment such as EMP/AEMP/Remote CCTV jack box shall be responsible for satisfactory system operation and its certification.

2.02 EMERGENCY MANAGEMENT PANELS (EMP)

A. General Description

1. One EMP shall be provided for each underground station. The EMP shall be the primary fire fighting command center. EMP shall be installed at concourse or ancillary level in proximity to the primary station entrance. The EMP shall be

featured with the capability for Graphic Zone Annunciation and Supervisory Control (GZASC), CCTV camera monitoring and control, Public Address (PA) interface, emergency telephone communication, intrusion detection interface, fire/gas detection interface, seismic detection interface, escalator status, elevator "home" control, ventilation control and monitoring alarm status and station evacuation systems interface.

2. The EMP GZASC shall provide supervisory control for emergency ventilation equipment control and other facilities equipment as required. Fire detection and fire suppression shall be annunciated separately via the remote fire alarm graphic annunciator within the EMP.

3. EMP shall be featured with the following:

   a. Two Emergency telephones (ETEL) with outside direct-dial capability

   b. Public address system access and a supervised circuit microphone for local announcement

   c. Single touch screen for HMI (Human Machine Interface) for emergency ventilation control: graphical control for monitoring and control of station and emergency ventilation, seismic **alarm monitoring** as well as station **releasing fare** gates and **control of homing of** elevators.

   d. Single touch screen for graphical fire/gas annunciator

   e. Intrusion detection panel within the station and ancillary areas feature

   f. Single touch screen CCTV workstation for viewing Metro rail cameras system-wide

   g. Keys necessary for access to all areas of station in nearby lockbox

   h. Designated space for As-built map books and emergency ventilation procedure books.

4. The following requirements shall be met as far as the EMP/ROC Controls and Interfaces:

   a. Each and every EVOP (Emergency Ventilation Operational Procedures) scenario shall have a pre-determined fans/dampers configuration, to be implemented upon activation of a single, discrete command from either ROC or anyone ~~of~~**at** the involved EMPs.

   b. The commands for each and every EVOP scenario originated at ROC and/or involved EMPs shall be sent to all station local controllers involved in the implementation of the respective scenarios.

   c. ROC and/or EMPs shall also be able to command and receive indication of status and alarms for each and all individual fan and/or damper separately.

d. Each and every EMP shall have all its function, EVOP and non-EVOP related, replicated at each and every EMP located at the two adjacent stations on each side (when existing). Therefore, the stations shall be "networked" accordingly. Currently operational stations in the existing systems (if any) are excluded of this requirement.

e. EMPs shall have priority over ROC and shall be able to assume control of all its local functions irrespective of any action originated at ROC.

f. If no EMP is in control then ROC is in control

g. The priority criteria between EMPs shall be as follows:

1) While one EMP is in full control, the other adjacent EMPs (up to 4) shall be able to request such control.

2) The EMP in full control shall receive an indication of such request.

3) The EMP in full control shall have up to 1 minute (with variable settings) to concede or deny the request for full control by the requesting EMP

4) If no action is taken by the EMP in full control within the set time, such control shall be automatically given to the requesting EMP.

5) In case of failure of any local controller, the respective EMP will have its controls relinquished, and send an alarm to SCADA.

~~5)~~**6) If the F&EM PLC detects that the EMP is offline, then the control shall revert to the ROC**

B. Design Criteria:

1. The EMP shall be ~~an~~**the** intuitively operated touch screen (with back-up keyboard/mouse) used to monitor and control emergency events in an underground station. It shall have graphical representations of the facilities, with detailed screens accessed from an overview map, which will show key events using Metro's icon system. Additionally, all alarms shall be shown on tabular screens.

2. Emergency ventilation controls and indications shall be graphically accessed, and shall show the complete ventilation area.

3. When active, the EMP shall have control priority over central control of the emergency ventilation. Alarm and indications shall be reported to the EMP and the central control regardless of which entity is in control.

4. EMP shall have the capability of controlling multiple ventilation zones at adjacent stations served by separate SCADA RTU.

5. EMP shall provide the capability to control and monitor individual HVAC equipment in response to smoke/fire and/or gas/seismic detection at the station to implement the following:

a. Emergency Ventilation Operating Procedures (EVOP)

b. Emergency Gas Operating Procedures (EGOP)

c. Emergency Seismic Operating Procedures (ESOP)

6. EMP shall have EVOP group scenario control of the station associated with the ventilation scenario.

7. EMP shall have the features to monitor and control CCTV cameras at the station.

8. The location of EMPs and their ventilation zone assignments shall be coordinated with the local Fire Department having jurisdiction. The design of the EMP shall be coordinated with Metro who will provide screen shots of EMPs currently in use.

9. F&EM PLC requirements:

a. Redundant CPU.

b. Redundant power supply fed from separate circuits.

~~8.~~**c. Continuously supervised redundant remote IO data links.**

C. EMP Cabinet Construction

1. The EMP shall be housed in a stainless steel cabinet with locking doors. Piano type hinges running the length of the doors shall be provided. The left hand Liquid Crystal Display (LCD) door face shall be ½" thick lexan. The remaining doors shall be of stainless steel. A two-inch flange shall be incorporated into the housing, extending from the perimeter to cover gaps between the block out and the cabinets. The housing shall incorporate supporting flanges for doors, and constructed for all doors to fit snugly. Locks shall be installed on all doors and should be keyed the same as other Red Line EMPs (coordinate with Metro locksmith). The EMP cabinet shall comply with the following equipments requirement:

a. Telephone panel with two emergency telephones

b. One public address panel with microphone and selector panel

c. **One** HMI workstation~~s~~ supervised by the ~~SCADA RTU~~**F&EM PLC** and alarm to SCADA on loss of communications, one 21" flat-screen rack mounted color graphic monitor (LCD), with drawer slides for extension of LCDs out of EMP cabinet for maintenance purposes.

d. One fire /gas alarm graphic annunicator and an EVAC microphone interfaced with the FACP. One 21" flat-screen rack mounted color graphic LCD monitor, with drawer slides for extension of LCDs out of EMP cabinet for maintenance purposes.

e. One IDS intrusion panel

f. Cooling slots at top and bottom of cabinet for ventilation

g. Conduit entry and wiring space in the back of the cabinet

h. Wiring terminations secured at the back of equipment openings for:

1) LCDs - Video cable terminations

2) Fire alarm graphic annunciator and EVAC microphone

3) Intrusion panel

4) PA panel - barrier type terminal block

5) Telephone panel - barrier type terminal block

6) Power strip - for power distribution

7) Fare gate release key switch

8) EMP intrusion alarm contacts

D. Controls and Indications

1. Alarms shall be divided into subcategories:

a. Gas monitoring

b. Seismic detection

c. Intrusion detection

d. Facilities/ventilation control

e. CCTV cameras monitor and control

f. Fire and gas alarms shall be annunciated on the graphic annunicator for remote monitoring.

2. Each alarm indicator shall be labeled with the geographic location of the event. Gas monitoring indicators shall also identify the sampling point by number.

3. Under default operation only the fire detection and fire suppression alarm zones will be annunciated at the EMP on the graphic annunciator. The alarm zones shall be accompanied by an audible sound. Upon detection of the alarm, the following shall occur:

a. The device symbol and the border around the affected floor plan segment shall be flashing.

b. All devices in alarm shall be indicated in an operator selectable alarm/trouble summary table Sub-Control Menus. Device type and exact location shall be listed.

4. Alarm acknowledge: Each alarm category shall be provided with an acknowledge control. Upon operation of the control, the alarm indicator shall go steady and the audible shall silence. The indicator shall de-activate when the alarm condition is remedied only after the alarm has been reset at its source. If the alarm condition is not remedied at its source, then, the audible alarm (as applicable) will again sound.

5. Facilities/Ventilation Controls and Indications:

    a. Status & Control shall be provided for the following station ventilation equipment:

        1) Emergency Ventilation Fans (EVFs), including Booster Fans (BFs)

        2) Group shutdown control of all ancillary supply & exhaust fans

        3) Station Emergency Ventilation Operating Procedures (EVOP) equipment control scenarios

    b. Status shall be provided on the Emergency Gas Operating Procedures (EGOP) screen for the following equipment:

        1) Supply Fans (SFs)

        2) Exhaust Fans (EFs)

        3) Air Conditioning Control Panel (ACCP)

        4) Air Conditioning Unit (ACU)

        5) Fire Smoke Dampers (FSD)

    c. Status & Control of Track & Emergency Dampers shall be provided in Sub-Control Menus.

    d. Open/close status for combination fire smoke damper shall be displayed on the remote fire graphic annunciator.

E. Equipment annunciation at the EMP:

1. Fans shall have distinguishing icons showing the fan type, identification number and status. Fan status shall be indicated by the rotation of a graphic icon propeller located within the fan symbol and an arrow, which shall be keyed on indication of airflow. Directional arrows shall appear in the icon vane indicating exhaust and supply airflow.

2. Dampers - Emergency Dampers (ED's), Bypass Dampers (BD's) and Track Dampers (TD's) shall be displayed upon change of status. Dampers shall have distinguishing icons showing their identification number and status.

F. Point of Control:

1. Each fan group shall provide indication and control at the ROC and at the EMP.

2.03 AUXILIARY EMERGENCY MANAGEMENT PANELS (AEMP)

A. Auxiliary Emergency Management Panels (AEMP) shall be provided at underground passenger stations which have a secondary entrance shall be used to augment the functions of the EMP. The AEMP shall contain:

1. Emergency telephone (ETEL)

2. Capability for facilitating evacuation of patrons, including controls for homing of elevators, and releasing fare gates.

3. PA system access

4. Intrusion detection alarm

2.04 REMOTE CCTV JACK BOX

A. A remote CCTV jack box shall be provided outside of the station at-grade level in order to manage incidents where entry into the station is not accessible. **CCTV jack box also needs to have an intrusion bug, and signage inside listing ROC's phone number.** The exact location shall be coordinated with the FLSC.

B. **The locks for the EMP, AEMP, and CCTV box needs to be compatible with the Metro keying scheme. Appropriate locks and keys need to be coordinated with the Metro key shop, and need to be same as existing EMP keys.**~~The remote EMP lock(s) should be keyed the same as the EMP.~~

C. The weather-proof remote CCTV jack box enclosure shall include the following:

1. MTEL RJ-11 plug

2. Network port (RJ45) for connection of emergency responder laptop

3. Power jacks (GFCI duplex receptacle)

4. Intrusion alarm

D. Two KNOX boxes shall be installed adjacent to the remote CCTV jack box for LASD and fire department to access to the key.

E. Network Requirements

1. A dedicated industrial firewall shall be provided for each remote CCTV jack box.

2. The firewall shall be configured with an outside zone for the remote CCTV jack box port and an inside zone connected to the local station network router.

3. The firewall shall only permit the port and protocols from the outside zone necessary for the following functions:

a. Web-based access to the CCTV system

4. The firewall shall be configured with simple network management protocol (SNMP) traps and other capabilities to allow remote monitoring of the following by the Metro provided network management system:

a. Failure of the firewall device

b. Network intrusion detection

c. Firewall blocked traffic

d. Enable DHCP to provide an IP address for emergency responder laptop to connect to the CCTV network.

5. Emergency responder laptop shall be connected via network port to local firewall and router/switch in TC&C room via local area network.

F. The CCTV system shall have a web-based interface so that the emergency responder's laptop only needs a web browser to call up cameras.

2.05 CONDUIT AND WIRE

A. As minimum requirements, the contractor shall provide the conduits specified.

B. The Emergency Management Panel (EMP) shall be provided with four (4) three inch (3") conduit and two (2) one inch (1") which shall run directly from the EMP to the TC & C room.

C. The remote CCTV jack box shall be provided with three (3) two inch (2") conduits which shall run directly from remote CCTV jack box to the TC & C room.

D. The Auxiliary Emergency Management Panel (AEMP) shall be provided with two (2) two inch (2") conduits which shall run directly from the CP to the TC & C room.

E. Fire and Emergency Management conduits shall be embedded GRS conduits for various types of detectors, sound powered telephones and emergency annunciation cabinets/panels.

2.06 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. The Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed as shown in the Contract Drawings.

B. The installation of the EMP shall comply with NFPA 70, Article 760.

C. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.

D. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.

E. Cable must be separated from any open conductors of Power, or Class circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29.

F. Cable and conductors shall have surge protection circuit installed at each end.

G. Wiring shall be in conduit in accordance with local, state and national codes and as recommended by the manufacturer.

H. T-Tapping shall not be allowed

I. All equipment shall be grounded in accordance with manufacturer's installation instructions and any local or NEC Standards.

3.02 TESTING

A. Operational testing shall be accomplished by a specialty subcontractor, licensed and certified for EMP Design, installation and testing by the State of California.

1. Factory Acceptance Test - Factory Acceptance Test shall verify that each unit is defect free and ready for shipment. All functional and specification requirements shall be verified at the factory prior to shipping the project site.

2. Field Test

a. As a minimum, the test shall include:

1) Test all inputs, outputs, and functions of the EMP

2) Measure audible alarms output level

B. System End-to-End Acceptance Test

1. Contractor shall provide a local end-to-end test procedure for the EMP/AEMP/remote CCTV jack box at every station to show the proper functionality and performance.

2. Contractor shall provide qualified technical staff to support the end-to-end testing of the EMP/AEMP/remote CCTV jack box equipment.

3. System Integration Test

a. System Integration Test (SIT) shall be performed after the completion of all individual system testing. Contractor shall submit a complete and detailed SIT plan and procedure for approval.

END OF SECTION 27 01 07

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SECTION 27 13 00

COMMUNICATIONS CABLE TRANSMISSION SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Detailed technical requirements for the cable transmission system (CTS) to be designed, furnished, installed and tested under this Contract. The CTS consists of the synchronous optical network (SONET) add-drop multiplexers (ADM), network switches, media converter, main distribution panel (MDF), fiber distribution panel (FDP), outside plant cable (OSP) and the inside plant cable (ISP). The SONET ADM shall provide integrated Ethernet services to support video, voice and data services in the passenger stations and tunnel areas. The Westside Extension (WSE)'s SONET OC-48 subring network topology structure, Unidirectional Path Switched Rings (UPSR), consisting of a node at all passenger station shall be connected to the Metro's OC-192 node at Wilshire/Western Station.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

~~B.~~**C. Section 01 78 43 Spare Parts, Spare Parts Catalog, and Replacement Materials**

1.03 REFERENCES

A. American National Standards Institute (ANSI):

1. T1.101 Synchronization Interface Standards for Digital Networks

B. Code of Federal Regulations (CFR):

1. 7 CFR 1755.900(p) Measurement of Fiber Point Defects Using an OTDR

C. Electronic Industries Association (EIA)/Telecommunications Industry Association (TIA):

1. TIA/EIA-472 Generic Specification of Fiber Optic Cables
2. TIA/EIA-598-B Optical Fiber Cable Color Coding
3. EIA/TIA 232 Standard for Employing Serial Binary Data Interchange
4. EIA 485 Standard for Balanced Digital Multi-Point Systems

5. EIA-310-D — Cabinets, Racks, Panels, and Associated Equipment

D. Electromagnetic Compatibility (EMC):

1. EMC Emission — EN55022 Class A

E. Insulated Cable Engineers Association (ICEA):

1. ANSI/ICEA S-87-640 — Standard for Outside Plant Communications Cable

2. ANSI/ICEA S-83-596 — Standard for Fiber Optic Premises Distribution Cable

F. International Electro-technical Commission (IEC):

1. IEC 61000 — Electromagnetic Compatibility (EMC)

2. IEC 60529 — Ingress Protection (IP) 66

G. Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE 802.3 — Ethernet LAN

2. IEEE 802.3af — Power over Ethernet (PoE)

H. International Telecommunication Union (ITU):

1. ITU-T G.652.D — Characteristics of a Single-mode Optical Fiber and Cable

I. National Fire Protection Association (NFPA):

1. NFPA 70 — Article 770, Optical Fiber Cables and Raceways

J. Simple Network Management Protocol (SNMP):

1. SNMPv1 and v2 — Network Management Protocols

K. Telcordia:

1. GR-20-CORE — Generic Requirements for Optical Fiber and Optical Fiber

2. GR-409-CORE — Generic Requirements for Premises Fiber Optic Cable

3. GR-326-CORE — Single-mode Optical Connectors and Jumper Assemblies

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, Safety and System Assurance, Section 1.04 for Quality Assurance requirements.

C. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in Subsection 1.03 – References.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Plan drawings showing the location of the CTS equipment and the interconnection diagrams for all outside plant (OSP) fiber optic cable provided and installed under this contract.

C. Rack layouts and elevations for CTS equipment including assembly drawings, shelf layout and inventory within equipment chassis.

D. Fiber optic link loss budgets for all fiber optic spans installed. Calculations shall show total anticipated optical loss in dB for each span compared to the published link or span loss budget for that particular piece of optical transmission gear.

E. Detailed hardware interface and installation details.

F. Detailed plan required to modify the existing CTS equipment to add voice, video and data services for the subsystems provided under this contract.

G. ~~Provide IP (Internet Protocol) addressing of all networked equipment.~~**Not Used.**

H. Termination and interconnection diagrams for all cable to each component furnished and installed under this Contract. Include any intermediate terminations to the MDF, FDP or cable protection equipment terminal block assignments.

I. The cable wiring schedule

J. Detailed installation work plans and procedures

K. Drawings and Diagrams

1. Cable pair and fiber strand usage diagrams.

2. MDF and FDP wiring and termination assignments

L. Installation Procedures

1. Cable pulling layout including distances and tension calculations for each installation

2. Pulling equipment and tension monitoring devices including the chronological plan for installing cable for each pull and plan for protecting cable on –reel and in slack loops during installation.

3. SONET ADM equipment, media converter and Ethernet switches

4. Fiber Distribution Panel (FDP)

5. Splice and termination testing procedure

M. Manufacturer's technical product data for all devices furnished with certificates of compliance, dimensions, capacities, performance, electrical characteristics and start-up instructions

N. Detailed test plans and procedures for the following:

1. Factory acceptance tests (FAT)

2. Local field acceptance tests (LFAT)

3. Systemwide field acceptance tests (SFAT)

O. Test records

P. Calculations and Certifications

1. Calculations as listed above

2. ISO certifications for all proposed manufacturers

Q. Equipment mounting details and power requirements

R. As-Built Documentation

S. Shop Drawings with the following information:

1. Plan diagram showing location of all CTS equipment

2. Wiring diagrams - clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

3. Logic diagrams showing sequence of events and their relationship

4. Sequence of operation

5. Point-to-point wiring diagrams indicating terminal-to-terminal connection between system components

6. Detailed information for all programmable equipment together with the associated passwords and access codes

T. Product Data

1. Approved manufacturer's technical product data

U. Manufacturer's operating and maintenance instructions for the complete system

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. Functional Requirements

1. The CTS system shall operate in a SONET ring arrangement, with self-healing equipment in **the** event of a fiber **optical cable** break or equipment failure. **Redundant cable paths, with space diversity, must be employed to make possible this self-healing ring capability needed to provide fault-tolerant reliability for all functionally critical nodes.** Self-healing shall complete fast enough to avoid dropping the active telephone calls. **All equipment comprising the CTS shall have carrier class reliability. The backbone design must not have any single point of failure.**

2. As a minimum, SONET backbone rings should consist of two fiber cables with 144 or above single mode fiber strands.

~~B.~~

~~1.~~**3.** Full featured CTS management tools shall be included to allow system configuration and alarms to be managed from a single remote location. Maintenance and diagnostic capabilities shall be provided at each local node

~~2.~~**4.** Bandwidth and Quality of Service (QoS) shall be allocated in accordance with the specific subsystem requirements (e.g., TPIS, Telephone, etc).

~~C.~~**B.** Network Backbone System

1. The CTS shall be an optical fiber-based system to mitigate electrically-induced interference to the communications system. Fiber optic terminal equipment shall be equipped for 1:1 protection. The WSE's nodes shall be interconnected by optical fibers to operate as two physically separated fiber optic rings for redundancy and shall be installed in dedicated conduits in the system-wide duct bank and wire-way along the right-of-way with all local distribution cables. Ethernet connectivity shall be provided for station equipment and wayside equipment to communicate with the ROC.

~~D.~~**C.** Design Criteria

1. The CTS shall include the following components:

   a. Fujitsu Flashwave 4500 SONET ADM (Metro furnished)

   b. LAN Network switching and routing equipment

   c. Electro-optic Modulators or Optical Transmitters (sources), converting an electrical signal input to an optical signal by modulating a light source shall transmit information via an optical fiber of the fiber optic transmission link. Sources shall be capable of operation at a data rate compatible with the type of data transmitted.

   d. Optical Cable

1) All outside main backbone optical fiber cable shall be loose tube ribbon and gel-filled. Two (2) fiber strands each from two separate 144 singlemode fiber cables shall be provided to support the CTS subsystem plus future extensions. Safety-critical signals will be backed up by another independent transmission path.

2) All local distribution cables shall be placed in galvanized rigid steel conduit or totally enclosed raceway.

3) The backbone and local distribution fiber optical cables shall meet the following requirements:

a) Indoor/outdoor Optical Fiber Non-Conductive Plenum (OFNP) Loose Tube with Enhanced (Low Water Peak) Single mode optical fibers

b) Class Iva dispersion, unshifted single mode fibers with low waterpeak

c) The zero dispersion wavelength shall be between 1300 nm. The ANSI/EIA/TIA 455-168 maximum value of the dispersion slope shall be no greater than 0.090 ps/km/nm^2.

d) Optical transmission losses shall not exceed the 0.5 and 0.4 dB/km loss for 1310 and 1550 nm respectively.

e) Fiber shall be marked with an OFNP and OFNP FT-6 Flame Rating

f) Temperature range shall be from -40° to +75°C

g) Fiber Optical cable shall comply with NFPA 72 and NFPA 130 Code and EIA/TIA 568B

h) Fusion splice loss shall not exceed .02dB

~~g)~~

e. Local Distribution - Copper Cables

1) Local CTS distribution for video, voice and data circuits copper cables.

2) All outside plant cables shall be 22 AWG minimum, gel-filled, foam/skin insulated conductors that meet Rural Electrification Administration (REA) PE-89 and shall be gopher-protected. All cables shall be sized for initial requirements plus 25%. Outside plant cable shall not be less than 12 pairs. All outside main and riser-paired cables shall be shielded.

3) All main riser cables shall be 22 AWG minimum, and shall meet REA PE-22 or PE-89.

4) Inside wire from distribution terminals to instruments shall be 22 AWG minimum, and have a characteristic impedance of 105 ohms + 15%.

5) Optical parameters of the connectors shall meet the requirements of TIA/EIA-568.

f. Fiber Distribution Panels

1) Enclosure

a) The enclosure shall house the splice shelf and connector sleeve panels for all optical connections, as a minimum the enclosure shall be capable of providing 288 connections for singlemode.

b) All OSP cable jackets and central strength members shall be secured to relieve strain.

g. Fiber Connectors and pigtails

1) FDP connectors shall be SC type, unless otherwise directed.

2) Patch cords shall be complete factory fabricated assemblies from manufacturer's standard product lines.

3) Connectors for media converter equipment shall be SC type. Jumpers cables shall be provided that match the connectors at each end of the cable.

4) Pigtails shall be cable assemblies consisting of flexible optical fiber cable with SC compatible connectors.

Connector loss shall not exceed .5dB.

~~4)~~**5)**

h. Fiber Slack Enclosure (FSE)

1) Enclosures shall be NEMA-12 type with hinged cover and securing mechanism.

2) Enclosures shall be sized for 300 feet of cable slack.

3) Hardware

a) Hooks shall be provided to hold cable slack, with coils of required bend radius.

b) Velcro ties to restrain cable shall be utilized

4) 2-4” GRS conduits will be installed from the FSE mounted to the wall to the cable tray.

i. **DC Power Supply and** Fuse Panel

1) 48VDC Power Supply and Fuse Panel A -48V DC power shall be provided in the following configuration: two power supplies each sized to provide 100 percent of the maximum design load, which shall be 125 percent of the actual load. Each power supply shall power an individual fuse panel located in each communications equipment rack.

2) Each power supply arrangement shall include an alarm relay with two sets of Form C contacts (2 NO and 2 NC) rated at 48 VDC and 1 Amp. The alarm shall be activated if either of the shared power supplies fails to provide more than 45 percent of the load. The relay contacts will be monitored by the station RTU, programmed, and forwarded to the Supervisory Control System at ROC.

2.02 MAJOR COMPONENTS

A. SONET Add-Drop Multiplexers (Metro furnished)

1. Fiber Optic SONET ADM node shall be Fujitstu Flashwave 4500. The FLASHWAVE 4500 is a multiservice broadband transport element that provides a variety of advanced transport, add/drop, and switching capabilities within single compact shelf. The FLASHWAVE 4500 shelf fits in a standard 23-inch rack.

B. System Description

1. The FLASHWAVE 4500 system supports a wide range of applications:

a. OC-48 and OC-192 line optics (plus STM-16 and STM-64)

b. DS1, DS3, EC-1, OC-3/-3c, OC-12/-12c, OC-48/-48c, and 10/100/1000-Mb/s Ethernet service connections (including STM-1, STM-4, and STM-16)

c. 10/100Base-T and gigabit Ethernet interfaces for point-to-point Ethernet-Over-SONET (EOS) applications up to full wirespeed

d. Full 864x864 STS nonblocking switch matrix for grooming ring interconnections, hairpinning, time-slot interchange (TSI), broadcast, and multiple ring support

e. Optional 1344x1344 VT1.5 nonblocking switch matrix

f. Unrestricted mix and match of OC-3, OC-12, and OC-48 unidirectional path-switched ring (UPSR) configurations

g. Two 2-fiber bidirectional line-switched ring (2F-BLSR) nodes (OC-48, OC-192)

h. The ability to protect or not protect individual STS-1s and VT1.5s

i. Extra switch module slots for future enhancements

j. Narrowband, tunable, OC-48 and OC-192 optics for direct connection to metro dense wavelength division multiplexing (DWDM) systems

2. The FLASHWAVE 4500 supports multiple network architectures:

a. Terminal and linear add/drop (unprotected)

b. Terminal and linear add/drop (1+1)

c. UPSR

d. 2F-BLSR

3. Physical Architecture

a. The FLASHWAVE 4500 supports all applications, including terminal, linear add/drop multiplexer, UPSR, bidirectional line-switched ring (BLSR), optical hub, and small digital cross-connect system (DCS) from a single shelf. The FLASHWAVE 4500 system contains three logical sections:

1) Flexible service slot section

2) STS switching section

3) Management section

4. Functional Description

a. Interface plug-in units ranging from DS1 through OC-192, 10/100 Base-T, Gigabit Ethernet, and 2.5-Gb/s VT1.5 switch fabric are supported by the FLASHWAVE 4500 system. The centralized, high-density STS switch fabric plug-in unit provides 864x864 STS-1, -3c, -12c, and -48c switching capabilities across all interface types. CPU, clocking, data communications channel (DCC), alarm and status, and equipment switching functionality are all available via the I/O bus.

5. Traffic Interface/Switching Units

a. Various interface cards transmit and receive data signals to and from the shelf. The signals are processed and routed to the switch-fabric interface card where further routing is accomplished.

6. Traffic Support Units

a. The traffic support units provide various functions, such as DS3/EC-1 switching, alarm and status monitoring, and timing for the traffic-interface units.

7. System Management Units

a. The system management units provide overall command and control functions for the shelf. These units contain the system software that monitors and controls system operation, configuration, and user-interface commands. These units also contain the provisioning database for the shelf and provide local and remote communications interfaces.

8. Power Distribution

a. Power requirements for the shelf are provided by redundant –48 V DC inputs via DC inputs to the backplane of the FLASHWAVE 4500 shelf. The –48 V DC input is routed to the appropriate units where further conversion takes place, depending on the requirements of the unit. A Circuit Breaker Panel (CBP) with associated 25-A circuit breakers is recommended by Fujitsu Network Communications, Inc. (FNC) for power distribution. Also, 25-A breakers are recommended to provide a 2X margin to the typical maximum shelf loading of 12.5 A. The system is capable of supporting breakers up to 30 A.

9. System Features

a. The FLASHWAVE 4500 system is a next-generation, multiservice, optical transport element that optimizes the simultaneous delivery of traditional and next-generation services over a broad range of metropolitan transport networks. Through its next-generation functionality, the FLASHWAVE 4500 system can absorb multiple network elements into a compact, customer-standard shelf. This allows networks to realize immediate capital and operational savings while expanding their service-offering capabilities. The platform supports various features and capabilities, including the following:

1) Supports optical transport rates (OC-3, OC-12, OC-48, and OC-192)

2) Supports electrical transport rates (DS1, DS3, and EC-1)

3) Supports data transport of 10-, 100-, or 1000-Mb Ethernet (including full wirespeed gigabit Ethernet)

4) Supports multiple rings and configurations, including the following:

a) One OC-192 ring with 100 percent drop capacity

b) Four OC-48 rings with 100 percent drop capacity

c) Optical hub for up to eight OC-48 rings

d) Optical hub for up to 34 OC-12 rings

e) Optical hub for up to 40 OC-3 rings

5) Supports broadcast transport for switched video applications

6) Supports VT1.5, STS-1, STS-3c, STS-12c, and STS-48c payloads

7) C-band amplifier (optional for OC-48 and OC-192 narrowband optics)

8) Short-reach, long-reach, and narrowband optics availability

9) In-service wavelength change for narrowband optics

10) In-service upgrade for OC-n optics

11) Automatic in-service provisioning

12) Twenty flexible service-interface plug-in slots

13) Full SONET and Synchronous Digital Hierarchy (SDH) transport support

14) Efficient transport of video, data, and voice signals

15) Centralized 864 x 864 STS-1 cross-connect matrix (45 Gb/s)

16) Optional 1344 x 1344 VT1.5 cross-connect matrix (2.5 Gb/s)

17) Multiple system applications:

    a) Linear (all OC-n, up to OC-48)

    b) Terminal (all OC-n)

    c) Unidirectional path-switched ring (UPSR)—VT1.5 and STS (all OC-n)

    d) Two-fiber bidirectional line-switched ring (2F-BLSR) (OC-48, OC-192, two maximum)

    e) Unprotected

18) Multiple network applications

    a) Terminal hub

    b) Linear mesh

    c) Subtending rings

    d) Ring-on-ring

    e) Integrated dual-node ring (2F-BLSR)

    f) Virtual rings (UPSR)

    g) Ring interconnection (UPSR, BLSR)

h) Ethernet point-to-point transport

19) Full interoperation capability with the following platforms:

a) Fujitsu Lightwave Multiplexer (FLM): FLM 150, 600, and 2400 ADMs (software download [SWDL]-based)

b) FLASH®-192 transport system (terminal and UPSR, 2F-BLSR)

c) FLASHWAVE 4100 and 4300 (terminal, UPSR and 2F-BLSR)

d) FLASHWAVE 7100 (OC-48 and OC-192)

e) Full operation, administration, maintenance, and provisioning (OAM&P)

f) DS1 and DS3 test access with Spirent layer-1 BERT equipment

20) Auto concatenation detection (STS bundling)

21) Operating environment:

a) Temperature (–5 to +50 ºC or 0 to +50 ºC with Ethernet interfaces)

b) Humidity (5 to 95 percent)

22) Compliance:

a) NEBS 3 (EMI)

b) FCC, Part 15, Section J

2.03 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Contractor shall be responsible for installation of all communications equipment including the Metro furnished Fujitsu Flashwave 4500.

2. Installations shall comply with NFPA, IBC, IFC, NEC and equipment manufacturers' requirements and procedures.

3. Install all wire and conduit in accordance with manufacturer's recommendations and applicable codes and standards.

4. Furnish and install clamps or other cable-restraining hardware in areas where support is required for cables entering or leaving conduit.

5. Furnish filling compound for cables entering or leaving conduit. The filling compound shall be applied in conformance with manufacturer’s instructions.

6. Cable entrance openings in equipment enclosures and junction boxes shall be sealed with compression-type fittings or pliable sealing compound after cable is in place. Sealing compound shall be used to seal area around cable where it emerges from the end of a conduit or junction boxes.

7. Cable terminations shall have permanent cable tags identifying the cable number, the number of copper pairs in the cable.

8. Cable and conductors, which serve as communications links, shall have surge protection circuits installed at each end.

9. All equipment shall be grounded in accordance with manufacturer's installation instructions and any local or NEC Standards.

B. Fiber Installation

1. All LAN fiber optic cable shall be installed in innerduct. OSP fiber optic cable shall be installed in the orange innerduct. Duct bank conduit serving fiber optic cable shall contain three 1-1/4 inch innerducts each. No more than one OSP fiber optic cable shall be installed in a single innerduct without Metro’s approval. The innerduct shall be installed without coils or twists.

2. If a winch or pulling machine is used during installation, a dynamometer shall be used to monitor the tension on the cable. The dynamometer shall be certified as calibrated and shall hold the peak value of the cable pull. The peak value shall be recorded and forwarded to the Metro as part of the installation test data submittals.

3. Contractor shall not exceed the cable's minimum bend radius for cable under tension or long term installation/storage.

4. Continuity of cable shall be maintained between termination or splice locations. Additional splices shall not be allowed without the approval from Metro.

5. All cable entrance openings in equipment enclosures, rooms and junction boxes shall be sealed with either a compression type fitting or pliable sealing compound after the cable is in place. Sealing compounds for rooms, houses, walls, or other partitions shall be fire retardant per ASTM E-814. Sealing compound shall be used to seal the area around cable where the cable emerges from the end of a conduit, pipe, or duct bank. All spare conduits shall be sealed or plugged in an approved manner.

6. Cable shall be installed through conduit installations and pulled through conduit with wire or synthetic rope with a tension to not exceed 90 lbs.

7. Fittings shall not cause fiber cable to make sharp bends or pressed against corners and shall not require a 90° turn.

8. Pull tension shall be monitored with a line tensiometer or equivalent and cable lubricant shall be used.

9. Termination

   a. Slack in FDP's shall be restrained and shall be sufficient for strain relief.

   b. The central strength member of cable shall be attached to the FDP. The outer jacket of cable shall be attached to the FDP with a cable clamp.

   ~~c.~~ All fiber optic splices shall be fusion splices. Fusion splicing shall be performed by qualified personnel utilizing a splicer equipped with local injection and detection (LID) to optimize splices. ~~The loss across each spliced fiber shall be less than or equal to 0.04 dB.~~

   ~~d.~~**c.** Splice enclosures shall be used as appropriate for terminating ends.

   ~~e. Splicing shall be done with fusion splices only and shall not have a splice loss to exceed 0.1 dB.~~

      1) All fiber optic installations shall be provided an end-to-end power meter test and a trace by a calibrated OTDR at 1310 and 1550 nm.

C. Copper Cable Installation

1. Wires and cables shall be continuous without splices between junction boxes, terminals, pull boxes, manholes and hand holes. Cables shall not be bent to a radius less than the greater of 20 times the diameter of the cable or the manufacturers' recommended minimum bending radius, during installation or as finally installed.

2. Contractor shall develop a written cable installation procedure and check-off list for approval prior to the field installation. The installation plan shall include proper procedures for feeding cable into conduit to maintain proper bend radii and to minimize friction.

3.02 TESTING

A. The Contractor shall perform the following inspections and tests on the CTS including the Metro furnished Fujitsu Flashwave 4500:

1. Factory Testing

   a. Fiber Optic Cable

      1) Cable shall be tested on-reel prior to shipment

2) End to end loss shall be recorded for each fiber at 1,310 nm and 1,550 nm

3) End to end loss shall be recorded for each multi-mode fiber at 850nm and 1,310 nm.

4) OTDR with hardcopy record shall be provided for each singlemode fiber at 1,300 nm and 1,550nm

5) OTDR with hardcopy record shall be provided for each multimode fiber, at 850 nm and 1,310nm.

b. ADM equipment

1) Factory Testing shall be conducted on individual equipment or assembled subsystems after all mounting, installation, wiring and other activities to support turn-up are complete.

2) Optical light levels for all optical ADM cards (working and protect)

3) Port-to-port continuity and wiring polarity testing between DSX and fiber distribution panels and all wired or patched equipment ports.

2. Field Testing

a. Fujistsu Flashwave 4500

1) The Contractor shall perform the following field tests:

a) Confirmation items before testing

i) Visual Inspection

ii) Shelf power verification

b) Synchronization reference switching test

i) Automatic Switching of Line Timed Node

ii) Manual Switching of Line Timed Node

iii) Forced Switching of Line Timed Node

iv) TCA Unit Automatic Protection Switching

c) Testing for UPSR Configurations

i) Verifying Fiber Connections

ii) Circuit Testing–DS1/DS3

iii) Testing DS3 Automatic Protection Switching

iv) Circuit Testing–OC-n Interfaces

v) Testing Optical Path Protection Switching

vi) Testing Switch Fabric

vii) Optical Path Fade Testing

viii) Deprovisioning of Test Channels

b. Fiber Optic Cable

1) Fiber optic cabling link installed by the Contractor shall be tested in accordance with the field test specifications defined by the TIA standard TIA-568-B.1-3.

2) All cables shall be OTDR tested at 1310 nm and 1550 nm operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.

OTDR tests shall be performed utilizing a pulse suppressor such that the FDP termination shall be shown.

3) All OTDR testing procedures and field-test instruments shall comply with applicable requirements of:

a) TIA-455-133-A

b) TIA-455-78-B

4) Each fiber link and channel shall be tested in one direction.

c. Copper Cable Tests

1) Insulation Resistance Tests

a) Tests shall be performed on all cables entering or leaving houses, after the cables are terminated.

b) Disconnect external apparatus prior to performing the test.

c) The Contractor shall verify conductor-to-ground resistance.

d) The Contractor shall verify conductor-to-conductor resistance for each pair.

e) Record all data on an approved test form.

f) DC Loop Resistance Test

~~g)~~**d.** Media Conversion Link Tests

~~d.~~**1)** The Contractor shall measure and record output power at the optical port of each media converter's transmitter output and at the fiber cable connector serving each media converter's receiver input.

~~1)~~**2)** The Contractor shall perform Ethernet link testing between media conversion devices. The field test shall include all applicable test requirements of RFC 2544 and as a minimum shall include the following test to verify compliance with the manufacturer's specifications:

~~2)~~**a)** Throughput testing to find the highest rate at which the media converter can forward frames

~~a)~~**b)** Frame Loss tests to show how the media converter responds to streams with different gaps separating the frames.

~~b)~~**c)** Back-to-back tests to show how the media converter responds to different quantities of frames, with the frames separated at the minimum gap allowed by IEEE 802.3 protocol specifications.

~~c)~~**e.** Test Results

~~e.~~**1)** Reflective events shall not exceed -40 dB

~~1)~~**2)** Connections shall not exceed ~~0.75 dB for multimode, and~~ 0.~~6~~**5 dB** for singlemode of attenuation.

~~2)~~**3)** Non-reflective events (splices) shall not exceed 0.~~3~~**02** dB.

~~3)~~**4)** Point discontinuities shall not exceed 0.1 dB in continuous fiber.

~~4)~~**5)** ORL shall be less than -30 dB.

~~5)~~**6)** OTDR Test results shall include OTDR link and channel traces and event tables at the required wavelength(s) and the length for each optical fiber as calculated by the OTDR.

~~6)~~**7)** An Optical Spectrum scan of each link shall be performed using an optical spectrum analyzer and optical switch to examine fiber nonlinear effects including but limited to Brillouin scattering and four waves mixing across the fiber's usable light spectrum.

f. Cable Plant Test Result Documentation

1) The test result records saved by the test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records.

2) The database records of all fiber shall be stored and delivered on CD-ROM and shall include the software tools required to view, inspect, and print any selection of test reports.

3) The identification of the link in accordance with the naming convention defined in the overall system documentation.

4) The overall Pass/Fail evaluation of the link-under-test including the Attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value).

5) The date and time of the test results

6) General Information to be provided in the electronic data base containing the test result information for each link:

a) The overall Pass/Fail evaluation of the link-under-test

b) The name of the standard selected to execute the stored test results

c) The cable type and the value of the 'index of refraction' used for length calculations

d) The date and time the test results were saved in the memory of the tester

e) The brand name, model and serial number and calibration data of the tester

f) The revision of the tester software and the revision of the test standards database in the tester

g) Test results data to be provided in the electronic database for each tested optical fiber shall contain the following information.

h) The identification of the link/fiber in accordance with the naming convention defined in the overall system documentation

i) The insertion loss (attenuation) measured at each wavelength

j) The link length shall be reported for each optical fiber for which the test limit calculated based on the provided formulas above.

3. Systems Integration Test

a. System integration test (SIT) shall be performed after the completion of all individual system testing. Contractor shall submit a complete and detailed SIT plan and procedure for Metro approval.

END OF SECTION 27 13 00

SECTION 27 30 00

COMMUNICATIONS TELEPHONE SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Detailed technical requirements for the telephone system to be designed, furnished, installed and tested under this Contract. Internet protocol (IP) telephony system with an interface to the existing Metro private telephone system shall provide telephone services for stations and cross passages. The telephones shall be terminated to a local network switch and communicate with the Cisco Unified Management Server at the Rail Operation Control (ROC) via the CTS fiber optic system. The Cisco Unified Communication Manager shall provide call control and messaging for the entire system.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 43 Spare Parts, Spare Parts Catalog, and Replacement Materials

~~C.~~ Section 27 05 56 Safety and System Assurance

D.

1.03 REFERENCES

A. Americans with Disabilities Act (ADA)

1. 28 CFR Part 36 ADA Standards for Accessible Design

B. American National Standards Institute (ANSI):

1. ANSI T1.311 DC Power Systems – Telecommunications Environment Protection

2. ANSI T1.315 Telecommunications – Voltage Levels for DC Powered Equipment

3. ANSI T1.403 Telecommunications – Carrier to Customer Installation – DS1 Metallic Interface

C. Military Standards (MIL-STD):

1. MIL-HDBK 781 Reliability Test Methods, Plans and Environments for Engineering Development, Qualification and Production

2. MIL-STD-882D System Safety Program Requirements

D. National Electrical Manufacturers Association (NEMA):

1. NEMA 250 Enclosures for Electrical Equipment

E. National Fire Protection Association (NFPA)

1. NFPA 70 National Electric Code (NEC)

2. NFPA 72 National Fire Alarm Code

3. NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Systems

F. Occupational Safety and Health Administration (OSHA):

1. Safety and Health Regulations for Construction, Part 1926, Subpart F – Fire Protection and Prevention

G. Underwriter Laboratories Inc. (UL):

1. UL 50 Cabinets and Boxes

2. UL 62 Flexible Cord and Fixture Wire

3. UL1459 UL Standard for Safety Telephone Equipment

4. UL/CSA 60960 Safety of Information Technology Equipment

5. UL 50, Type 3R Enclosures for Electrical Equipment

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, Safety and System Assurance, Section 1.04 and Metro Design Criteria 12.1.2 & 12.1.3 for Quality Assurance requirements.

C. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in Subsection 1.03 – References.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Floor plans showing locations of all devices.

C. Rack layouts and elevations for telephone system equipment including assembly and installation drawings.

D. Detailed hardware interface schematics and installation details.

E. ~~Provide IP addressing of all IP telephone equipment.~~**Not Used.**

F. Power cable voltage loss and telephone cable loop voltage loss calculations to confirm proper device operation at designed cable lengths.

G. Mounting and installation details for telephones instruments, pedestals and enclosures.

H. Termination and interconnection diagrams for all cable to each component furnished and installed under this Contract. Include any intermediate termination, Main Distribution Frame (MDF), Fiber Distribution Panel (FDP), and station protector equipment terminal block assignments.

I. Manufacturer's technical product data for all devices furnished with certificates of compliance, dimensions, capacities, performance, electrical characteristics and start-up instructions.

J. Detailed installation work plans and procedures.

K. Detailed test plans and procedures for the following:

1. Factory acceptance tests (FAT).

2. Local field acceptance tests (LFAT).

3. Systemwide field acceptance tests (SFAT).

L. Test records.

M. Calculations and Certifications

1. Calculations as listed above.

2. ISO certifications for all proposed.

N. Maintenance training course outlines.

O. As-Built Documentation

1. Shop Drawings with the following information:

a. Plan diagrams showing location of all telephone instruments and accessories.

b. Wiring diagrams - Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

c. Sequence of operations.

d. Detailed information for all programmable equipment together with the associated passwords and access codes.

P. Product Data

1. Submit approved manufacturer's technical product data.

Q. Manufacturer's operating and maintenance instructions for the complete system.

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. Functional Requirements

1. Equipment failure alarms from each telephone system shall be provided to the Supervisory Control and Data Acquisition (SCADA) system at each station. All ETEL line circuits shall be supervised and monitored via the SCADA system.

~~1.~~**2. Two ETELs shall be provided at each cross- passage. Each ETEL shall be terminated to separate network router, gatway and local distribution fiber cable installed under the safety walkway in each tunnel for redundancy. 2-24 singlemode local distribution fiber cables shall be provided between the passenger stations and terminated at every cross-passage in between the stations.**

~~2.~~**3.** All telephones must have a dedicated line (no party line)

~~3.~~**4.** Public Telephone shall be provided by the local telephone company and will not be part of the Metro private telephone system.

~~4.~~**5.** Caller's location shall be annunciated at the ROC telephone console and/or designated workstations.

~~5.~~**6.** Off- hook event for the ETELs, GTELs and PTELs in the public areas shall be captured by the local camera and displayed at the ROC on the event monitor.

B. IP Telephony System

1. The IP telephone system shall be designed for console-less operation, with dial service from IP telephone sets, auto ring down service from ETEL's, and public address access from telephones with keypads.

2. The systems shall consist of VoIP interface(s)/gateways. The gateways and/or concentrators shall route calls to the ROC telephone workstation via cable transmission system (CTS).

3. The equipment shall be digital solid-state, modular design, utilizing the same unified communications manager with the latest hardware and software technologies.

C. Emergency Telephone (ETEL)

1. The ETEL group shall provide priority point-to-point telephone communications for emergency reporting and coordination. Telephones in this group shall ring down to designate numbers.

2. The ETEL group shall be one of two types:

   a. Hands-free with single-button activation, used at public locations such as in public platforms and concourses. See Provisions for ADA Accessibility Guidelines (ADAAG). These phones will ring down to the ROC.

   b. Standard black wall mounted telephone shall be used in ancillary locations. These phones will be programmed to ring down to ROC controllers.

3. ETELs used in lieu of manual pull stations shall be fault monitored through the FACP in addition to the SCADA.

4. ETEL telephone instruments at station public areas shall be labeled "EMERGENCY ASSISTANCE" in English and Spanish. A minimum of one instrument per platform shall be Telecommunications Device for the Deaf (TDD) type for use by hearing impaired patrons.

5. Wall mounted ETEL as a minimum shall be installed in public concourses**/mezzanines**, public platforms, fire hose cabinets, emergency management panel, elevators, sprinkler valve rooms, tunnel cross passages, emergency fan rooms, emergency equipment rooms, emergency hatches, emergency exit corridors**,** ~~ and~~ **emergency** exit stairs**, blue light station boxes, and parking lots and structures**.

6. EMP ETELs shall allow direct outside dialing with no special codes required to gain access to the line. Call-waiting shall be provided.

7. Blue Light Station (BLS) Phones:

   a. Each BLS shall be equipped with an ETEL and connected to the telephone network via a dedicated cable.

   b. The ETEL in the BLS should be a standard black wall-mounted telephone, and should be line monitored.

D. Passenger Assistance Telephone (PTEL)

1. The PTEL group shall provide priority point-to-point telephone service from all station fare collection areas and any other designated public location in the plaza level to the CCTV observers at the ROC.

2. Instruments in this group shall be identical to the Type "A" ETEL as referenced in the Metro Design Criteria, except for distinctive activation buttons and signage to differentiate them from ETEL instruments.

3. Instruments in this group shall meet ADA requirements.

4. Each PTEL shall be labeled as "Assistance Telephone."

5. PTEL telephone shall be installed in the fare collection area and ~~plaza level~~**other locations as specified by Metro**.

E. Maintenance Telephone (MTEL)

1. The MTEL group shall provide access to the dial telephone system for maintenance personnel working in the Metro System. MTEL access shall be identical to ETELs – standard black wall-mounted telephones. They shall be able to dial other phones within the Metro system using the 5-digit extension.

2. MTEL shall be installed in the train control & communications room, traction power substation room, auxiliary power room, electrical room, elevator machine room, cross passage, staff security room, mechanical room, emergency fan room, custodial room, ejector **room,** ~~and~~ sump **pit** room **and cable turning room**. MTEL and ETEL installed in TC&C and ancillary rooms shall be within 15 feet of the room entrances. The handset furnished shall have 25 feet cord. In addition, all areas in the TC&C room should be able to be accessed while talking on either the MTEL or the ATEL. If this is not possible, more MTEL(s) shall be added.

F. Administrative Telephone (ATEL)

1. The ATEL group shall be multi-line phones with display, hold, conference, and transfer capabilities.

2. ATEL shall be installed in the TC&C and ancillary rooms.

G. Gate Telephones (GTEL)

1. **As a minimum, two** GTEL**s** shall be installed**, one phone on each side of the gate array.** ~~on either side of the of the fare barrier gates to enable patrons to obtain assistance.~~

2. GTELS should be identical to PTELS

H. Major Components

1. IP Phone Sets:

a. Support 10/100 Mbps Ethernet connections

b. Support Dynamic Host Control Protocol (DHCP) and static IP addressing.

c. Session Initiation Protocol (SIP) and H323 signal protocols compliant.

d. Cisco Unified IP phone 7945G or compatibles.

I. Network Switch:

1. Network Switch shall be Cisco 3750V2-48PS Ethernet switch or equivalent products will be provided at each station for servicing VoIP Telephone.

2. Provide Quality of Service (QoS) and Virtual Local Area Network (VLAN) features within all VoIP areas.

J. VoIP Analog Telephone Adapter (ATA):

1. VoIP ATA shall be used to convert standard analog telephones to digital VoIP phones.

2. The VoIP data shall be transmitted to the Metro telephone system via the local Ethernet switch.

K. Provide CISCO network equipment, CISCO telephone system and handsets, Cisco Unity voicemail, Nortel T1 card, as required, for interfacing to existing Nortel Option 61c with cable installation and termination in offices, shops, out buildings, manholes and the like, intermediate communication rooms/closets, and main communication rooms. Telephone and Local Area Network (LAN) equipment, support facilities installation and integration testing shall be provided.

L. Provide Metro standard communications equipment including, as a minimum, termination covers, backboards and cabinets, data/telephone ~~cross-connect~~ terminal~~s~~ **blocks**, all hardware for proper installation of UTP MDF, patch panels, FO cable terminal panels, equipment rack patch panel and Category 6 communication outlets, telephone outlet jacks, and cables.

2.02 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Installations shall comply with NFPA, IBC, IFC, NEC and equipment manufacturers' requirements and procedures.

2. Install all wire and conduit in accordance with manufacturer's recommendations and applicable codes and standards.

3. Furnish and install clamps or other cable-restraining hardware in areas where support is required for cables entering or leaving conduit.

4. Furnish filling compound for cables entering or leaving conduit. The filling compound shall be applied in conformance with manufacturer's instructions.

5. Cable entrance openings in equipment enclosures and junction boxes shall be sealed with compression-type fittings or pliable sealing compound after cable is in place. Sealing compound shall be used to seal area around cable where it emerges from the end of a conduit or junction boxes.

6. Cable terminations shall have permanent cable tags identifying the cable number, the number of copper pairs in the cable.

7. Cable and conductors, which serve as communications links, shall have surge protection circuits installed at each end.

B. Public Telephones Service

1. Public Telephone service at or adjacent to station platforms shall be coordinated with the local telephone company. The location shall not interfere with pedestrian flow.

C. Grounding

1. All equipment shall be grounded in accordance with manufacturer's installation instructions and any local or NEC Standards.

3.02 TESTING

A. Factory Test and Inspection

1. The Contractor shall submit manufacturer's certified test results for the telephone system and as a minimum provide the following test reports:

a. Power up verification

b. Keypad/speaker/microphone and ringer operational reports

c. Programming

d. Dual Tone Multi Frequency (DTMF) report

B. Field Test and Inspection

1. Contractor shall perform the following tests for the Telephone subsystem:

a. All telephone line connections shall be tested to assure transmission and supervision limits meet manufacturer’s recommendations.

b. Station to station calling

c. Station to trunk calling

d. Trunk to station calling.

e. Initiate traffic to/from the system and verify the following signaling tones:

1) Dial Tone

2) Station busy tone

3) All trunks busy (congestion) tone

4) Ringback tone

5) Station ringing

6) Distinctive ringing

f. Transmission and signal levels across all interfaces with other systems and subsystems including camera call-up and line monitoring to SCADA (and FACP if required).

C. System End-to-End Acceptance Test

1. Contractor shall provide a local end-to-end test procedure for the telephone system at every station to show the proper functionality and performance.

2. Contractor shall provide qualified technical staff to support the end-to-end testing of the telephone equipment located at the ROC.

D. System Integration Test

1. System Integration Test (SIT) shall be performed after the completion of all individual system testing. Contractor shall submit a complete and detailed SIT plan and procedure for approval.

END OF SECTION 27 30 00

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SECTION 27 32 43

COMMUNICATIONS RADIO SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. General

1. **This section specifies the communications system for the underground stations and shall be used in conjunction with the latest Metro Design Criteria, Chapter 9 for the below ground radio system.** ~~The~~ Contractor shall design, furnish, install and test the installation of a RF based ~~radio~~ Tunnel Radio Communications System as required to support communications from the ~~LA~~ Metro ROC to mobile and portable radio transceivers onboard trains or carried by personnel within the tunnels and below ground stations for rail line expansion. ~~The~~ Contractor shall as needed, expand the capabilities of the ROC facilities or transmission systems to provide the required radio communications and to seamlessly integrate the systems requirements of the **P~~p~~**roject.

2. The below ground RF **C~~c~~**ommunications ~~s~~**S**ystem shall serve to provide voice communication~~s~~ between train operators or other onboard Metro personnel or personnel within tunnels or at LA Metro Stations or ROC. The RF radio system shall operate on a 24x7 basis.

3. The below ground RF communications system shall also provide the retransmission of Los Angeles County Police and Fire departments**,** ~~and~~ the LA County Sherriff's Department**, City of Beverly Hills Police and Fire Department** as well as Mutual Aid radio channels from above ground antenna systems to the below ground facilities including tunnels and all station areas.

4. The radio system for Metro Operation and Maintenance shall be an extension of Metro currently operational ICOM's IDAS' digital radio system using ICOM IP Voice & Control Protocol (Conventional Mode) over Ethernet and the NXDN (Next Generation Digital Network) common air interface. The NXDN protocol uses frequency division multiple access (FDMA) and 6.25 KHz very narrowband channels.

5. The radio system for Metro Transit Police shall be an extension of currently used analog narrow band (12.5 KHz) 450/460 MHz radio system.

6. The radio system shall support subscriber vote scanning to optimize radio service connections. Repeater system based ~~receives~~ voting and multi-cast transmitting shall be used to optimize uplink and downlink signal communications across the strongest signal available.

7. All radio system and supplementary equipment shall be compliant with TASC monitoring system including alarm monitoring and event notification for message status and alerts to the ROC.

~~3.~~

~~4. The below ground RF radio communications system shall use radio systems equipment and design standards that are identical and fully compatible to the existing below ground and above ground radio systems of the LA Metro and in accordance with all design criteria and specifications and standards that apply to the project as specified in the below ground design criteria.~~

~~5. The below ground RF shall use an architecture that provides below ground head-end communications facilities that have terrestrial redundant fiber optical transmission facilities to the ROC and use distributed antenna system antennas to provide RF coverage to the local station facility and along tunnels fully between all head-end station facilities. Continuous RF coverage shall be provided.~~

~~6. Tunnels shall require the use of radiating coaxial with separate transmit and receive cables and shall include repeaters for long tunnels in order to provide the required signal receive strength along the trackage. The below ground radio system shall use specified radio On Frequency Repeater and Directional panel antennas that support UHF (450-512 MHz) and 800 MHz (806-898 MHz). Below ground in-station antennas shall use Tri-Band Antennas to support the required frequencies of the police, fire, sheriffs and mutual aid radio services.~~

~~7. Head-end equipment rooms shall be designed by the Contractor to include the RF equipment, data communications equipment including switches and fiber optical multiplexers, transmission interfaces including racks, uninterruptable power supplies sufficient for 4 hours of back-up operation of all radio system communications equipment at the station site as well as tunnel communications. The Contractor shall design and build the below ground radio communications to include terminal blocks, connectors and patch panels to provide a complete working system.~~

~~8. Passive RF components including but not limited to; power dividers, duplexers, attenuators, and multi-couplers.~~

~~9. The Contractor shall develop a network management system that uses the specified network management platforms including the TASC radio system monitoring and control system.~~

~~10. The radio system shall provide two-way radio communications over six channels in very high frequency (VHF) band for rail operations and maintenance, three channels in ultra high frequency (UHF) band for Metro security. Channels in UHF band for Los Angeles Police Dept, Los Angeles Sheriff Dept. (LASD) or other contract security group, Mutual Aid service, 800MHz band for the Los Angeles City Fire Department (LAFD) or other local fire department shall be determined by Metro. Provisions of train borne~~

~~mobile radios, vehicle mobile radios, and portable radios are not part of this scope of work.~~

B. Tunnel/Underground Station Radio System Description

1. The underground radio system shall include two radio base stations (RBS) provided within the Train Control and Communications (TC&C) room of the Wilshire/La Brea and Wilshire/La Cienega stations. The base station shall transmit, receive, and process radio signals for Metro VHF and UHF channels.

2. The underground radio system shall repeat Radio Frequency (RF) uplink transmissions of LAPD UHF channels and LAFD 800 MHz channels, or other local jurisdictional channels from users in the underground environs, and transmit to their respective underground repeater sites. Contractor shall be held responsible for evaluating the Contract design drawings to determine the final locations of the base station and the repeater sites based on the signal strength and signal to noise ratio.

~~3.~~ The Contractor shall furnish and install antenna and support structures (masts) outside the station's entrance. ~~—~~Antennas for the LAPD or local police department UHF, and LAFD 800 MHz or local fire department channels shall be installed on the mast and aimed towards their respective broadcast sites. ~~Incoming signals (downlinks) received on these antennas shall be amplified and distributed to on-frequency repeaters within the TC&C room. The outputs of the downlink repeaters shall be combined and fed to a distributed antenna system, which shall provide downlink radio coverage throughout the underground stations including stairwells, elevator, escalator, platform and tunnels.~~

~~4. A separate uplink antenna system, essentially a mirror of the downlink system, shall be provided to feed radio signals received from train mobiles and portable radios in the underground stations/tunnel to uplink on-frequency repeaters and radio base station in the Wilshire/La Brea and Wilshire/La Cienega station TC&C rooms.~~

~~5. The uplink radio base station shall transmit Metro data to ROC. The uplink on-frequency repeaters shall in turn feed their RF output signals to the outside antenna.~~

~~6.~~**3.** The underground antenna system shall be a combination of radiating cables and freespace antennas. Radiating cables shall be used within tunnels and ancillary areas. ~~–~~Freespace antennas shall be used to transmit/receive RF signals within the public areas (**e.g.,** platforms/**concourse**~~mezzanines~~) in the underground stations. The distributed antenna system shall extend radio coverage to all areas of the underground segment.

~~7.~~**4.** The uplink and downlink RF signals shall require periodic amplification along the tunnel antenna cable system to assure that signal strength and signal to noise ratios remain sufficient to assure reception at CM-4 level throughout the system. RF preamplifiers and line amplifiers shall be furnished and installed at selected locations to maintain signal levels. Locations for

amplification equipment shall be determined and installed in tunnel cross passages and station TC&C rooms. ~~Line amplifier gain shall be limited to 30 dB (nominal). The uplink antenna cable size selection and amplifier gains levels shall be designed such that direct injection of a test RF signal level of –53 dBm at any uplink frequency and at any point on the cable system shall result in a signal level no less that –90 dBm, with a signal to noise ratio no less than 30 dB at the input of the test frequency's respective on-frequency repeater. The downlink antenna cable system and amplifier gains shall be designed such that a +37 dBm output signal from any on-frequency repeater shall not be less than –20 dBm, with a signal to noise ratio not less than 30 dB, measured directly between the cable shield and center conductor at any point on the antenna cable system. Sampling ports to inject test signals into the uplink cables/measure signal level off the downlink cables shall be provided at line amplifier input locations and at a minimum of 4 locations within each of the underground stations.~~ **Sampling ports to inject test signals into the uplink cables/measure signal level off the downlink cables shall be provided at the amplifier input locations and at a minimum of 4 locations with each of the underground stations.** Sampling ports shall be connected to the cables through 10dB directional couplers. Sampling ports within the stations shall be extended via coaxial cables to points approximately 5 feet above floor level. Sampling ports input output connectors shall be terminated in 50 Ohm loads, connected to the cables by BNC or N type connectors.

~~8.~~**5.** ~~All radiating and coaxial cables shall be plenum rated, with low smoke, low fume, non-halogen producing outer jackets. Radiating cables in tunnels shall be supported on standoffs, which shall support the cables approximately 3 inches from the tunnel walls. Standoffs shall be installed five ft. on center intervals apart along the entire length of the tunnels. Radiating cables within station ancillary rooms, passageways and emergency exits shall be supported on standoffs a minimum of 3 inches from walls/ceilings, at eight ft. on center.~~ The Contractor shall provide and install anchors in tunnel walls, station walls/ceilings, and other areas as required for mounting antenna cables and associated radio antenna hardware. Anchors, mounting studs, and other metallic mounting hardware shall be stainless steel. Wherever possible, uplink and downlink radiating cables shall be spaced a minimum distance of 9 feet apart. ~~Radiating cables and freespace antennas adjacent to exits at Wilshire/La Brea and Wilshire/La Cienega Stations shall be located so as to avoid RF feedback through the on-frequency repeaters at these locations. Standoffs, cable connectors, splices, taps, terminations, and all other miscellaneous parts/pieces of the radiating cable system shall be in accordance with the cable manufacturer' recommendations for tunnel radio service.~~

~~9.~~**6.** RF preamps and line amplifiers and their associated power supplies shall be alarmed. Alarm contacts shall be connected via inside/outside plant cables to SCADA system terminal blocks at their nearest respective station TC&C room. Float battery system power supplies shall power amplifiers in tunnel cross passages. The power supply shall include a rectifier-charger unit and sealed, non-outgassing gel cell batteries. The float battery system shall include alarm points to remotely annunciate:

a. Loss of AC power to rectifier

b. Rectifier Failure

c. Low DC Battery

d. Battery Disconnect

C. Test Transceivers

1. The Contractor shall furnish and install three remotely operated multichannel low power test transceivers to be used for remote operational testing of the LAPD~~, and~~ LAFD**, City of Beverly Hills Police and Fire Department** radio channels. These test transceivers shall be installed in equipment racks at the TC&C rooms. The test transceivers shall include one UHF low band, one UHF high band, and one 800 MHz unit, as required operating on all LAPD~~,~~/LAFD**, City of Beverly Hills Police and Fire Department** channels.

2. The SONET system shall be used to transport voice and control signals from the Wilshire/La Brea and Wilshire/La Cienega stations TC&C rooms to the ROC via Ether~~e~~net service at the station. If required, Contractor shall provide Ethernet service for radio receiver voting and retransmitting in the cross-passages.

3. ~~The~~ Metro shall make the required cross connects at the ROC on their existing system to complete the links to LAPD~~, and~~ LAFD**, City of Beverly Hills Police and Fire Department** command centers.

1.02 RELATED SECTIONS

A.	Section 01 33 00	Submittal Procedures
B.	Section 01 43 10	Project Quality Program Requirements – Design/Build
C.	**Section 01 78 43**	**Spare Parts, Spare Parts Catalog, and Replacement Materials**
~~C.~~**D.**	Section 27 05 56	Safety and System Assurance
~~——~~	Section 27 13 00	Communications Cable Transmission System
~~D.~~**E.**		

1.03 REFERENCES

A. Electronic Industries Alliance (EIA) Standards

1.	EIA 152	Minimum Standards for Land Mobile Communication, FM or PM Transmitters
2.	EIA 195	Electrical and Mechanical Characteristics for Terrestrial Relay System Antennas and Passive Reflectors

3. EIA 204 Minimum Standards for Land Mobile Communications, FM or PM Receivers

4. EIA 220 Minimum Standards for Land Mobile Communications Continuous Tone-Controlled Squelch Systems (CTCSS).

5. EIA 222 Structural Standards for Steel Antenna Towers and Antenna Supporting Structures

6. EIA 252 Standard Microwave Transmission Systems

7. EIA 258 Semi-Flexible Air Dielectric Coaxial Cables and Connectors, 50 Ohms

8. EIA 310 Racks, Panels, and Associated Equipment

9. EIA 316 Minimum Standards for Portable/Personal Radio Transmitters, Receivers, and Transmitters/Receiver Combination Land Mobile Communications FM or PM Equipment

10. EIA 329 Minimum Standards for Land Mobile Communications Antennas

    a. Part I Base or Fixed Station Antennas

    b. Part II Vehicular Antennas

11. EIA 368 Frequency Division Multiplex Equipment Standard for Nominal 4 KHz Channel Bandwidths

12. EIA 374 Land Mobile Selective Signaling Standard

13. EIA 450 Standard Form for Reporting Measurements of Land Mobile Base Station and Portable/Personal Radio Receivers in Compliance with Federal Communications Commission (FCC) Part 15 Rules

14. EIA 485 Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multi point Systems

15. EIA 603 Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

B. MIL-STD-810F, Military Standard Test Method Standard for Environmental Engineering Considerations and Laboratory Tests

1. Method 501.4 High Temperature (Both storage and operating)

2. Method 502.4 Low Temperature (Both storage and operating)

3. Method 503.4 Temperature Shock

4. Method 505.4 Solar Radiation

5. Method 507.4 Humidity.

6. Method 510.4 Sand and Dust

7. Method 514.5 Vibration (constant acceleration)

8. Method 516.5 Shock, transport shock

C. MIL-STD-810-E Military Standard Environmental Test Methods and Engineering Guidelines

1.04 QUALITY ASSURANCE

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

B. General - Refer to General Conditions specified in subsystem Section 27 05 56, Safety and System Assurance, Section 1.04 for quality assurance requirements.

C. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in Subsection 1.03 – References.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Rack layouts and elevations for radio system equipment including assembly and installation drawings.

C. Radio coverage analysis in tunnel.

D. Detailed hardware interface schematics and installation details.

E. Provide IP (Internet Protocol) addressing of all networked equipment.

F. Termination and interconnection diagrams for all cable to each component furnished and installed under this Contract. Include any intermediate termination, Main Distribution Frame (MDF) and Fiber Distribution Panel (FDP).

G. Manufacturer's technical product data for all devices furnished with certificates of compliance, dimensions, capacities, performance, electrical characteristics and start-up instructions.

H. Detailed installation work plans and procedures.

I. Detailed test plans and procedures for the following:

1. Factory Acceptance Tests (FAT).

2. Local Field Acceptance Tests (LFAT).

3. Systemwide Field Acceptance Tests (SFAT).

J. Test records.

K. Calculations and Certifications

1. Calculations as listed above.

2. ISO certifications for all proposed manufacturers.

L. Maintenance training course outlines.

M. As-Built Documentation

1. Shop Drawings with the following information:

2. Plan drawings showing location of all radio system equipment and accessories.

3. Wiring diagrams. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

4. Logic diagrams showing sequence of events and their relationship.

5. Sequence of operation.

6. Information for all programmable equipment together with the associated passwords and access codes.

7. As-built drawings showing power level (in dBm) for each frequency at each system test port. Note: Readings to be consistent with SFAT report.

N. Product Data

1. Approved manufacturer's technical product data.

O. Manufacturer's operating and maintenance instructions for the complete system.

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

~~2.01 SYSTEM OPERATION~~

~~A. RF Radio Communications Transceivers~~

~~1. Station sites shall use Icom base radios that use the NXDN communications protocol with Icom IDAS radios over up to thirty-two (32) 6.25 kHz RF channels in the 450 MHz UHF band. The Icom base radio for uplink and downlink communications to dedicated uplink and downlink only radiating coaxial cable through the local tunnels until the midpoint of the tunnel to the adjacent stations installed radiating cable.~~

2. The Icom base radio shall communicate over coaxial cable to a distributed antenna system (DAS) within the station complex.

3. The RF RSSI signal strength shall be greater than -92.8 dBm anywhere along the length of the tunnels or within the station complex to include platforms, stairwells, elevators and escalator areas in 99% of 100 test sites. RF coverage shall be 100% within 100 feet of all LA Metro property.

4. Downlink transmit noise levels shall be at least 60 dB below transit carrier levels and base station filters shall maintain a minimum of 85 dB of isolation between receive and transmit ports and have a maximum insertion loss of 1.2 dB.

5. The Icom radios shall be equipped to support vote scanning from mobile and portable radios within the tunnel or station complex.

6. Base radios shall support AMBE +2 encoder and provide an audio voice quality of CM-4 or DAQ-4 (95% coverage probability, 95% of the locations.

7. Base station radios shall support the following emission masks: 16KOF3E, 11KOF3E, 4K00F1E and 4K00F1D.

8. Base station radios shall operate at a data transmission rate of 4,800 bits per second and a codec rate of 3,600 bits per second.

9. Base radio frequency deviation shall be for a +/- 5 kHz for wideband emissions and +/- 2.5 kHz for narrowband emissions; FM hum and noise no greater than 50 dB for wideband emissions and 45 dB for narrowband emissions.

10. Mean time between failures of radio components should be no less than 25,000 hours with a mean time to repair of one hour.

11. Base radios shall report alarm conditions to a TASC alarm located in the head-end site.

B. On-Frequency Repeater System

1. The On-Frequency Repeater (OFR) shall be located in below ground station head-end equipment rooms. The OFR provides 50 ohm SMA connectors to off air base antennas located above ground to each below ground station complex. Off air communications shall use two antennas and two coaxial cable runs to the head-end based equipment rooms and the OFR.

2. The OFR shall rebroadcast the UHF 450 to 470 MHz and 470 to 512 MHz and the 800 MHz from 806 to 824 and 851 to 869 MHz frequency bands. There shall be no VHF rebroadcast of off-air frequencies. The OFR provides interface ports to the tunnel radiating cable (uplink and downlink) to each of the two tunnel approaches to the station platform and head-end equipment.

3. The Contractor shall provide the design, commissioning, deployment and testing of the OFR at Head-end locations. The Contractor shall provide the

design to include all passive and non-passive RF control device levels to assure RF levels and system performance to provide the design criteria. Below ground RSSI levels shall be -92.8 dBm or better and provide the same RF coverage performance as the LA Metro NXDN base radios. This shall include CM-4 voice quality or better; and a Mean Opinion Score (MOS) test result of 3.5 or better and 100% coverage to areas within the tunnel, station platforms, station egress, stairwells and elevators.

4. The OFR shall provide a 12 dB SINAD of -115 dBm for OCR UHF and -113 dBm for 800 MHz and input carrier detection threshold of -113 dBm for UHF and 800 MHz.

5. For long tunnel segments where RSSI levels are modeled to provide less than 92.8 dBm, the Contractor shall use the additional amplifier equipped to provide the following elements:

   a. Channel repeater for 800 MHz, UHF and VHF off air frequencies

   b. The required off-air signal strengths should be optimized to provide RSSI levels from -50 dBm to -90 dBm.

   c. Line amplifier for Tri-band line amplifier

   d. Line Amplifier with Automatic Gain Control

   e. Interface modules to provide RF signal routing and switching for redundancy and

   f. Controller monitoring module and remote control of system equipment at sites

   g. Automatic Gain Control (AGC) Gain ranges shall vary for VHF, UHF and 800 MHz channels in 1 dB increments and range from 4 to 32 dB depending on source frequency.

   h. AGC Pilot Input levels shall vary from -45 to 0 dBm

   i. AGC Input interface shall be a RS232 or RS445 at 9,600 baud

6. The uplink antenna cable size selection and amplifier gains shall be designed such that direct insertion of a test RF signal of -53 dBm at any uplink frequency and at any point on the cable system shall result in a signal level no less than -98 dBm with a signal to noise ratio no less than 30 dB at the input of the test frequency respective OFR.

7. The downlink antenna cable system and amplifier gains shall be designed such that a +37 dBm output signal from any OFR shall not be less than -20 dBm, with a signal to noise ration not less than 30 dB measured directly between the cable shield and center conductor at any point on the antenna cable system.

8. OFR's shall operate over a temperature range of -20°C to 140°F and 50G trapezoidal shock pulse shock and vibration tolerance and vibration tolerance of 500 Hz.

C. Data Communications Network and Equipment

1. The base transmitter and receiver bases shall each have an RJ45 Ethernet connector port from the network controller card.

2. The network controller card shall be interconnected through a four pair Category 5 UTP Ethernet patch cord to a Cisco Layer 3 Ethernet switch. The Ethernet switch shall provide the following requirements:

a. 50G trapezoidal shock pulse shock and vibration tolerance

b. Dual power supplies

c. Port alarm, power alarms and high temperature alarms

d. SNMP v2, v3, and CiscoWorks, Resource Manager and AVVID support for VoIP services

e. 10Base-T100 Base-TX ports, RJ45 connectors, four pair Category 5 UTP cabling

f. 100Base-LX connectors, 9/125 micron single mode fiber optic interface @ 1300 nm with optical receiver sensitivity of -38 to -31 dBm and optical transmitter power of -15 to -8 dBm and a maximum distance of 15 km.

3. The network switch shall interface to the Fijitsu Flashwave 4500 Multiservice multiplexer.

D. Communications Network Management

1. All RF radio communications equipment shall support the SNMP v2 and v3 network management protocol .

2. Head-end equipment rooms shall be outfitted with TASC Systems site RSM for Icom IDAS network systems support. TASC monitoring shall include the following contact points or alarm conditions:

a. Ambient Temperature

b. Forward and Reverse Power (VSWR)

c. Charge current and battery voltage

d. Generator status

e. Doors and contacts

f. Remote Reset of Equipment

g. PA Alarms

h. Power Supply Fan

i. TX PLL and RX PLL

j. Combined Channel Current Consumption (PA + IDAS Repeater)

k. Support for eight contact closures, 8 digital inputs, 8 analog inputs

l. Operating temperatures of -40° to 65°F

m. Multiple temperature sensors

n. Ethernet interfaces

o. Input expansion to 40 digital inputs, 24 analog inputs

3. Sensor options for Forward and Reflected Power Sensor (BPS) and differential sensor for monitoring current.

4. Interface to the operation of the OFR

E. Cabling: Radiating Coaxial Cable and Single Mode Fiber Optical

1. Radiating Coaxial Cable shall be used to provide RF communications from the LA Metro Base Transmitter and Receiver at each Head-end site. The radiating cable shall also connect to a 50 ohm SMA interface of the OFR. Downlink and uplink radiating cable shall be separate and located on tunnel walls in accordance with LA Metro practice. Radiating cable shall be installed in cable trays or attached by vendor specified radiating cable hardware and upon the arch of the tunnel as approved by the LA Metro Project Manager.

2. Radiating cable shall be installed with pull boxes at intervals to be determined as part of the design. Cable hanger type and frequency shall be in accordance with design criteria.

3. For longer distance tunnels, OFR amplifiers shall be used for Off Air services of Police, FD, Sheriff and Mutual Aid. Longer distances of the LA Metro base radio transmissions shall be addressed by additional Icom base radio deployments within the tunnel segments. Fiber optic cable shall be used to provide extension to in tunnel repeaters or supplemental base stations.

4. Radiating Cable shall conform to the following performance criteria:

a. Radiating Cable shall be 7/8 inch in diameter and shall be the low smoke type suitable for use in tunnel environment with black non-halogenated fire retardant polyolefin jacket.

b. Cable waterproofing shall be provided.

c. Cable hangers shall be at 3 foot intervals

~~d. Operating frequency band of 50 to 2800 MHz with an optimum frequency range of 70 to 960 MHz~~

~~e. Attenuation of 0.49 dB/100 feet at 150 MHz and 1.16 dB/100 feet at 800 MHz.~~

~~f. Coupling Losses of 72, 86 and 86 dB at 150, 450 and 800 MHz respectively.~~

~~g. VSWR type from 50 to 960 MHz of 1.30~~

~~h. Cable impedance of 50 ohm +/- 2 ohm~~

~~i. Shall use 7/8 inch Male and Female Positive Stop connectors~~

~~5. Coaxial jumper cables shall be exterior rated ½ inch low density foam coaxial cable with corrugated copper with corresponding 50 ohm ½ inch connectors.~~

~~6. Fiber Optic cable shall be used for connectivity of the OFR repeaters and Icom bases in long tunnels to achieve RSSI levels no less than -92.8 dBm. Refer to the specification section 27 13 00, Communications Cable Transmission System for fiber optical cable requirements.~~

~~2.02~~2.01 GENERAL DESIGN REQUIREMENTS

A. Functional Requirements

1. All base station radios shall be new. –Used radio equipment will not be acceptable to Metro.

2. All base station radios, mobile radios, and portable radios shall be from the same vendor.

3. Base station radios shall be provided so as an alternate method to use 4-wire analog with tone control keying to communicate with other 6.25 KHz NXDN equipped radios.

4. All base station radios, mobile radios, and portable radios shall operate native mode in the IP domain and shall be able to communicate with each other for the purposes of scanning, voting, and general radio operation.

~~2.03~~2.02 MAJOR COMPONENTS

A. Base Stations Radios

Base Stations Radios to be supplied shall be the ICOM IC-UCFR5000/6000.

1. General Requirements for the base station radios are as follows:

a. Frequency Coverage - The Frequency coverage shall be between 136-174 MHz (VHF) for IC-UCFR5000, and 400-470MHz or 450-520MHz (UHF) for IC-UCFR6000.

b. UCFR-5000 Interface board for VHF channels – All base station receivers shall be provided with the built-in/on-board UCFR5000 board so as to insure receiver voter capabilities is present and immediately implementable.

c. UCFR-6000 Interface board for UHF channels – All base station receivers shall be provided with the built-in/on-board UCFR6000 board so as to insure receiver voter capabilities is present and immediately implementable.

d. Receiver Voting – Receiver voting and functionality shall be supplied with the UCFR-5000/6000 Base Station,

e. Metro intends to mount two (2) ICOM IC-FR5000 in the same cabinet

2. The requirements for the ICOM IC-UCFR5000/6000 Base Station Transmitter are as follows:

a. Output Power – The maximum output transmit power shall be 50W adjustable down to 5W.

b. Duty Cycle – The Duty Cycle 25W shall be 100%.

c. Frequency Deviation – The maximum frequency deviation shall be for ±5.0 kHz for wideband emissions and ±2.5 kHz for narrowband emissions.

d. Spurious Emissions – Spurious Emissions shall be no greater than 82dB.

e. Adjacent Channel Power – The adjacent channel power shall be no greater than 73 dB for wideband emissions and no greater than 67 dB for narrow band emissions.

f. FM Hum and Noise – The FM Hum and noise for wideband emissions shall be no greater than 50 dB for wideband emissions and 45 dB for narrow band emissions.

g. Audio Harmonic Distortion – Total Audio Harmonic Distortion 40% deviation shall be no greater than 1%.

h. Microphone Impedance – The microphone input impedance shall be 600Ω.

3. The requirements for the ICOM IC-UCFR5000/6000 Base Station Receiver are as follows:

a. Analog FM Sensitivity - The FM Sensitivity for FM Wideband Analog Emissions shall be 0.30µV at 12dB SINAD..

b. Digital Sensitivity – The Digital Bit Error Rate (BER) for Narrowband Digital Emissions at 0.25µV shall be 5% BER

c. Spurious Response – The Spurious Response shall be 90dB +/- 1 dB.

d. Intermodulation – The Intermodulation Rejection Ratio shall be 78dB +/-1 dB.

e. Hum and Noise Ratio for Wideband Emissions – The hum and noise ratio for wideband emission shall be 50 dB

f. Hum and Noise Ratio for Narrowband Emissions – The hum and noise radio for narrowband emissions shall be 45 dB.

g. Audio Output Power – The audio output power at 5% distortion into a 4 ohm load shall be 4.0 W typical

External Speaker Connection – An external speaker connector shall be supplied on the base station radio. The connector shall be a 2-conductor 3.5 mm in diameter female jack. The impedance shall be capable of handling 4 ohm loads.

~~e.~~**h.**

~~2. The requirements for the ICOM IC-UCFR5000/6000 Base Station Transmitter are as follows:~~

~~3. The requirements for the ICOM IC-UCFR5000/6000 Base Station Receiver are as follows:~~

~~a. External Speaker Connection – An external speaker connector shall be supplied on the base station radio. The connector shall be a 2-conductor 3.5 mm in diameter female jack. The impedance shall be capable of handling 4 ohm loads.~~

Channelized booster amplifier, power amplifier, coupler, combiners, splitters, duplexers, filters, distributed antenna system and other equipment required shall be provided per the Metro Design Criteria.

~~B. On Frequency Repeater~~

~~On frequency repeaters shall be Futurecom Series 7V046X or Metro approved equivalent.~~

~~C. Amplifier~~

~~Amplifier devices shall be TXRX Series 60 RF Unidirectional units, or Metro approved equivalents.~~

~~D. At-grade Antenna~~

~~UHF and 800 MHz at-grade antenna to be installed on mast at the 1st/ Central station shall be Decibel Products high gain (12-15 dB) flat panel type, or Metro approved equivalents.~~

~~E. Freespace antennas~~

~~Freespace antennas within stations concourse and platform areas shall be Childs Tri-band types, or Metro approved equivalents.~~

~~F. Radiating cables~~

~~Radiating cables shall be Andrew, Cablewave, or other Metro approved types with nominal characteristics as follows:~~

	~~VHF~~	~~UHF~~	~~800 MHz~~
~~Maximum Attenuation (dB/100ft)~~	~~0.5~~	~~1.1~~	~~1.6~~
~~Maximum Coupling Loss (dB at 20 ft)~~	~~62~~	~~72~~	~~72~~

~~G. Other accessories~~

~~Multicoupler combiners and splitters, duplexers, and filters shall be TX/RX or Metro approved equivalents.~~

B.

2.03 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Installations shall comply with NFPA, IBC, IFC, NEC and equipment manufacturers' requirements and procedures.

2. Install all wire and conduit in accordance with manufacturer's recommendations and applicable codes and standards.

3. Furnish and install clamps or other cable-restraining hardware in areas where support is required for cables entering or leaving conduit.

4. Furnish filling compound for cables entering or leaving conduit. The filling compound shall be applied in conformance with manufacturer's instructions.

5. Cable entrance openings in equipment enclosures and junction boxes shall be sealed with compression-type fittings or pliable sealing compound after cable is in place. Sealing compound shall be used to seal area around cable where it emerges from the end of a conduit or junction boxes.

6. Cable terminations shall have permanent cable tags identifying the cable number, the number of copper pairs in the cable.

7. Cable and conductors, which serve as communications links, shall have surge protection circuits installed at each end.

8. All equipment shall be grounded in accordance with manufacturer's installation instructions and any local or NEC Standards.

9. Radio base stations, OFRs, amplifiers, antenna cables, and supports shall be installed as shown on the design drawings.

3.02 TESTING

A. The Contractor shall perform the following tests on the radio system:

Testing shall include injection of fixed level signals at RF test ports on the uplink antenna system, with corresponding measurements at the headend site to prove compliance with specification requirements. Similar tests shall be performed on the downlink antenna system. Operation and test measurements shall be made on all channel frequencies. Testing shall include verification of ~~OFR~~**CRA** alarms and controls and amplifier and paver supply alarms. Testing shall also include functional tests of LAPD and LAFD **and City of Beverly Hills Police and Fire Department** test transmitters. All "airwave" transmission tests shall be coordinated with the agency involved (M**etro**~~TA~~, LAPD, LAFD, **City of Beverly Hills Police and Fire Department and** other local jurisdictions departments) prior to launching RF signals into their respective aboveground base stations.

B. System End-to-End Acceptance Test

Contractor shall provide a local End-to-End test procedure for the Radio system at every station to show the proper functionality and performance.

Contractor shall provide qualified technical staff to support the End-to-End testing of the Radio equipment located at the ROC.

C. System Integration Test

System ~~i~~**I**ntegration ~~t~~**T**est (SIT) shall be performed after the completion of all individual system testing. Contractor shall submit a complete and detailed SIT plan and procedure for approval.

END OF SECTION 27 32 43

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SECTION 27 51 16

COMMUNICATIONS TRANSIT PASSENGER INFORMATION SYSTEM (TPIS)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section details technical requirements for the Transit Passenger Information System (TPIS). The system shall be designed to allow the authorized personnel to originate both live and prerecorded announcements. The TPIS shall consist of public address (PA) and visual message sign (VMS) announcement devices in the paid and unpaid passenger station areas. The system prerecorded voice announcements shall be coordinated with stored, preset text messages displayed on the VMS signboards. TPIS shall interface with the signaling train detection and train to wayside communication (TWC) subsystems to automatically activate dynamic train arrival/destination and other selected messages. The station controller unit (SCU) shall communicate with the rail operations control (ROC) through the station Ethernet protocol. The TPIS shall report status/alarm locally to the Supervisory Control and Data Acquisition (SCADA) Remote Terminal Unit (RTU) and to the ROC.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 43 Spare Parts, Spare Parts Catalog, and Replacement Materials

~~——~~Section 27 05 56 Safety and System Assurance

~~C.~~**D.**

1.03 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO LTS-5 Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals"

B. American Disability Act (ADA)

C. Code of Federal Regulations (CFR):

1. 49 CFR ADA requirements defined in Parts (37, 38)

D. Electronic Industries Association (EIA):

1. EIA RS-160-51 Sound Systems

2. EIA RS-174 Audio Transformers for Electronic Equipment

3.	EIA RS-232	Interface between Data Terminal Equipment Employing Serial Binary Data Interchange
4.	EIA RS-276-A	Acceptance Testing of Dynamic Loudspeakers
5.	EIA RS-485	Electrical Characteristics for use in Balanced Digital Multipoint Systems
6.	EIA RS-310-D	Cabinets, Racks, Panels, and Associated Equipment
7.	EIA RS-359	Standard Colors for Color Identification and Coding
8.	EIA RS-426-A	Loudspeakers, Power Rating, Full Range

E. Institute of Electrical and Electronic Engineers (IEEE):

1.	IEEE 802.3	10/100 Base Ethernet

F. Insulated Cable Engineers Association (ICEA):

1.	ICEA S-80-576	Insulated Cable Engineers Association
2.	ICEA S1.13	Methods for the Measurement of Sound Pressure Levels
3.	ICEA S1.4	Specification for Sound Level Meters
4.	ICEA S3.5	Methods for the Calculation Of the Speech Intelligibility

G. International Electrotechnical Commission (IEC):

1.	IEC 801-2 Part 2	Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment
2.	IEC 60268-16	The Objective Rating Of Speech Intelligibility by Speech Transmission Index (STI)
3.	IEC 60849	Sound systems for emergency purposes

H. National Electrical Manufacturers Association (NEMA):

1.	NEMA Publication	National Electrical Safety Code (NESC)
2.	NEMA WC63.1-2000	Performance Standard for Twisted Pair Premise Voice and Data Communications Cables

I. National Fire Protection Association (NFPA):

1.	NFPA 70	National Electrical Code (NEC)
2.	NFPA 72	National Fire Alarm Code
3.	NFPA 101	Life Safety Code

4. NFPA 130 Standard for Fixed Guideway Transit Systems

J. Underwriters Laboratories (UL):

1. UL 48 Standard for Safety Electric Signs
2. UL 467 Standard for Grounding and Bonding Equipment
3. UL 1433 Standard for Safety Control Centers for Changing Message Type Electric Signs
4. UL 1449 Standard for Transient Voltage Surge Suppressors
5. UL 1480 Speakers for Fire Protective Signaling Systems
6. UL 1666 Standard Test for Flame Propagation Height of Electrical and Optical- Fiber Cables Installed Vertically in Shafts

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, Safety and System Assurance, Section 1.04 and Metro Design Criteria 12.1.2 & 12.1.3 for Quality Assurance requirements

C. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in Subsection 1.03 – References.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Plan drawings showing locations of devices including speakers, ambient noise detectors, and liquid crystal displays (LCDs).

C. An audio coverage analysis verifying the sound coverage and sound levels

D. Power calculations and requirements

E. TPIS Block Diagram

F. Rack layouts and elevations for TPIS system equipment including assembly drawings and installation drawings.

G. Detailed hardware interface schematics and installation details.

H. Termination and interconnection diagrams for all cable to each component furnished and installed under this Contract. Include any intermediate termination,

Main Distribution Frame (MDF), Fiber Distribution Panel (FDP), or station protector equipment terminal block assignments.

I. Manufacturer's technical product data for all devices furnished with certificates of compliance, dimensions, capacities, performance, electrical characteristics and start-up instructions.

J. Detailed installation work plans and procedures.

K. Detailed test plans and procedures for the following:

1. Factory acceptance tests (FAT).

2. Local field acceptance tests (LFAT).

3. Systemwide field acceptance tests (SFAT).

L. Test records.

M. Calculations and Certifications

1. Calculations as listed above

2. ISO certifications for all proposed manufacturers

N. As-Built Documentation

1. Shop Drawings with the following information:

a. Floor plans showing locations of all devices.

b. Wiring diagrams. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

c. Sequence of operation

d. Detailed information for all programmable equipment together with the associated passwords and access codes

O. Product Data

A. Approved manufacturer's technical product data

P. Manufacturer's operating and maintenance instructions for the complete system

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. Public Address (PA) Subsystem

The PA subsystem shall be designed to provide general announcements to single and multiple zones within individual and multiple passenger stations. The PA shall be designed for local and remote access and control from various locations and from the Metro private telephone system.

1. Functional Requirements

    a. The PA subsystem shall provide an effective sound-masking system which utilizes loudspeakers strategically placed to produce uniformly distributed audio throughout the passenger stations. Uniform audio in both tonality and sound level, at 5 ft elevation above finished floor, so that normal moving does not result in 5 dB changes in the sound level.

    b. The PA subsystem shall be fully supervised with failure annunciation of all major system components such as **station controller unit, PA processor,**~~preamplifiers,~~ power amplifiers, supervision tone generators and detectors, power supplies, and speaker wiring. Failure reporting shall be via SCADA to ROC.

    c. The primary means of access to ROC PA systems shall be through the Metro private telephone line.

    d. The primary means of access to the station PA systems shall be from the PA consoles located at the ROC. The PA consoles shall allow a user to select one or more stations/zones for broadcast of live audio from the console microphone or pre-recorded announcements stored at the ROC ~~.~~**or local station control unit.** All audio and control shall be transmitted over Ethernet.

    e. Station Equipment shall be powered from the communications UPS.

2. Design Criteria

    a. Technical Characteristics

        1) Active Components are all solid-state devices.

        2) Frequency Response:

            a) End-to-End Station amplifier to speaker frequency response:

                i) 1.5dB from 100 Hz to 10 kHz

                ii) 3.0dB 10 kHz to 15 kHz

            b) Pre-recorded audio messages shall be capable of being recorded, stored and delivered at CD quality encoding (44 KHz, 16-bit) from both the ROC server and the local **station control unit.**~~digital message repeater.~~

            c) Live microphone audio shall be encoded and delivered at a minimum of 22 KHz, 8 bit.

3) Total Harmonic Distortion (THD): Not greater than 1 percent at full rated output.

4) Distribution:

a) 70V normal, transformer isolated

5) Overload Protection

a) All amplifier outputs shall be protected with automatically resetting thermal overload, short circuit and current limited protection.

b. Minimum sound level at 5 ft. or lower above the finished floor shall be:

1) Concourse: 70 dBA minimum

2) Platform: 78 dBA minimum

3) Yard and High Bay Areas: 78 dBA minimum

4) Ancillary: 70 dBA minimum

5) Horn speakers' frequency response shall be in the range of 150Hz to 15 kHz

c. Supervision and Alarms

1) The PA subsystem shall be fully supervised.

2) A local annunciator /alarm panel shall:

a) Individually indicate the failure of any supervised circuit or equipment

b) Annunciate the transfer to standby power amplifier

c) Upon failure of standby power amplifier, activate the appropriate an alarm.

d. System Input Priorities

Up to five (5) levels of prioritized inputs shall be selected from various sources at the stations and the ROC subsystems. Prerecorded voice announcements shall be activated either locally or by remote control from the ROC for information or emergency announcements. Input from ROC shall be transmitted via CTS. Remote access to the PA subsystem shall also be provided via dial access from the telephone subsystem. The input priorities shall be as follow:

1) Passenger Stations

a) Highest Priority – live announcement from the local panel

b) Second Priority – live, real time announcement from the ROC consoles

c) Third Priority – live, real time announcement from Metro EPABX telephone

d) Fourth Priority – train arrival/destination/stand clear announcement

e) Lowest Priority – prerecorded announcement from central control

e. Remote Access

1) Remote access via the telephone subsystem to PA subsystem shall be provided from both the communications and CCTV operations telephones at the ROC to passenger stations. This feature shall allow the console operators to individually select any passenger station for PA announcements or select any number of stations for group announcements. This is a redundancy feature intended to provide an alternate means of public address announcement in the event of a ROC server or Cable Transmission System outage.

2) This feature shall allow live audio to be broadcasted via the telephone system. Station selection shall be accomplished by dialing a designated phone extension. If not busy, the call shall be automatically connected. Upon call connection, zone selection shall be accomplished using the Metro private telephone system to access any one zone or “all zones” at the station. The call shall automatically end when the ROC caller hangs up or upon ROC caller selection a hang-up code.

f. Console Access

Remote access via TPIS graphical user interface consoles shall be provided at the ROC.

1) Consoles shall allow selection of one or more stations and zones announcement groups for broadcast of live or pre-recorded announcement.

2) It shall be possible to select broadcast destinations using a map-based graphical display or a sort-able tabular style display.

3) Console shall allow system maintainers to define announcement groups for quick selection of broadcast destinations. The system shall include the following pre-configured groups:

a) Systemwide - all stations and all zones

b) Systemwide - all stations platforms

c) All stations and all zones - one group for each rail line

d) All stations platforms - one group for each rail line

4) Consoles shall include maintenance display to indicate the following:

a) Status of each remote TPIS station control unit

b) TPIS server status

c) Status of each TPIS console

g. Pre-recorded Announcement Devices

1) **Station control unit** ~~Solid-state digital type prerecorded message repeater devices~~ shall be used in all stations for local automatic messages initiation.

2) Equipment at the ROC shall be capable of recording and storing new announcement. Equipment shall be provided to allow recording and storing of new announcements on local **station control unit.**~~message repeater devices.~~

~~2)~~**3) The station EMP shall be able to broadcast an emergency evacuation message from the local SCU**

h. PA Zones

Separate zones with separate amplifying systems and speaker systems shall be accessible individually or in combination. Passenger stations typically have one to three zones covering; platform, concourse/mezzanine and ancillary areas.

i. Standby Amplifiers

Hot-standby power amplifiers shall be provided on a one **to one** ~~-for-two~~ basis for each power amplifier used in the PA subsystem installation. The hot-standby amplifiers shall be switched to active use by the PA supervisory function.

j. Speaker by Local Microphone

Provision shall be made to reduce output level of speakers in close proximity of local microphones to prevent acoustic feedback.

k. Noise-Operated Level Adjustments for Power Amplifiers

1) Automatic gain **control (AGC)**~~adjustment~~ of the PA subsystem shall be provided based upon ambient noise levels. The controller shall provide a graduated increase in power output in proportion to the increase in noise level from a preset quiet level. As an alternative to automatic gain control (AGC), additional speakers can be used to provide better coverage.

2) The adjustment range for ambient noise shall be a minimum of 20 dB but shall never result in a sound level greater than 100 dB as measured 8 feet above finished floor.

3) Noise sensing devices for each controlled areas shall be mounted toward the incoming train and away from the loud speaker to avoid feedback with the ambient noise sensor to reduce the announcement volume.

l. There shall be no perceptible delay, i.e. less than 50 milliseconds, between an operator pressing the push-to-talk and speaking into any PA/TPIS microphone and the audio being heard on the selected PA zone speakers.

B. Visual Message Signs (VMS) Subsystem

1. General Description:

a. VMS shall provide visual information at selected locations in passenger stations. The display of the visual information shall be compliance with the ADA Accessibility Guideline (ADAAG) for the hearing impaired, operational and safety related messages for patron awareness (refer to ADAAG 4.30, DOT 49 CFR parts 27, 37 and 38, and the CalDAG-California Disability Accessibility Guidebook for guidance). The generation of messages for display at each passenger station shall be provided in both preprogrammed format and real time terminal input. As a minimum, these communications shall be provided on the platforms and mezzanine/concourse areas, at fare vending areas and at the underground entrances.

b. The VMS shall provide centralized message generator including message creation, storage, selection, and dispatch functions at the ROC for individual stations, groups of stations and all station sign activation and display. Each passenger station VMS shall accept message inputs from both a centralized processing unit located at the ROC and from local passenger station. Passenger station input consists of pre-programmed messages emulating the pre-programmed public announcements activated from train control/signaling system equipment.

c. For HRT ~~back-to-back~~ 46" (diagonally measured) LCD monitors shall be environmentally housed to prevent damage from moisture, dust, and vandalism. ~~Sign units installed in outdoor environments shall be fabricated for direct sunlight exposure and protection from ultraviolet, rain and atmospheric damage. Outdoor signs shall be equipped with the latest technology display devices to ensure readability in direct sunlight using reflective shielding of signs, and display device illumination intensity of the sign's display characters.~~ The LCD monitors should be installed in the following areas:

1) Above map cases;

2) Near fare collection ticket vending machine;

3) Along the edge of the platform;

4) At grade level station entrance;

5) Areas as required by FLS

~~c. **For HRT back-to-back 42" (diagonally measured) LCD monitors or LED signs shall be environmentally housed to prevent damage from moisture, dust, and vandalism. Sign units installed in outdoor environments shall be fabricated for direct sunlight exposure and protection from ultraviolet, rain and atmospheric damage. Outdoor signs, shall be equipped with the latest technology display devices to ensure readability in direct sunlight using reflective shielding of signs, and display device illumination intensity of the sign's display characters. The LCD monitors should be installed above map cases and near fare collection ticket vending machines. LED signs should be installed along the edge of the platform and areas as required by FLS.**ll station message sign unit shall be back-to-back 46" (diagonally measured) LCD monitor and be environmentally housed to prevent damage from moisture, dust, and vandalism The LCD monitors sh**all**ould be installed in the following areas:~~

~~1) Above map cases~~

~~2) Near fare collection ticket vending machine~~

~~3) Along the edge of the platform~~

~~4) At grade level station entrance and plaza level~~

~~5) Area required by the FLS~~

2. System Requirements

   a. The VMS system shall be configured using a standard computer system Passenger station display signs and shall be remotely accessed by the ROC via CTS. Data transmission to and from the ROC and each passenger station display sign shall be transmitted over Ethernet.

   b. All interfaces between the passenger station VMS system and other systems shall be accomplished in the TC&C room. Interfaces include train control signaling system and public address system activation switches to the station EMP.

   c. Power for VMS system equipment located in the TC&C room shall be from UPS.

C. Transit Passenger Information System Automatic Announcement

1. The Visual Message Sign (VMS) subsystem shall function in conjunction with the PA subsystem. For the pre-programmed messages VMS shall be able to display equivalent text as announced on the public address (PA) subsystem simultaneously for the hearing impaired passengers in compliance with the

ADA Accessibility Guidelines (ADAAG). The TPIS system shall interface with the train control and / or other vehicle detection system to provide information to the passengers. The System shall provide automatic announcements that include:

a. Information on route, final destination, time of arrival of the next three trains approaching a particular platform – "Next Train". The system shall indicate "The train is arriving, please stand clear" for trains predicted to arrive within 30 seconds of the reported train control or other vehicle detection transmission.

b. Information on service interruptions or delays such as "The approaching train is not in service, please stand clear"

c. Emergency instructions such as "Evacuate Station"

d. Prohibitive instructions such as "No Smoking, Eating, or Drinking"

e. News, sports, weather

f. Commercial advertising

g. Day, Date, and Time synchronized to a master clock at the ROC

h. Other pre-recorded message to be determined by the Metro

2. The TPIS software shall ~~be~~ generate arrival messages as described above.

3. The TPIS installed at the stations will be compatible with the existing TPIS server/workstation at ROC.

4. The TPIS system shall be designed to have the TPIS workstations at the ROC control and monitor the prerecorded as well as live audio/visual messages.

2.02 MAJOR COMPONENTS

A. **Public** Address system

1. Audio Processor - The audio processor shall provide mixing, filtering, busy and processor faults, and sound level controls.

2. Audio Power Amplifiers - The Contractor shall provide amplifiers in the size and quantity to provide a power capacity 50 percent greater than the power output required at nominal sound pressure levels.

3. Digital Processor (DSP) – Fault Monitor

   a. The module shall provide digital sampling processing and continuous supervision of the amplifier and loudspeaker lines.

4. Speakers

   a. Cone speakers

b. Cone Speakers shall be Atlas Model UHT, Lowell Manufacturing Model ULS-IC105-CT70, or Metro approved equal. Back boxes and baffles shall be compatible with their respective speaker assembly to maintain NFPA and UL listings.

c. Horn speakers

d. Horn speakers shall be Atlas AP-15T, or Metro approved equal.

5. Sensing Microphones - The microphone shall be compatible with the PA controller.

6. Station Controller Unit

7. Local PA Input Device

8. Local PA announcement shall be initiated from a hardwired push-to-talk microphone located in the TC&C room.

9. Audio Loop Presence Detection

a. This module shall be provided to supervise the speakers loop.

B. Transit Information System (Metro furnished)

1. Hardware components:

a. TransitVUE Content Management Server

1) The TransitVUE Content Management Server centrally manages the network of media players using a secure web interface or can be also used as a web based central processing server with no localized media players. It is a robust DSN content display server designed for the 24/7/365 message display environments. It is ideal for use in the transportation industry. Used together with the user-friendly TPIS Vantage Server Software, the server will be able to manage all of the displayed information to individual or multiple media players throughout the network.

b. TransitVUE Media Players

1) TransitVUE station media player is used for linking to the content management system via a LAN, WAN or wireless connection. The station media players can run independently from the content management server in case network connection is lost.

2) The station media controllers are capable of supporting multiple blocks of content, tickers, layouts, dynamic vehicle location maps, arrival/departure information, and much more. Each display controller is configured with Vantage Host Software prior to shipment to allow for maximum accessibility and quick delivery of information.

c. Liquid Crystal Display (LCD)

1) 46” sunlight readable high brightness LCD to run 24x7x365 continuously

2) RS-232C in/out for controlling the monitor via server/PC

3) 1368x768 or higher resolution

4) Video BNC In/Out, 1 S-video In/Out, 1 VGA-In

5) LCD enclosure: custom fabricated modular, heavy duty metal construction.

6) “Vandal-resistant” single sided and double sided LCD mount with A/R coated retro-shield with ½” acrylic protection screen.

d. LCD Display Enclosure

1) The TransitVUE® monitor display mounts are custom made and designed to accommodate and support one or two monitors in a back-to-back, side-by-side or single unit configuration for transit station environments. A variation of ceiling, pendulum, and wall mounts are available as required by application.

2. VGA/DVI Video Extenders

2.03 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Contractor shall be responsible for the installation of all TPIS equipment which include the Metro furnished TPIS equipment specified in this section.

B. Contractor shall provide mounting supports for all Metro Furnished VMS equipment as specified on the Architectural Standard Drawing (AS-024 detail 4).

C. General Installations shall comply with NFPA, IBC, IFC, NEC and equipment manufacturers’ requirements and procedures.

D. Install all wire and conduit in accordance with manufacturer's recommendations and applicable codes and standards.

E. Furnish and install clamps or other cable-restraining hardware in areas where support is required for cables entering or leaving conduit.

F. Furnish filling compound for cables entering or leaving conduit. The filling compound shall be applied in conformance with manufacturer's instructions.

G. Cable entrance openings in equipment enclosures and junction boxes shall be sealed with compression-type fittings or pliable sealing compound after cable is in place. Sealing compound shall be used to seal area around cable where it emerges from the end of a conduit or junction boxes.

H. Cable terminations shall have permanent cable tags identifying the cable number, the number of copper pairs in the cable.

I. Cable and conductors, which serve as communications links, shall have surge protection circuits installed at each end.

J. All connections shall be provided for all equipment wiring via rack-mounted interface terminal panel, connect interface carrier wiring to the proper wiring-frame terminals and, after testing both the PA/VMS system and carrier installations, complete the cross-connects on the wiring frame to the assigned carrier terminals.

K. All equipment shall be grounded in accordance with manufacturer's installation instructions and any local or NEC Standards.

3.02 TESTING

The Contractor shall perform the following inspections and tests on the TPIS, including the Metro furnished TPIS equipment specified in this specification.

A. Factory Test and Inspection:

Contractor shall perform factory test on all rack mounted and wired components.

1. Installations shall comply with NFPA, IBC, IFC, NEC and equipment manufacturers' requirements and procedures.

2. Install all wire and conduit in accordance with manufacturer's recommendations and applicable codes and standards.

3. Furnish and install clamps or other cable-restraining hardware in areas where support is required for cables entering or leaving conduit.

4. Furnish filling compound for cables entering or leaving conduit. The filling compound shall be applied in conformance with manufacturer's instructions.

5. Cable entrance openings in equipment enclosures and junction boxes shall be sealed with compression-type fittings or pliable sealing compound after cable is in place. Sealing compound shall be used to seal area around cable where it emerges from the end of a conduit or junction boxes.

6. Cable terminations shall have permanent cable tags identifying the cable number, the number of copper pairs in the cable.

7. Cable and conductors, which serve as communications links, shall have surge protection circuits installed at each end.

B. Field Test

As a minimum, the following tests shall be conducted:

1. Line and microphone inputs at nominal sound pressure level
2. All message features
3. Demonstration of graphics capability
4. Single and multiple zones operation
5. Priority select between local and the ROC messages
6. The next train arrival message announcement and visual indication at each station
7. Functional Test of feedback for locally generated PA messages
8. Ambient sound level sensing and PA level compensation mechanism
9. Confirm PA coverage requirements
10. Contractor shall perform an intelligibility test using the STI method as described in IEC 60628 -16.

C. System End-to-End Acceptance Test

1. Contractor shall provide a local End-to-End test procedure to the PA/TPIS system at every station to show the proper functionality and performance.
2. Contractor shall provide a local End-to-End test procedure to complete “train arrival/destination/stand clear announcement” functionality at each station.
3. Contractor shall provide qualified technical staff to support the End-to-End testing of the PA/TPIS equipment located at the ROC.

D. System Integration Test

System Integration Test (SIT) shall be performed after the completion of all individual system testing. Contractor shall submit a complete and detailed SIT plan and procedure for approval

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SECTION 28 16 00

COMMUNICATIONS INTRUSION DETECTION ACCESS CONTROLLED SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Detailed technical requirements for the intrusion detection and controlled access system (IDCAS) to be designed, furnished, installed, and tested under this contract. The IDCAS system shall be designed to provide controlled access through designated doors to detect unauthorized entries for the stations. All detected entries, alarms, and troubles shall be transmitted to the Rail Operations Control (ROC) via Cable Transmission System (CTS) for recording **and to the station EMP**.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 43 Spare Parts, Spare Parts Catalog, and Replacement Materials

D. Section 27 05 56 Safety and System Assurance

1.03 REFERENCES

A. National Fire Protection Association (NFPA):

1. NFPA 70 National Electrical Code

B. Underwriter Laboratories Inc. (UL):

1. UL 294

2. UL 1076

C. Federal Communications Commission (FCC):

1. FCC Part 15 Radio Frequency Devices

D. National Electrical Manufactures Association (NEMA):

1. NEMA 250 Enclosures for Electrical Equipment

E. The Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE C62.41 Surge Voltages in Low-Voltage AC Power Circuits

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, Safety and System Assurance, Section 1.04 for Quality Assurance requirements.

C. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in Subsection 1.03 – References.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Floor plans showing locations of all devices.

C. Rack layouts and elevations for the intrusion detection system equipment including assembly and installation drawings.

D. Battery calculation for supervisory and alarm power requirements.

E. Detailed hardware interface schematics and installation details.

F. Termination and interconnection diagrams for all cable to each component furnished and installed under this Contract. Include any intermediate termination, Main Distribution Frame (MDF) or station protector equipment terminal block assignments.

G. Manufacturer's technical product data for all devices furnished with certificates of compliance, dimensions, capacities, performance, electrical characteristics and start-up instructions.

H. Detailed installation work plans and procedures.

I. Detailed test plans and procedures for the following:

1. Factory acceptance tests (FAT)

2. Local field acceptance tests (LFAT)

3. Systemwide field acceptance tests (SFAT)

J. Test records.

K. Calculations and Certifications

1. Calculations as listed above.

2. ISO certifications for all proposed manufacturers.

L. As-Built Documentation

1. Shop Drawings with the following information:

    a. Plan drawings showing locations of all controlled access doors.

    b. Wiring diagrams. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

    c. Logic diagrams showing sequence of events and their relationship.

    d. Sequence of Operation.

    e. Detailed information for all programmable equipment together with the associated passwords and access codes.

M. Product Data

1. Submit approved manufacturer's technical product data.

N. Manufacturer's operating and maintenance instructions for the complete system.

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. All equipment and components shall be UL listed and installed in compliance with manufacturer's recommendations. At minimum, intrusion detection system devices shall be provided based on Metro Design Criteria Section 9.13.

B. The IDCAS shall be comprised of the following major components:

1. Card reader controllers

2. Card Readers

3. Intrusion detection magnetic door contacts

4. Intrusion detection limit switches

5. Electric door strikes

6. Exit request devices

7. Audible/Visible alarm devices

8. Bypass switches

9. Local station intrusion detection monitors and controls processing equipment and rack

2.02 HARDWARE REQUIREMENTS

A. Intrusion detection magnetic door contacts shall be located between top of door and jamb.

B. Card Reader Controllers:

1. Card reader controllers shall be fully stand-alone processors capable of making all access control decisions without the involvement of the main CPU.

2. Card reader controllers shall use flash memory modules to provide non-volatile storage of both data and operational codes.

3. Card reader controllers shall support the direct connection of a standard dot matrix printer for local transaction and report printing.

4. Card reader controllers shall provide the capability for interfacing with up to 16 card readers.

5. Card reader controllers shall be mounted remotely on the “secure” side of the door.

6. Card reader controller shall be provided with built-in hardware to support hard-wired communication between the card reader controller(s) and card readers.

C. Card Readers shall be a proximity readers, surface mounted, and located as specified in this section.

1. Card readers shall be free from sources of interference to the signals transmitted by the modules.

2. The card readers shall be integrated and contain all reader electronics inside a single polycarbonate enclosure.

3. The card readers shall operate when mounted on a variety of surfaces including metal. Maximum read range degradation when mounted on a metal surface shall be less than 50-percent.

4. The card readers shall contain an integral color LED (Light Emitted Diode) and shall sound audio tone to indicate when a card has been successfully read.

5. The card reader size shall be 12” x 12” x 2” maximum.

6. Read range shall be a minimum of 20”.

7. The card readers shall be rated for normal operation from -5 to 150 deg. F.

D. Card Keys:

1. Card key shall be encased in sealed plastic with a surface suitable to receive an adhesive backed photo ID (Photo identification).

2. Card key shall contain a machine-detectable code indicating a unique, four-digit SCN.

3. Communications between the card reader controller(s) and the host server shall be via Industry Standard Ethernet TCP/IP (Transmission Control Protocol/Internet Protocol).

4. The card reader controller(s) shall be furnished with a UPS battery configuration instead of a standard AC line power supply configuration. The battery shall power the controller upon failure of the primary AC service for a minimum of eight hours.

5. The card reader controller database, the time clock, the transaction history, and all operator entered parameters shall be backed-up by an internal battery module for 30 days after the failure of the primary power.

6. The card reader controllers shall have built-in LED to indicate communication status with the IDCAS computer.

2.03 SYSTEM WIDE OPERATION

A. Intrusion detection, key-bypass switches and audible/visual alarm shall be provided, as a minimum, for the TC&C rooms, roll up doors, emergency exits, exit hatches, end of the station platform gates and any doors that lead from public area to non-public area. Door to a hallway that serves ancillary rooms shall have a card key (and associated equipment). Contractor shall coordinate the door schedule with the architect.

B. Card readers along with intrusion detection magnetic door contacts and exit request devices shall be provided for all access controlled doors. **Internally wired request to exit hardware integrated into doors/frame shall be provided for equipment rooms.**

C. Limit switches with bypass switch and audible alarm shall be provided for the emergency exit hatches.

D. If the system fails or is out of service due to a Central Processor Unit (CPU) failure, its functions shall transfer to a backup mode of operation at each station.

2.04 INTRUSION ALARMS

A. The IDCAS comprises of ROC equipment (video display terminal, CPU, Printer and rack for modems) and local station/facility equipment (card reader controllers, card readers, magnetic door contacts, limit switches, electric door strikes, exit request devices, audible alarm devices, bypass switches, and local station/facility monitor and control processing equipment and rack). Limit switches with bypass switch and audible alarm shall be provided for the emergency exit hatches but for At-grade stations' access hatches an exit request device is also required. Door strikes shall be fail safe type which shall open upon power failure. Existing CPU (Cardkey PEGASYS 1000) shall be expanded to accommodate card readers and alarm contacts added by the Project or upgraded, as required, with future expansion capabilities up to 50 percent.

B. Provision shall be made in the intrusion detection equipment for a station-wide operation, actuated by an external input to the intrusion detection panel, to release all electrically locked doors. This control shall be actuated from a touch screen control at the ROC.

C. If the system fails or is out of service due to a CPU failure, its functions shall transfer to a backup mode of operation at each station.

D. If both the subsystem and its backup mode fail, door releases shall be affected from a remote terminal. In the event of a total failure, a mechanical means of activating door releases for exiting through the controlled doors shall be provided. This provision shall allow the pre-selection of the appropriate failure mode, be it locked or unlocked, for each specific door.

E. Upon using a key card the door shall be unlatched within 2 seconds, and shall remain unlatched for 5 seconds or until door has been opened and closed within 15 seconds. An alarm shall be sent to the ROC after any door has been opened for more than 15 seconds.

F. Upon detection of an intrusion alarm monitored door, the local station processing equipment shall provide for temporary storage, processing, and transmission of the alarm to the Facilities Emergency Management (FEM) system and the IDCAS CPU at ROC. The FEM shall provide for storage, processing and transmission of the alarm to the EMP for annunciation. The system shall maintain a record on the main CPU. The record shall include door openings, alarms, input of card with voided Security Classification Number, attempted use of invalid, identification of cards used and operator commands.

G. Card reader controllers shall be fully stand-alone processors capable of making all access control decisions without the involvement of the main IDCAS CPU based on a set of parameters passed to the card reader controller from the main IDCAS CPU. Controllers shall support the direct connection of a standard dot matrix printer for local transaction and report printing, provide the capability for interfacing with up to 16 card readers, and shall be furnished with a UPS battery configuration instead of a standard AC line power supply configuration. The card reader controller(s) shall be furnished with a UPS battery configuration instead of a standard AC liner power supply configuration.

H. Card readers shall be free of sources of interference to the signals transmitted by the modules and operate when mounted on a variety of surfaces including metal. Maximum read range degradation when mounted on a metal surface shall be less than 50-percent.

I. Each card shall contain a machine-detectable code indicating a unique, four-digit SCN. The system shall provide for input of voided SCNs and shall deny access to a card bearing a voided SCN within 30 seconds of such input.

2.05 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this

Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installations shall comply with NFPA, IBC, IFC, NEC and equipment manufacturers' requirements and procedures.

B. Install all wire and conduit in accordance with manufacturer's recommendations and applicable codes and standards.

C. Furnish and install clamps or other cable-restraining hardware in areas where support is required for cables entering or leaving conduit.

D. Furnish filling compound for cables entering or leaving conduit. The filling compound shall be applied in conformance with manufacturer's instructions.

E. Cable entrance openings in equipment enclosures and junction boxes shall be sealed with compression-type fittings or pliable sealing compound after cable is in place. Sealing compound shall be used to seal area around cable where it emerges from the end of a conduit or junction boxes.

F. Cable terminations shall have permanent cable tags identifying the cable number, the number of copper pairs in the cable.

G. Cable and conductors, which serve as communications links, shall have surge protection circuits installed at each end.

H. All equipment shall be grounded in accordance with manufacturer's installation instructions and any local or NEC Standards.

3.02 TESTING

A. Factory Testing and Inspection

1. Each intrusion detection control panel shall be powered-up and tested after the factory wiring is complete

2. Verify the magnetic switch and alarm operation

3. Verify intrusion detection keypad operation

4. Verify the card reader and the controlled door operation

B. Field Testing

1. Provide all instruments and personnel required for the test.

2. Upon completion of the installation, the Contractor shall subject the system to a complete functional and operational test. As a minimum, the tests shall include:

a. Verify the operation of the keypad panel

b. Verify the operation of the controlled access card and door

c. Measure audible alarms output level

d. Test Request-To-Exit target pattern and timeout

e. Test all inputs, outputs and functions of the intrusion detection supervisory, card access and network panels.

3. When all corrections have been made, the system shall be re-tested to assure that it is functional.

C. System End-to-End Acceptance Test

1. Contractor shall provide a local end-to-end test procedure for the IDCAS system at every station to show the proper functionality and performance.

2. Contractor shall provide qualified technical staff to support the end-to-end testing of the IDCAS equipment located at the ROC.

D. System Integration Test

1. System integration test (SIT) shall be performed after the completion of all individual system testing. Contractor shall submit a complete and detailed SIT plan and procedure for approval.

END OF SECTION 28 16 00

SECTION 28 23 00

COMMUNICATIONS CLOSED CIRCUIT TELEVISION SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Detailed technical requirements for the closed circuit television (CCTV) system to be designed, furnished, installed and tested under this contract. The CCTV system shall be designed to provide visual surveillance of designated passenger platform and ticket vending areas for security control and assistance to patrons. This system shall provide monitoring capability for the stations, parking **lots** and **parking** structures, cross-passages, and shall be compatible with the existing equipment at the Rail Operations Control (ROC).

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 43 Spare Parts, Spare Parts Catalog, and Replacement Materials

D. Section 27 05 56 Safety and System Assurance

1.03 REFERENCES

A. American Public Transportation Association (APTA)

1. APTA IT-CCTV-RP-001-11 Recommended Practice, Selection of Cameras, Digital Recording Systems, Digital High-Speed Networks and Trainlines for Use in Transit-Related CCTV Systems

2. APTA SS-SIS-RP-002-08 Technical Recommended Practice for Cameras Coverage and Field of View Criteria for Passenger Facilities

3. APTA-RT-S-SC-012-03 Standard for Closed Circuit Television (CCTV) Inspection, Testing and Maintenance

B. Electronic Industries Association (EIAA)

1. Bulletin #1 CCTV Definitions

2. EIA-310D 19-inch Rack Standard

3. EIA-568-A Commercial Building Telecommunications Cabling Standard

4.	EIA-632	Electronics Industrial Alliance (EIA) Standard: Processes for Engineering a System
5.	EIA-649	Standard for Configuration Management
6.	EIA-836	Configuration Management Data Exchange and Interoperability

C. Industry Foundation Classes Standard (IFC)

D. Institute of Electrical and Electronics Engineers (IEEE)

1.	IEEE 802.3	Ethernet (CSMA/CD)
2.	IEEE 1473	Communications Protocol Aboard Passenger Trains
3.	IEEE 1220	Application and Management of the Systems Engineering Process

E. International Building Code (IBC)

F. International Organization for Standardization (ISO)

1.	ISO/IEC/JTC1/SC29 WG11	Coding of Moving Pictures and Audio

G. Manufacturing Method (MM)

1.	MM-33A	Process Control Specification for Paint Application
2.	MM-42	Process Control Specification of Chromate Conversion Coating

H. National Fire Protection Association (NFPA)

1.	NFPA 70	National Electrical Code

I. National Electrical Manufacturers Association (NEMA)

1.	NEMA 3R	Standards for Enclosure, Box & Cabinet - Rating & Definition

J. California Occupational Safety and Health Standard (Cal/OSHA)

K. National Fire Protection Association (NFPA)

1.	NFPA 70	National Electric Code (NEC)

L. Underwriters Laboratories (UL)

1.	UL 2044	Standard for Commercial Closed Circuit Television Equipment

2.	UL 2391	Equipment with Remote Feeding Telecommunication circuits Intend for Backwards Compatibility in Legacy Telecommunication Equipment
3.	UL 3044	Standard for Surveillance Closed Circuit Television Equipment

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, Safety and System Assurance, Section 1.04 for Quality Assurance requirements.

C. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in Subsection 1.03 – References.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Plan drawings showing location, mounting and viewing angle of each camera.

C. Provide additional estimated capacity required at the centralized network video server (NVS) for all new CCTV equipment, based on calculations for archiving system video with 30-day retention at 30 frames per second (fps), 4 Common Intermediate Format (4 CIF) resolution, and Moving Picture Experts Group 4 (MPEG-4) compression.

D. Rack layouts and elevations for CCTV equipment including assembly and installation drawings.

E. Fiber optic link loss budgets for all fiber optic spans installed under this contract. Calculations shall show that total anticipated optical loss in dB for each span meets the published link loss budgets.

F. Detailed hardware interface schematics and installation details.

G. Provide IP addressing of all networked equipment.

H. Termination and interconnection diagrams for all cable to each component furnished and installed under this Contract. Include any intermediate termination, main distribution frame (MDF) and fiber distribution panel (FDP).

I. Manufacturer’s technical product data for all devices furnished with certificates of compliance, dimensions, capacities, performance, electrical characteristics and start-up instructions.

J. Detailed installation work plans and procedures.

K. Detailed test plans and procedures for the following:

1. Factory acceptance tests (FAT)

2. Local field acceptance tests (LFAT)

3. Systemwide field acceptance tests (SFAT)

L. Test records.

M. Calculations and Certifications

1. Calculations as listed above

2. ISO certifications for all proposed manufacturers

N. Maintenance training course outlines.

O. As-Built Documentation

1. Shop Drawings with the following information:

a. Floor plans showing locations of all devices. Label each control device with setting or adjustable range of control.

b. Wiring diagrams. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

c. Logic diagrams showing sequence of events and their relationship.

d. Sequence of operation

e. Information for all programmable equipment together with the associated passwords and access codes

P. Product Data: Approved manufacturer's technical product data

Q. Manufacturer's operating and maintenance instructions for the complete system

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. Functional Requirements

1. The system shall be designed for everyday safety and security requirements as well as revenue protection, anticrime and antiterrorist applications requiring the identification of unknown people and objects depicted within images and provide monitoring capability and video recording of all cameras at the ROC. CCTV video at each facility shall be concurrently recorded on a local **Network** ~~Digital~~ Video Recorder (**N**~~D~~VR) and transmitted via CTS to the ROC as a live

video stream concurrently displayed on the video wall in the monitoring stations.

2. The system shall provide monitoring capability and video recording of all cameras at the ROC

B. Passenger Stations

1. IP pan tilt zoom (PTZ) cameras shall be installed to permit monitoring of the station**,** ~~and~~ platform **and plaza** areas**.** ~~and shall provide a minimum default viewing of:~~

a. 100% coverage required in the public areas of the station with cameras at their "home" position (in other words, 100% coverage should be achieved without requiring PTZ).

~~a.~~**b.** Ticket vending machine (TVM) equipment, passenger assistance telephone (PTEL) and **gate telephone (GTEL)** in the paid areas**.**

c. Passenger loading/unloading areas on platforms**.**

~~b.~~**d. Entrances from public areas to authorized ancillary areas.**

~~c.~~**e.** Additional locations such as intersections at entrances to stations, **emergency exit areas,** security-sensitive areas and station bike parking areas**.**

f. All CCTV camera signals shall be locally recorded and capable of transmitting recorded or live video images back to ROC for viewing at the CCTV console.

g. Pull-out areas adjacent to platforms.

h. Cameras need to look out, as well as in, to the station on the plaza level; in other words, camera views should show whether a station is "being watched".

~~d.~~**i. The entire plaza level, including bike-parking areas should be covered.**

~~e.~~**j.** Activation of the handsfree emergency telephone (ETEL)**, (GTEL)** or PTEL in the station shall trigger an alarm and automatic selection of the camera with the best view of the area.

2. As a minimum, camera placement shall be one per 75'-0" of viewing area**.**

C. Dedicated cameras shall be provided for elevators that give full coverage and field of view of the cab interior and elevator entrances. Two cameras shall be provided for elevator cabs with doors on opposite sides. Dedicated PTZ cameras shall be provided for monitoring all elevator entrances areas. Dedicated PTZ cameras shall be provided to monitor each escalator at each landing (Top & Bottom).

D. Parking Lots and Structure

– **CCTVs shall be provided for specific locations in parking lots, parking structures.**

~~D.~~

1. PTZ cameras shall be installed to provide full coverage in parking lots **and ramps**.

2. PTZ cameras shall be installed in parking structures in the following locations:

   a. Elevators

   b. Elevator lobbies (on each level)

   c. 100% coverage of parking areas.

   ~~c.~~**d. Enclosed** Stairways

   e. Entrances and **E**~~e~~xits

   ~~d.~~**f. Provision shall be** made **for future Automatic License Plate Recognition (ALPR) cameras to be installed at the vehicle entrances and exits.**

3. Power and communication conduits, two (2) x 1" minimum, shall be provided from CCTV hub location to all public and employee parking **structure and** lots associated with HRT passenger stations for future surveillance **and additional conduits shall be provided for future ALPR** cameras. The conduit stub-ups shall be designed and installed at locations/intervals to provide comprehensive surveillance of the lot or structure. Actual camera quantities and camera grouping will be used in determination of actual conduit size.

E. Cross-Passages

1. One PTZ camera shall be installed at each cross-passage to monitor the cross-passage area in the tunnel. Power and communication conduits shall be provided from the CCTV camera location to the communications interface cabinet (CIC) or CCTV enclosure at the cross-passage.

F. General

1. The CCTV system shall be **TCP/IP based video transmission network system.**~~an IP-based system.~~

2. IP PTZ cameras shall be used in CCTV system design, wherever it is possible.

~~1.~~**3.** The CCTV picture characteristics shall be as follows:

   a. National Television System Committee (NTSC) color format

   b. The CCTV system shall be capable of supporting the following video resolutions and shall be user-adjustable at the ROC console:

1) Up to 30 fps (frame per second, user selectable 5, 15 or 30) at Common Intermediate Format (CIF) (360x240)

2) Up to 30 fps (user selectable 5, 15 or 30) at 2CIF (720x 240 or 640x480)

3) Up to 30 fps (user selectable 5, 15 or 30) at 4CIF (720x576)

4) Minimum monitor resolution shall be 720 lines

~~2.~~**4.** The camera shall provide a usable video signal (as defined below) over the entire specified range with a scene illumination as low as 1.0 foot-candle. The camera shall detect and render 10 shades of gray from the EIA (Electronic Industries Alliance) TV resolution chart with 5 fc (foot candle) illuminations.

~~3.~~**5.** System shall be designed to provide a minimum resolution of 4 CIF at 15 fps from all cameras.

~~4.~~**6.** System shall be IP based and use the MPEG 4 protocol for transmission on the dedicated CCTV network.

7. Minimum ambient illumination shall be one fc when emergency lighting is activated.

8. The IP PTZ cameras can be powered by using Power over Ethernet (PoE), wherever it is applicable.

~~5.~~

~~6. The signal-to-noise ratio over the entire system length shall be no less than 44 dB (for analog portion of the system, if used).~~

~~7.~~**9.** CCTV systems shall be configured in a hub-and-spoke arrangement, with local recording being undertaken and **images** compressed images then being transmitted back to the ROC via the CTS fiber optical network.

~~8.~~**10.** Camera Identification

a. A discrete camera ID consisting of a minimum of sixteen alphanumeric digits in ASCII-II code shall be superimposed on each camera video to identify the camera location including the platform (east/southbound or west/north bound) location.

~~9.~~**11.** Wayside Transmission

a. Video transmission between each passenger station and the ROC monitoring areas shall be by digital fiber optic techniques. Each passenger station shall be designed with sufficient supporting equipment capacity to add 40% additional cameras for expansion. The fiber optic network for the CCTV system shall provide equipment for multiple CCTV camera inputs. The optically transmitted signal shall be recreated at the ROC for distribution to the various monitors.

~~10.~~**12.** Video Recording System

a. All CCTV camera signals shall **be** record**ed** ~~video images~~ in real time **at the station network video recorder**. Local server equipped with video storage hardware shall be able to store at least ~~3~~**7** days of recorded video images set to highest resolution quality. The **selected camera signals can be controlled and routed from remote sites to the CCTV observer consoles in ROC.**~~recorded video images shall be capable of being retrieved and controlled by the ROC control console.~~ **A CCTV management system shall control and record the selected CCTV video images into the network video repository at the ROC. The playback provision shall be able to display recorded images.**

b. The CCTV system shall be capable of applying time and date stamps on each recording

G. Operation: Continuous Duty

1. Digital Signatures

a. In order to digitally sign a file, all data/video files, which are to be protected, shall be passed through a hashing function. The hashing function shall produce a large checksum value for the file, which shall then be encrypted using the private key. The two hashing functions most recognized by and acceptable to Metro, which may be used for digital signature technologies, are MD5 and SHA-1. Contractor may propose equivalents for approval.

b. Watermarks shall not be used for traceability of video evidence.

H. Interface

1. The CCTV system shall be interfaced with GTEL, ETEL and PTEL such that activation of GTEL, ETEL and PTEL within viewing distance of a CCTV camera shall cause the video scene from that camera to be automatically displayed at the ROC on the console (event) monitor (camera call-up). If several calls are originated, the images shall be rotated on the console (event) monitor. The image shall be maintained until the GTEL, ETEL or PTEL call(s) is terminated. After that the event monitor should display the last camera image prior to call-up event.

I. Alarms

1. CCTV individual alarms shall be transmitted from each station to the CCTV or supervisory control and data acquisition (SCADA) console in the ROC.

2. The alarms, at a minimum, shall include:

a. Power failure

b. CCTV communications equipment failure (transmission equipment)

c. CCTV cable failure

d. Video loss

2.02 MAJOR COMPONENTS

A. IP Cameras

1. Contractor shall provide the necessary number of cameras to comply with surveillance coverage requirements.

2. Camera equipment shall have the following features and meet the technical requirements listed herein:

   a. All camera equipment shall be IP-based and interchangeable between locations.

   b. Input Voltage: 24 VAC

   c. Produce a picture with no geometric distortion

   d. Signal-to-line ratio shall be at least 48dB.

   e. The line loss between each camera and the multiplexer or recorder shall not cause the signal-to-noise ratio fall below 45dB.

   f. Gamma correction (0.45 to 1.0 adjustable) shall have an automatic light range that results in not more than 3dB video output change with a 1000:1 change in scene luminance.

3. PTZ commands shall be non-proprietary and conform to industry standards.

4. PTZ cameras shall have the following additional features:

   a. Pan movement: -3° ~ 90°

   b. Tilt movement: 0° horizontal to 90° down

5. Power over Ethernet shall be used for all cameras in the station, tunnel and cross-passage areas.

B. Camera Lenses

1. Contractor shall provide lenses in each camera and determine size, type, and features necessary to achieve coverage requirements of this Specification.

2. Lenses shall be auto-iris, directly interchangeable without electrical or mechanical modifications or adaptations. Each lens shall have a neutral density spot filter. Lenses shall be capable of mounting in a sealed environmental housing.

C. Camera Enclosures

1. The Contractor shall provide an enclosure and mounting hardware required to install camera.

2. Enclosures shall run on 24 VAC power.

3. Enclosures shall meet NEMA 3R standards or better.

4. Window material shall be scratch-resistant.

5. Enclosures shall be installed with sunshields in areas where they are exposed to direct sunlight that could distort camera images.

6. Enclosures shall have lockable latches, capable of being padlocked for security. Any exterior fasteners shall be tamper-resistant.

7. Enclosures shall have a minimum of two sealable glands on the bottom of the enclosure for cable entry. All wiring shall be terminated neatly on wiring blocks/terminals within the enclosure. **The connecting cabling shall have drip loops and also be in liquid tight.**

8. All holes in camera enclosures shall be sealed to prevent debris from entering. Camera equipment shall be electrically isolated from station building and structure grounding systems.

9. Any deviation from the approved configuration of camera placement shall be subject to Metro approval.

D. Camera Mounting Kits

1. Camera mounting kits shall be used to support the loads of camera and enclosure along with the wind load. All parts shall be protected from corrosion.

2. For pole-mounted cameras, adapters shall be provided for placing standard wall-mount units on camera-equipped poles.

E. Local Area Networking (LAN) Equipment

1. Ethernet switches shall be required to connect all cameras locally, aggregate video from a single station or portion of a station, and transmit video to a CTS node that transports video to the ROC CCTV console via the CTS network. Ethernet switches shall have following features:

   a. Ethernet switches shall support IEEE 802.3 (10BaseT), IEEE 802.3u (100BaseTX, FX) standards.

   b. Ethernet switches shall have sufficient quantities of copper, RJ-45, 10/100 ports sufficient to connect all cameras, plus 10 percent spare. Where an Ethernet switch is more than 300 feet from the CTS node it connects to, two or more 100BaseFX fiber ports supporting transmission over multimode or single-mode fiber-optic cabling or media converter shall be provided to uplink all station video to the CTS as indicated. All fiber ports shall be duplex.

   c. Ethernet switches shall have the following indicators - Port status LEDs, system status LEDs, power status LEDs.

d. Ethernet switches shall be capable of local management and shall be remotely **managed** ~~manageable~~ by **CTS local Ethernet** ~~a telnet~~ connection and a single simple network management protocol (SNMP)-based manager application.

e. Ethernet switches shall be rack-mounted.

F. PoE Extender

1. Category 6 cable extenders shall be used when the cable length between the nearest switch and the camera is greater than 300 ft, or when the signal becomes degraded due to cable length.

2. Ethernet extenders shall be paired identically to ensure compatibility.

3. Units shall have a line interface and a 10/100BaseT Ethernet RJ-45 equipment interface.

4. Remote extenders used at cameras shall be non-powered.

G. PoE Media Converter

1. Media converters shall be used to convert optical input signals from the remote or wayside CCTV cameras to electrical signal output to the Ethernet switch.

2. LAN media converters shall convert the 10/100 Base-T/TX ports of Ethernet switching modules at stations to 100 Base-FX for transmission over fiber optic media. The Contractor shall furnish, install, and test these media converters.

3. Where installed with other modular media converter chassis, modules shall be added to that chasses rather than installing stand-alone media converters.

4. The converters shall comply with the following requirements:

a. 10/100 Base-T/TX to 100 Base- FX converter

b. Interfaces: 100 Base-TX (RJ-45), 100 Base-FX (SC) optical

c. Protocol Compatibility: IEEE 802u 100 Base-TX and 100 Base-FX Standards

d. Operating Distance: 328feet for 100Base-TX, 1.3 mile for 100 Base-FX MM, 9.4 miles for 100 Base-FX SM

e. Data Flow: Half or full duplex support

f. LEDs: Power, link, transmit, receive

g. Fiber Requirements: Multimode, and single-mode fiber cabling with SC connectors

h. Input Power Requirement: 120 VAC

5. Power Supplies - If Power over Ethernet (PoE) is not used, both camera and enclosure shall be powered by a 24 VAC power supply. Input power shall be sourced from the station uninterruptible power supply (UPS), 120V, 208 or 277 VAC) through a transformer. Each power supply output shall have a fuse sized adequately for all connected equipment, but no less than one (1) amp. PTZ cameras shall have their own power supply. Power supply shall have integrated surge suppression on the AC voltage input.

6. Individual camera power transformer shall be provided for 24 VAC power requirements of camera and enclosure where conduits cannot connect camera location to a centralized camera power supply. Single-phase primary input voltage will be 120/208/277 VAC, depending on the available station power at the camera location. The output voltage will be 24 VAC to the camera and enclosure.

~~7. Digital Video Recording~~

~~a. A server with 5 terabytes of storage shall be provided for video data recording. Recorded image resolution can be up to 30 fps (user selectable 5, 15 or 30) at 4CIF.~~

H. Local Network Video Server (NVS)

1. Contractor shall provide the network video server at each station for local and remote access, playback, and evaluate the video surveillance data stored in the NVS.

2. Storage capacity shall be as specified.

I. Network Video Server (NVS) Monitoring and Archival Software (Metro furnished)

1. The NVS shall be the centralized administration tool for management of all local network video archive server (LNVAS), virtual matrixes, cameras, and client viewers as well as authenticating and managing access to both live and archived video feeds. All software specifications, features, and functionalities shall be compatible with the software selected for the Local Network Video Archive Servers to provide a completely integrated video management system.

2.03 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installations shall comply with NFPA, IBC, IFC, NEC and equipment manufacturers' requirements and procedures.

B. Field adjustments shall be made as required to provide or improve the field of view of the area to be monitored. Final alignment shall be the responsibility of the contractor, and any costs related to changing lenses to obtain the desired field of view shall be included in the original bid price.

C. All equipment shall be grounded in accordance with the recommendations of the manufacturers.

D. Field Installation

1. Cabinets shall be installed and securely bolted to the floor.

2. Cabling shall be secured to racks and cable trays using approved cable management equipment to avoid any pinching or micro bends. Fiber optic cables shall be secured only with Velcro-type cable ties.

3. All power, control, and communications cabling shall be concealed from public view inside conduits or other defined cableways.

4. Fiber boots shall be installed on fiber jumper connectors at connection points requiring a 90-degree or greater bend within six inches of the connector.

5. All cables shall be routed in cable trays between racks.

3.02 TESTING

A. The Contractor shall perform the following inspections and tests on the CCTV subsystem:

1. Camera Performance Criteria and Field of View Target Testing

a. Recorded images captured at 4CIF shall achieve a minimum of 400 TVL (TV Line) of resolution when tested against a Rotakin standard or similar calibrated card for digital camera systems, when recorded and observed in playback on a normal video monitor.

b. Test target shall occupy 100% of the screen height of the monitor on which the image is viewed. Picture quality and detail shall be sufficient to enable the identity of an individual. Metro shall be present during field of view testing to validate the quality of live and recorded video from the CCTV system. If Metro determines that the images produced by the system are of insufficient quality to maximize the likelihood of identifying people or objects depicted therein, the contractor, upon notification by Metro, shall make any necessary changes, modifications, or repairs to conform video quality to the goals and requirements of this Specification.

c. The contractor shall perform testing under all operating station conditions such as day/night; train entering, berthed, and leaving station.

d. Verify and record all power connections and levels at the camera.

e. Ethernet continuity testing over media converters and fiber extension links from TC&C rooms to the wayside cameras utilizing media conversion equipment over fiber optic cable.

B. System End-to-End Acceptance Test

1. Contractor shall provide a local end-to-end test procedure for the CCTV system at every station to show the proper functionality and performance.

2. Contractor shall provide qualified technical staff to support the end-to-end testing of the CCTV equipment located at the ROC.

C. System Integration Test

1. System integration test (SIT) shall be performed after the completion of all individual system testing. Contractor shall submit a complete and detailed SIT plan and procedure for approval.

END OF SECTION 28 23 00

SECTION 28 31 00

COMMUNICATIONS FIRE DETECTION SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Detailed technical requirements for an intelligent microprocessor based fire alarm system. The system shall be designed to provide fire detection and reporting for the stations and the cross-passages. It shall include, but not be limited to alarm initiating devices, alarm notification appliances, power supplies, auxiliary control devices, control panels and graphic annuciator panel.

B. Performance of initiating device circuits (IDC) and signaling line circuits (SLC) shall be Class A, Style D and Style 2, as defined in NFPA 72, Sections 23.5 and 23.6, respectively. All control and monitoring circuits shall be supervised.

C. Notification appliances shall meet Americans with Disabilities Act (ADA) and NFPA-72 requirements. Performance and capabilities of notification appliance circuits shall meet Class B as defined in NFPA-72 Section 23.7.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 43 Spare Parts, Spare Parts Catalog, and Replacement Materials

D. Section 27 05 56 Safety and System Assurance

1.03 REFERENCES

A. National Fire Protection Association (NFPA):

1. NFPA 70 National Electric Code
2. NFPA 72 National Fire Alarm Code
3. NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail.

B. Underwriters Laboratories, Inc. (UL):

1. UL 268 Standard for Safety Smoke Detectors for Fire Protective Signaling Systems
2. UL 864 Control Units And Accessories For Fire Alarm Systems

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, Safety and System Assurance, for Quality Assurance requirements

C. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in Subsection 1.03 – References.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Floor plans showing locations of all devices.

C. Standby battery calculations.

D. Voltage drop calculations.

E. Sequence of operations.

F. Single-line system architecture drawings representing the entire fire alarm system provide for each station.

G. Interfaces with all connected sub-systems.

H. Drawings shall be signed by the California licensed fire safety professional engineer.

I. Termination and interconnection diagrams for all cable to each component to be furnished and installed.

J. Manufacturer's technical product data for all devices furnished with certificates of compliance, dimensions, capacities, performance, electrical characteristics and start-up instructions.

K. Detailed installation work plans and procedures.

L. Detailed test plans and procedures for the following:

1. Local field acceptance tests (LFAT)

2. Systemwide field acceptance tests (SFAT)

M. Test records.

N. Calculations and Certifications

1. Calculations as listed

2. Certifications: ISO certification for all proposed manufacturers

3. Certificate of Completion per NFPA 72

O. As-Built Documentation

1. Shop drawings with the following information:

a. Plan drawings showing locations of initiating and notification devices

b. Wiring diagrams

c. Logic diagrams showing sequence of events and their relationship

P. Product Data: Submit approved manufacturer's technical product data.

Q. Record of Completion per NFPA 72 requirements.

R. Manufacturer's operating and maintenance instructions for the complete system.

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

All equipment and components shall be new and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency. The authorized representative of the manufacturer of the major equipment such as fire alarm control panel (FACP) and transmitters shall be responsible for satisfactory system operation and its certification.

A. Fire detection throughout the system shall be accomplished via intelligent, addressable detectors. Addressable modules and/or supervised FACP remote I/O shall be provided to control and monitor the ventilation system and door releases. All fire initiated actions such as fan shutdown, elevator recall, shunt trip, door releases, etc. shall be implemented using addressable control modules. The FACP shall transmit alarm/trouble zones to the Metro's provided fire alarm workstation located in the rail operations control (ROC).

B. FACP shall automatically activate fire protection functions (such as recalling elevators and shutting down fans & dampers) as required in the fire activation matrix.

C. The fire alarm system shall be electrically supervised and shall monitor the integrity of all conductors.

D. The system shall be an active/interrogative type system where each addressable device is repetitively scanned, causing a signal to be transmitted to the FACP indicating that the device and its associated circuit wiring is functional. Loss of this signal at the FACP shall result in a trouble indication as specified hereinafter for the particular input.

E. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the ROC.

F. Upon activation of the Evacuation microphone at the FACP or EMP, the FACP shall suppress all active fire audible devices in the notification appliance circuits (NAC).

2.02 FIRE ALARM CONTROL PANEL (FACP)

FACP shall be an intelligent device with network capability. It shall be of modular design for ease of future system expansion. The FACP shall incorporate a microprocessor-based central processing unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, control circuits, and notification appliance circuits, local and remote operator terminals, printers and annunciators.

A. The FACP shall perform the following functions:

1. Supervise and monitor all intelligent addressable detectors and modules for normal, trouble, and alarm conditions

2. Supervise all initiating signaling and notification circuits

3. Detect activation of any initiating devices and indicate the location of the alarm condition. Operate all notification appliances and auxiliary devices

4. Automatically perform self-diagnostic testing and initiation of alarms and identify any faults within the systems

5. The FACP shall include a full featured operator interface control and annunciation panel, style alphanumeric keypad for the field programming and control of the fire alarm system

6. The FACP shall have drift compensation feature which adjusts detector sensitivity and increase resistance to false alarms caused by dust accumulation

7. The Gas controller shall interface with the FACP through monitor modules to report gas alarms. These alarms will be displayed at the graphical annunciator at the EMP and at the dedicated FLS console at the ROC. The gas alarms will cause the activation of notification devices as shown on the activation matrix.

8. FACP shall provide dry contact summary alarm, summary trouble and summary supervisory interface to the SCADA PLC for system redundancy.

~~7.~~

B. Central Processing Unit (CPU)

1. The CPU shall provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost in the event of system primary and secondary power failure.

2. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

C. Display

1. The system display shall provide all the controls and indicators used by the system operator.

2. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.

3. The system display shall provide keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

D. Loop Control Module:

1. The loop control module (LCM) shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.

2. The (LCM) shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Style 6 (Class A) circuit.

3. The signaling line circuit (SLC) interface board shall be able to drive an NFPA Style 6 twisted unshielded circuit up to 12,500 feet in length. The SLC Interface shall also be capable of driving an NFPA Style 6, no twist, no shield circuit for limited distances determined by the manufacturer. In addition, SLC wiring shall meet the listing requirements for it to exit the building or structure.

4. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

E. Enclosures:

1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

2. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.

F. Power Supply:

1. The power supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.

2. The power supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.

G. System Circuit Supervision

1. All speaker and emergency phone circuits shall be supervised for opens and shorts. Each transponder speaker and emergency phone circuit shall have an individual ON/OFF indication (green LED).

H. Field Programming

1. All field defined programs shall be stored in non-volatile memory.

2. The system programming shall be "backed" up via an upload/download program, and stored on compatible removable media. A system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.

2.03 FIRE DETECTION DEVICES

A. Fire detection devices shall be addressable and shall include, but not be limited to:

1. Smoke detectors (photoelectric and ionization)

2. Duct detectors (detector, housing, remote LED, and sampling tube)

3. Heat detectors

a. Combination rate-of-rise and fixed-temperature

b. Rate-compensated heat detector

4. Monitor modules

5. Control modules

6. Isolation modules

7. Strobe Light, chime/strobes lights and horn with strobe lights

8. Sprinkler standpipe valve supervisory switches

9. Supervised Remote I/O

B. Detectors shall be provided as specified and per the Metro Design Criteria.

1. Ionization or photoelectric area smoke detectors shall be provided at station TC&C rooms, and the cross passages.

2. Ionization duct smoke detectors shall be furnished for the following HVAC equipment:

a. Supply fans having capacity of 2000 CFM or more

b. Return air ducts that circulate air from one area of the structure to another

c. Combination fire/smoke dampers (use area smoke detectors where applicable)

3. Heat detectors shall be furnished at:

a. High voltage areas (such as TPSS's and auxiliary power rooms)

b. Elevator equipment room

c. Rate-compensated heat detector to be mounted onto edge light of the station platform for detecting fire on the train to immediately initiating the EVOP.

2.04 LOCAL GRAPHICAL ANNUNCIATION PANEL

A. The equipment installed is only for monitoring fire/gas detection and fire suppression.

B. The local graphical annunciation panel shall be installed inside the facilities emergency management panel (EMP) for monitoring of the fire alarm devices.

2.05 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed as indicated.

B. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.

C. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.

D. Conduit shall be one inch minimum.

E. All field wiring shall be supervised.

F. T-Tapping shall not be allowed.

~~F.~~**G. The originated and the returned path of the fire alarm supervision loop which monitors the status of the fire alarm equipment in the cross-passages shall be in separate tunnels.**

~~G.~~**H.** All equipment shall be grounded in accordance with manufacturer's installation instructions and any local or NEC Standards.

~~H.~~**I.** All devices must be accessible for maintenance, and shall not be installed directly over high voltage equipment. If a device cannot be accessed with an eight foot ladder, it must have a fall protection device installed next to it, and room to access with a ladder. Otherwise, fixed ladders and fall protection devices must be installed.

3.02 SEQUENCE OF OPERATION

A. Detection of a fire alarm condition by a system initiating device shall cause the following:

1. Indicate the device and its associated zone at the FACP

2. ROC shall evaluate the alarm condition and select a pre-programmed scenario(s) developed and programmed by the Contractor. However, heat detectors mounted above station platform shall automatically activate the emergency ventilation system (exhaust/station fire mode) within 90 seconds.

3. Annunciate both visually and audibly at the FACP, the EMP, and Metro's fire alarm workstation

4. Execute all automatic programs assigned to the alarm point per the sequence of operation

5. Automatically shutdown fans and air conditioning equipment associated with the **heat detectors,flow switches, smoke detectors and** duct detector**s.**

6. Automatically close combination fire/smoke dampers associated with duct smoke detection or local area smoke detection

7. Automatically close fire held open doors associated with local area smoke detection

8. Activate notification appliances and release faregates per zone

9. Elevator fire recall **/ shunt trip (as applicable).**

B. Detection of a trouble condition by the system initiating device shall cause the following:

1. Indicate the appropriate detector failure or supervising circuit trouble signal at the FACP

2. Transmit trouble signal from the FACP to the Metro's provided fire alarm work station

3. Annunciate visually and audibly the appropriate trouble at the FACP and at the fire alarm work station

3.03 TESTING

A. Operational testing for the fire alarm system shall be accomplished by a specialty subcontractor, licensed and certified for fire alarm system design, installation and testing by the state of California.

1. Field Test

a. As a minimum, the test shall include:

1) Test all inputs, outputs, and functions of the fire alarm control panel

2) Verify operation of the heat detectors

3) Measure audible alarms output level

B. System end-to-end acceptance test

1. Contractor shall provide a local end-to-end test procedure for the fire alarm system at every station to show the proper functionality and performance.

2. Contractor shall provide qualified technical staff to support the end-to-end testing of the fire alarm equipment from ROC.

3. System Integration Test

a. System integration test (SIT) shall be performed after the completion of all individual system testing. Contractor shall submit a complete and detailed SIT plan and procedure for approval.

END OF SECTION 28 31 00

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SECTION 28 33 00

COMMUNICATIONS GAS DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Detailed technical requirements for the Gas detection system to be designed, furnished, installed and tested under this contract for the stations and the tunnels.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 43 Spare Parts, Spare Parts Catalog, and Replacement Materials

D. Section 27 05 56 Safety and System Assurance

1.03 REFERENCES

A. California Code of Regulations (CCR):

1. Title 24, Part 2 California Building Code
2. Title 24, Part 3 California Electrical Code
3. Title 8 Cal OSHA
4. Title 19 Public Safety

B. National Fire Protection Association (NFPA):

1. NFPA 70 National Electrical Code (NEC)
2. NFPA 72 National Fire Alarm Code
3. NFPA 72D Installation, Maintenance, and Use of Proprietary Protective Signaling Systems
4. NFPA 101 Life Safety Code
5. NFPA 130 Fixed Guide Way Transit Systems

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Section 27 05 56, Safety and System Assurance, Section 1.04 for Quality Assurance requirements

C. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in Subsection 1.03 – References.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Floor plans showing locations of all devices.

C. Rack layouts and elevations for gas detection system equipment including assembly and installation drawings.

D. Detailed hardware interface schematics and installation details.

E. Termination and interconnection diagrams for all cable to each component furnished and installed under this Contract. Include any intermediate termination, Main Distribution Frame (MDF), Fiber Distribution Panel (FDP), or station protector equipment terminal block assignments.

F. Manufacturer's technical product data for all devices furnished with certificates of compliance, dimensions, capacities, performance, electrical characteristics and start-up instructions.

G. Detailed installation work plans and procedures.

H. Detailed test plans and procedures for the following:

1. Factory acceptance tests (FAT)

2. Local field acceptance tests (LFAT)

3. Systemwide field acceptance tests (SFAT)

I. Test records.

J. Certifications:

1. ISO certification for all proposed manufacturers

K. Maintenance training course outlines.

L. As-Built Documentation

1. Shop Drawings with the following information:

a. Plan drawings showing location of all gas sensors.

b. Wiring diagrams – clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

c. Logic diagrams showing sequence of events and their relationship.

d. Provide sequence of operation.

e. Submit detailed information for all programmable equipment together with the associated passwords and access codes.

M. Product Data

1. Approved manufacturer's technical product data for devices.

N. Operation and Maintenance Data

1. Manufacturer's operating and maintenance instructions for all items of equipment.

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. The gas monitoring system shall be a working stand-alone subsystem consisting of a Control Unit, detector head, transmitter, cabinet, power supply, and all accessories necessary for proper operation. Control Unit(s) and other components to be installed in a given Train Control & Communications room shall serve sensors for that station and its associated tunnel cross passages.

B. Products used in shall be produced by manufacturers regularly engaged in the manufacture of similar items and have a history of satisfactory production acceptable to the Metro. The system component parts manufacturer shall have an ISO 9001 Registered Quality Control System in place.

C. Components and assemblies shall have applicable CSFM, UL, ETL or FM listings and shall conform to standard EIA requirements as applicable.

D. The equipment items and accessories provided shall be new, free from defects impairing performance, durability, or acceptance, and in the quality best suited for the indicated purposes.

E. The system shall minimize the risk to personnel and facilities of exposure to dangerously high concentrations of gases. Inherent in the system design will be the ability to help manage the gas exposure. Also, inherent in the system design will be internal, continuous self-diagnostic testing to ensure the system is operating properly.

F. The gas control panel shall monitor the gas levels and communicate to the Rail Operations Control (ROC). The gas monitoring instruments shall provide the gas concentration and the calibration mode to the RTU system. The set point alarm for evacuation and trouble alarms shall be annunciated at the Fire Alarm Control Panel (FACP).

G. The gas alarms will be annunciated on the graphical annunciator at the EMP through the fire alarm panel. The SCADA System will provide a programmed response to the alarm by activating tunnel/station ventilation systems Emergency Gas Operation procedure (EGOP), in accordance with contractor produced pre-programmed scenarios. The SCADA system shall provide two single-bit EGOP

commands, one for half-speed fan operation and one for full speed operation. Methane gas levels in excess of 25% LEL (Lower Explosive Limit) or Hydrogen sulfide in excess of 10ppm will initiate an evacuation notice via the FACP.

H. The Contractor shall be responsible to ensure that all equipment items and accessories supplied as part of the gas monitoring system are compatible and will operate as a complete working system.

2.02 CONTROL UNIT

A. The Control Unit shall be a standard, current manufacture unit designed for supervising and monitoring gas detectors. The Control Unit shall consist of a cabinet mounted programmable gas detector input/output modules and controller.

B. The Control Unit shall be equipped to receive and condition the gas detector signals, determine calibration information, store event information, and communicate configurable information to the SCADA. The Control Unit shall also provide the local audible alarm when preset alarm levels are detected and shall automatically cancel the audible alarm when gas levels decline below the preset alarm levels.

C. The Control units shall provide communication link to the SCADA for analog gas concentration and control unit calibration status. When a malfunction occurs in the sensing element, wiring, transmitter, or control unit, a trouble alarm shall be sent to the FACP for annunciation at ROC and at EMP.

D. During the calibration process, no alarms shall be sent to the ROC and the EMP. A clear indication shall be provided on the Control Unit for each sensor to indicate the sensor being calibrated. This calibration status shall also be configurable as a condition for the trouble alarms sent to the ROC and the EMP. The Control Unit shall display the sensor reading during calibration. The EVAC alarms to FACP shall be suppressed during the calibration. For each Control Unit, provide a label that identifies each detector being monitored and all the detector locations.

E. The Control Unit shall be a microprocessor based controller and shall be utilized to control the performance of the gas detection system. System configuration shall be user programmable. Alarm set points shall be adjustable. Memory device shall retain configuration data and event data, even after power to the unit is cycled. The Control Unit shall include:

1. Capability to handle any combination (up to the maximum number of sensors) of combustible gas (methane: CH4) or toxic gas (hydrogen sulfide: H2S) sensor modules

2. Capability for each sensor to be configured for two alarm levels (major/minor and alarm reset levels. Initial alarm programming/configuration shall be provided and tested per Metro's requirements.

3. An internal clock for time and date stamping events shall be provided. –The clock's date and time shall be synchronized with the date and time from the SCADA system clocks.

4. A RS-232C interface to download information from memory device shall be provided. Configurations shall be through the RS-232C interface.

5. Personnel Computer (PC) based software for downloading and viewing events, configuration, or status information shall be provided.

6. All software and cables required for configuring, changing, or developing software for the controllers shall be provided.

7. 115 VAC, 60 Hz operating power input

8. Each Control Unit shall have an alphanumeric messages indicator to display the sensor information, including: status, sensor level, history, calibration and diagnostic information, and trouble alarms for each sensor. The alphanumeric display shall be, at a minimum, large enough to display a configurable name (minimum sixteen characters) and the associated level. The interface shall allow the user to easily scroll all sensors and calibration information listed above without the need of additional equipment.

9. Lithium battery for configuration and event memory retention

10. Ability to test alarms and displays

11. Rack mounting with modular design that allows the wiring to remain intact when Control Unit is disconnected or removed.

12. Provide the following diagnostic information at the Control Unit:

    a. Calibration low sensibility

    b. Calibration low output voltage level

    c. Calibration error

    d. Sensor needs to be replaced

    e. Disconnected sensor

    f. Failed sensors

    g. Calibration required

    h. Memory error

    i. Clock error

    j. Communications errors with the SCADA system

F. System diagnostics shall be available on the alphanumeric display.

G. Events shall be collected and stored in the internal memory to be downloaded through a RS232C port. Provide the following events and data:

1. Major gas level alarms with date, time, and sensor identification

2. Minor gas level alarms with date, time, and sensor identification

3. Trouble alarm with date, time, and type

4. Power up/down events with date and time

5. Sensor or Control Unit diagnostic errors events with date, time, sensor identification and type of error

6. Calibration required events with date, time, and sensor identification.

7. Calibration event with person calibrating, date, time, sensor identification, and sensor sensitivity, sensor output voltage, and any other sensor status data.

8. Configuration change events with date and time

H. The number of events stored on the Control Unit shall be adequate for the number of sensors (A minimum of 20 events per sensors).

I. The system shall avoid repetitive multiple events from being logged by requiring a given event to clear before the same event is stored again. The calibration required event is only stored one time for each sensor when the calibration date has expired. After the sensor is calibrated the calibration date shall automatically reset.

2.03 DETECTOR HEAD

A. The detector heads shall be for Methane (CH4) or Hydrogen Sulfide (H2S), configured as required for station ancillary rooms, tunnels, and tunnel cross passages.

1. Methane Gas (CH4) Sensor Configuration

a. The gas-sensing element shall be FM (Factory Mutual), ETL (ETL Testing Laboratories), CSA (Canadian Standards Association) or UL (Underwriters Laboratories Inc) Approved for use with the transmitter and control unit as a combustible-gas detection instrument. Combustible-gas detection instruments shall be calibrated using methane.

b. The combustible gas monitoring (Methane gas detector head and transmitter) being furnished hereunder shall have a range of 0 to 100 percent Lower Explosive Limit (LEL). Note: Minor Alarm is at 10% of LEL, Major Alarm is at 20% of LEL, and Evacuate Alarm is at 25% of LEL.

c. Combustible gas sensors shall utilize a Wheatstone bridge circuits with two beads - one catalyzed bead for sensing gas and one un-catalyzed reference bead. Gas shall diffuse through a flame arrestor to the sensor or semi-conductor type.

d. Combustible gas sensors shall be poison resistant to non-combustible gases.

2. Hydrogen Sulfide (H2S) Sensor Configuration

    a. The gas monitoring instruments shall be a standard product that are manufactured by the combustible-gas monitoring instrument manufacturer, and must be FM, CSA, ETL or UL approved. Hydrogen sulfide detector heads that have the sensing device and transmitter in one housing are acceptable only with approved mounting brackets.

    b. The toxic gas monitoring (hydrogen sulfide gas detector head and transmitter) being furnished shall have a range that is compatible with the gas-sensing element and shall have an acceptable margin between the major alarm level and the maximum range. Note: Minor Alarm is at 5 parts per million (ppm) and Evacuate/Major Alarm is at 10 ppm.

3. Detector head shall include a gas-sensing element, gas-sensing-element housing, transmitter, transmitter housing, extension and interconnecting wiring from gas sensing element housing to the transmitter, conduit seal, vibration-isolation devices, dust filters, wind baffles, housing and adjunct components as required to meet these technical specifications.

4. Detector heads shall have shields to protect against wind, and water splash/drips as necessary.

5. Detector heads shall have an auto-adjusting calibration feature. Manual adjustments will not be acceptable. Sensor sensibility, output voltage, drift, and other sensor diagnostic information shall be automatically determined during the calibration process.

6. Detector heads shall be immune to ambient noise.

7. Provide a nameplate and a unique identifier for each detector head. The nameplate may be mounted on the transmitter housing cover or installed near the transmitter. If the nameplates cannot be read from eye level, additional nameplates shall be installed at eye level identifying each detector head.The nameplates shall be rigid plastic engraved on the backside with the engraving colored (either with paint or by the laminate) to contrast with the backing. Mounting shall be by mechanical means.

8. The contractor to design the gas detection system which will place the detector heads in locations best to monitor gas intrusions, based on the elevated potential for gas intrusions along the Wilshire corridor. Contractor shall determine the height and placement in relation to air ducts, cable tray, etc. As a minimum, detector heads shall be provided at the following locations:

    a. Platform

    b. Cable Room

    c. Electrical Room

    d. Sump Pump Room

e. Access Hatch

f. Emergency Equipment Room

g. Custodial Room

h. Air Plenum Room

i. Emergency Fan Room

j. Hallway

k. Stair

l. Vestibule

m. TC&C Room

n. Mechanical Room

o. Aux Power Room

p. Emergency Exit Stair

q. Sprinkler Valve Room

r. Trash Room

s. Fire Pump Room

t. Cross Passage

u. Staff Security Room

v. Ejector Room

2.04 TRANSMITTER

A. The transmitter shall include an amplifier or other signal-conditioning components required to modify the signal from the sensing element for transmission to the control unit. The transmitter shall include screw-type terminal block for terminating cable from control unit. The transmitter housing shall be suitable for surface mounting on a concrete surface or sheet-steel duct. Mounting brackets, plates, and any other required hardware shall be included. Any extension from the gas-sensing element housing to the transmitter shall be galvanized rigid steel (GRS) conduit.

B. Transmitters shall use digital signal modulation for transmission to the Control Unit to provide immunity to RFI (radio frequency interference) and EMI (electromagnetic interference).

C. Transmitters shall be addressable type modules, multiplexed to minimize wiring.

2.05 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Installations shall comply with NFPA, IBC, IFC, NEC and equipment manufacturers' requirements and procedures.

2. All equipment shall be grounded in accordance with the recommendations of the manufacturers.

~~2.~~**3. As a minimum, one Methane (CH4) and one Hydrogen Sulfide (H2S) gas detector shall be provided for each of the cross-passages. The individual gas detectors shall be daisy-chained with three conductor cable installed under the safety walkway on one side of the tunnel and looped back under the safety walkway in the other tunnel and terminated to the gas controller in the TC&C room to complete the loop for redundancy.**

~~3.~~**4.** Device accessibility:

a. All devices must be accessible for maintenance, and shall not be installed directly over high voltage equipment. If a device cannot be accessed with an eight foot ladder, it must have a fall protection device installed next to it, and room to access with a ladder. Otherwise, fixed ladders and fall protection devices must be installed. Gas sensors in the tunnel area should be accessible during revenue operations (in between trains with a look-out) and should not require a high rail bucket truck.

3.02 SYSTEM OPERATION

Operational characteristics of the Gas Monitoring System shall be as follows.

A. Gas sensors shall be independent discrete gas monitoring units that shall be capable of producing minor and major alarms upon detection of the following levels of methane and hydrogen sulfide gases in air stream velocities less than 200 feet per minute.

B. Alarms shall be provided to the Emergency Management Panel (EMP) and ROC only during the time when the gas reading reaches or exceeds the alarm level set points. The Alarm indications shall be maintained for a minimum of 30 seconds to avoid spurious alarms, only storing one event during this time. Re-setting of the Control Unit shall not be required once a Minor Alarm has been generated. The Minor Alarms shall be automatically cleared when the condition is cleared for 30 seconds. Major Alarms shall latch, requiring reset at the Control Unit. At the Major

Evacuate alarm level, the RTU shall start locally controlled fans required for gas mitigation at full speed.

In addition, station levels greater than 25% LEL or 10 ppm hydrogen sulfide shall initiate, via the FACP, an evacuation notification.

C. The Control Units shall supervise and monitor the status of all the discrete gas sensors. The Control Units shall provide minor/major alarm level and trouble signals to the ROC and the EMP. EVAC and trouble alarms shall be annunciated at FACP and remote annunciator.

D. Records of system status, alarm events, trouble, calibration, and system configuration shall be available for viewing or file transfer to a disk drive. Software for downloading and viewing these records shall be provided.

E. The Control Unit shall store data to memory devices without losing or mixing data even if multiple heads signal simultaneously. The Control Unit shall store information on a first-in, first-out basis. If the event memory is full the Control Unit shall store the latest event over the oldest event. User shall be able to clear event data after the data is viewed or stored on a disk. After downloading all the Control Unit information to a file the user shall be able to configure reports consisting of:

1. Sensor level alarm activity showing: alarm, time, and date for each sensor.

2. Calibration activity showing each sensor's: low sensitivity, low output voltage, calibration time, next calibration require, name of person calibrating, and diagnostic status.

3. Configuration of each sensor alarms levels

F. The time from detection of minor or major gas alarms by the gas sensor to delivery of the alarm signal to the SCADA equipment shall be less than two seconds.

G. The gas detection system shall provide analog signals for trending purposes and these signals will continue to function during any alarms. EGOP scenarios shall be activated at ROC. All automatic procedures and associated software shall be provided by Metro. If ROC is unavailable, then manual operation will be provided at the local EMP level.

3.03 WORKSHOP EQUIPMENT

A. The contractor shall provide an additional Control Unit and gas sensors for bench level testing, calibrating, configuring, and repairing of gas monitoring equipment. The workshop equipment shall be setup as a fully functional standalone gas monitoring system identical to the field configuration. The workshop equipment shall allow the unit under test (UUT) to be easily connected and removed.

3.04 CALIBRATION

A. The system shall include calibration gas supplies and gas cylinders as required to perform all calibrations required within one-year period.

B. Calibration shall be conducted by a single-person at floor level, in an area that is easily accessible, at each sensor location. Calibration gas shall be connected at floor level. Ladders shall not be required. Hoses used for calibrating sensors above floor level shall be secured and mounted in conduit.

C. Calibration system shall be available consisting of cylinders of calibration gas plus pressure and flow regulators for delivery of the calibration gas to the sensor.

D. If the resolution of the sensor is not adequate for reliable operation, the controller shall automatically identify those specific sensors with an error. —Calibration for those sensors shall be automatically aborted.

E. The calibration events for each sensor shall be stored and shall include:

1. Date/Time of calibration

2. Name of test technician

3. Sensor identification

4. Special remarks, notes

F. Diagnostic information shall be indicated if sensor needs replacement

G. Normal calibration procedure, on average, should not take more than six (6) minutes for a Hydrogen Sulfide sensor and six (6) minutes for a Methane sensor.

H. Hoses used in the calibration process shall be free of splices and pinches.

I. Calibration procedures shall follow manufacturers' recommendations.

J. All equipment shall be grounded in accordance with manufacturer's installation instructions and any local or NEC Standards.

3.05 TESTING

A. Field Test

Operational testing of each gas sensing device and the associated transmitters, receivers and controls at each station and cross passage shall be accomplished by a specialty subcontractor, licensed and certified for gas monitoring system design, installation and testing by the State of California. Upon successful completion of all tests, this subcontractor shall provide a safety certification notice, pursuant to the requirements of the Metro's Fire, Life, Safety Committee and Los Angeles or Local Fire Department (LAFD).

B. System End-to-End Acceptance Test

1. Contractor shall provide a local end-to-end test procedure for the Gas Detection System at every station to show the proper functionality and performance.

C. System Integration Test

System integration test (SIT) shall be performed after the completion of all individual system testing. Contractor shall submit a complete and detailed SIT plan and procedure for approval.

END OF SECTION 28 33 00

SECTION 28 40 00

COMMUNICATIONS SUPERVISORY CONTROL AND DATA ACQUISITION REMOTE TERMINAL UNIT (SCADA RTU)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes the detailed technical requirements for the Supervisory Control and Data Acquisition (SCADA) and the Remote Terminal Units (RTUs) to be designed, furnished, installed and tested under this contract. RTUs provided at each passenger stations shall interface with the SCADA computers located at the ROC via the Cable Transmission System (CTS). The RTUs shall be based on an open-ended distributed processing philosophy. A main CPU mode shall provide the core of the RTU for data collection, message formatting communications and transmission. I/O or field connective peripherals modules shall provide the interface function for statuses, controls and analog points.

B. Dedicated local communication links shall be provided from each RTU for the following system: Traction power supply substation (TPSS), Train Control and Facilities and Emergency Management (F&EM) Programmable Logic Controller (PLC). Interface to CTS for data transmission between ROC and each TC&C location shall be provided as dedicated Ethernet service over SONET.

C. Standard industry protocols such as Allen Bradley DF1, Allen Bradley Ethernet/IP, Modbus Serial, MODBUS TCP or other Metro approved compatible protocol, shall be used for data transmission between the RTU and the TPSS, TC and F&EM PLC systems; communication with the SCADA System at ROC shall be established using a communication protocol developed and supported by the SCADA System manufacturer and approved by Metro.

D. An offline portable diagnostic, training and development system shall be provided to allow RTU diagnostic, programming and simulation task offline. The system shall contain a functional PLC assembly with each type of I/O and communications module as well as switches and indicators to test/ demonstrate discrete input and output. The system shall be enclosed in a ruggedized hard shell case.

E. A diagnostic and programming laptop shall be provided for performing online and offline functions. All software licenses required for programming and diagnostic for ladder logic and all peripheral modules shall be included.

F. Identify the functional and physical interfaces associated with field devices or equipment of Train Control, TPSS and Communications Systems, and Facilities that require supervisory control and remote monitoring at ROC. Field equipment status or alarms reported to RTUs are defined as ‘monitoring’; likewise, commands initiated from the SCADA system via RTUs to the field equipment are defined as ‘Controls’. Actual SCADA controls and indications are to be based on Contractor design and approved by Metro.

G. Develop the communication protocols required for data transmission between RTUs and other systems identified herein.

H. Classify the control and indication data bits stream requirements for transmission on each of the communication links.

I. Provide an interface data sheet (IDS) for each interface point identified. Each IDS shall include, but not limited to, an interface number, point name, functional description, termination points, voltage and type, and shall form the basis of interface control document (ICD) providing detailed information pertaining to the point.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 43 Spare Parts, Spare Parts Catalog, and Replacement Materials

D. Section 27 05 56 Safety and System Assurance

1.03 REFERENCES

A. Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)

1. TIA/EIA-606-A Administration Standard for Commercial Telecommunications Infrastructure

B. American National Standard Institute (ANSI)

1. ANSI/ISO/ASQ Q9001 2000 - Quality Management Systems Requirements

C. National Fire Protection Association (NFPA)

1. NFPA 70 National Electric Code

D. National Electrical Manufacturers Association (NEMA)

1. NEMA ICS 2-230 -Noise Immunity Standard

E. Underwriters Laboratories, Inc. (UL)

1. UL 94 Test for Flammability of Plastic Materials for Parts in Devices and Appliances

F. UL 508 Industrial Control Equipment

1.04 QUALITY ASSURANCE

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

B. General - Refer to subsystem Specification 27 05 56, Safety and System Assurance, Section 1.04 and Metro Design Criteria 12.1.2 & 12.1.3 for Quality Assurance requirements.

C. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in Subsection 1.03 – References.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. System block diagrams, equipment layout and electrical diagrams for RTU system.

C. Point to point wiring diagrams including termination details between the RTU, power supplies, terminal blocks.

D. Performance analysis using manufacturer's data or test data.

E. Rack layouts and elevations for RTU equipment including assembly and installation drawings.

F. Detailed hardware interface schematics and installation details.

G. Manufacturer's technical product data for all components furnished with certificates of compliance, dimensions, capacities, performance, electrical characteristics and start-up instructions.

H. PLC software block diagram and fully commented Source code.

I. SCADA I/O database.

J. Power calculations to show the selection of the RTU power supply, isolation transformer, and the total load of the RTU assembly.

K. Installation Work Plans and Detailed Documentation

1. Drawings and Diagrams

2. Installation Procedures

L. Test Plan and Procedures

1. Contractor shall submit a detailed procedure for the following:

a. Factory Acceptance Tests (FAT)

b. Local Field Acceptance Tests (LFAT)

c. Systemwide Field Acceptance Tests (SFAT)

M. Test records.

N. Calculations and Certifications

1. Calculations as listed above.

2. ISO certifications for all proposed manufacturers.

O. As-Built Documentation

1. Shop Drawings with the following information:

2. Detailed block diagram including all physical interconnections and interfaces.

3. Wiring diagrams including termination details between the RTU, power supplies and terminal blocks.

4. Physical equipment layout and installation diagram.

5. Submit information for all programmable equipment together with the associated passwords and access codes.

P. Product Data: Submit approved manufacturer's technical product data.

Q. Submit manufacturer's operating and maintenance instructions for the complete system.

R. SCADA I/O database.

S. Software licenses for all software installed and delivered on the project.

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. Refer to Appendix A and Appendix B from the Metro Design Criteria for the RTU system design and equipment requirements. In addition, the underground station RTU shall comply with the following requirements:

1. RTU installed in TC&C room that performs fire/life/safety system functions such as emergency ventilation supervision and control shall conform to the additional specifications herein.

2. The RTU shall have redundant CPU in a hot standby configuration.

3. The hot standby configuration shall automatically switch to an available CPU when the currently online CPU is failed.

4. The hot standby configuration shall be capable of operating normally with only one CPU in service.

5. Failover from one CPU to another shall be transparent to the SCADA and EMP HMI except for diagnostic indicator states.

6. Remote I/O for fire/life/safety systems interfaces shall utilize redundant media using diverse pathways.

7. Remote I/O media and pathways for fire/life/safety systems interfaces shall have a 2-hour fire rating as described in National Fire Code.

8. Remote I/O media for fire/life/safety systems shall be continuously supervised for both the active and standby media.

9. Redundancy shall include SCADA indications for the following:

   a. Remote I/O media active

   b. Remote I/O media available

   c. CPU online

   d. CPU available

10. Redundancy components shall include local indicator lamps to provide visual indication of status and alarm.

2.02 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Installations shall comply with NFPA, IBC, IFC, NEC and equipment manufacturers' requirements and procedures.

2. Install all wire and conduit in accordance with manufacturer's recommendations and applicable codes and standards.

3. Furnish and install clamps or other cable-restraining hardware in areas where support is required for cables entering or leaving conduit.

4. Furnish filling compound for cables entering or leaving conduit. The filling compound shall be applied in conformance with manufacturer's instructions.

5. Cable entrance openings in equipment enclosures and junction boxes shall be sealed with compression-type fittings or pliable sealing compound after cable is in place. Sealing compound shall be used to seal area around cable where it emerges from the end of a conduit or junction boxes.

6. Cable terminations shall have permanent cable tags identifying the cable number, the number of copper pairs in the cable.

7. Cable and conductors, which serve as communications links, shall have surge protection circuits installed at each end.

8. All equipment shall be grounded in accordance with manufacturer's installation instructions and any local or NEC Standards.

9. The Contractor shall provide support and resources necessary to assist Metro to modify the RTU program, logic, and associated SCS databases and displays to ensure Expansion facilities are being monitored through existing RTUs.

3.02 TESTING

A. Factory Acceptance Test

1. Factory Acceptance Test shall verify that each unit is defect free and ready for shipment. All functional and specification requirements shall be verified including but not limited to:

   a. Firmware execution

   b. Communications SCADA interfaces with other communications subsystems, Train Control, Traction Power, Facilities, Mechanical, Electrical and others.

   c. Each output from SCADA memory to terminal block

2. Contractor shall submit the factory test procedure and notify Metro in advance to witness tests.

B. Local Field Acceptance Test

1. An installation test shall verify that each unit has been delivered free of damage and has been properly installed. Tests shall include but not limited to:

2. Proper mounting and securing of assemblies racks and enclosures

3. Power and safety ground connections

4. Power-up test

5. Wire pull test for all field wires

6. Each input from RTU terminal block to SCADA memory

7. Each indication from device to RTU memory

8. Each control function from RTU memory to device

9. SCADA communications

10. Test of redundancy functions

C. Systems Integration Test

1. System integration test (SIT) shall be performed after the completion of all individual system testing. Contractor shall submit a complete and detailed SIT plan and procedure for approval.

END OF SECTION 28 40 00

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SECTION 31 20 00

EARTHWORK

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Performing operations to excavate materials, regardless of character and subsurface conditions, necessary for construction of structures and other facilities; to excavate trenches for utilities; to excavate selected material from site and to obtain borrow material on- or off-site for use; to construct embankments, including placing and compacting selected material; to place and compact backfill for structures and other facilities; to backfill and compact trenches; to remove and replace unsuitable material; to excavate and grade roads, parking areas and driveways; to prepare base material for the placing of other material thereon; as indicated.

B. Earthwork may involve hazardous substances or materials containing contaminated substances.

C. The Work at the Wilshire/Fairfax Station excavation involves special excavation and monitoring and potential recovery of paleontological resources.

1.02 RELATED SECTIONS

A.	Section 01 33 00	Submittal Requirements
B.	Section 01 35 23	Worksite Safety Requirements
C.	Section 01 35 29	Health, Safety and Emergency Response for Contaminated and Hazardous Sites
D.	Section 01 35 43	Environmental Procedures for Contaminated and Hazardous Materials
E.	Section 01 35 92	Paleontological Coordination
F.	Section 01 43 10	Project Quality Program Requirements – Design/Build
G.	Section 01 56 19	Construction Noise and Vibration Control
H.	Section 01 57 19	Temporary Environmental Controls
I.	Section 01 66 00	Project Storage and Handling Requirements
J.	Section 02 41 00	Staging Area Clearing and Demolition
K.	Section 02 41 13	Selective Site Clearing and Demolition
L.	Section 32 11 00	(Aggregate) Base Course
M.	Section 33 30 00	Sanitary Sewerage Utilities

1.03 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO)

1. M 288 Standard Specification for Geotextiles

B. American Society for Testing and Materials (ASTM)

1. ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
2. ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method
3. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
4. ASTM D2419 Standard Test Method for Sand Equivalent Value of Soils and fine Aggregate
5. ASTM D2922 Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
6. ASTM D2974 Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
7. ASTM D3017 Standard Test Method for Water Content in Place by Nuclear Methods (Shallow Depth)
8. ASTM D4254 Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
9. ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
10. ASTM D4833 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
11. ASTM D4632 Standard Test Method for Grab Breaking & Elongation of Geotextiles

C. Standard Specification for Public Works Construction (SSPWC) – Greenbook Section 300 – Earthwork

D. City of Los Angeles Brown Book version 2011 and other applicable portions of codes and standards from City of Los Angeles, and City of Los Angeles, Bureau of Engineering, Special Order 001-0912.

1.04 QUALITY ASSURANCE

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

B. Perform testing as specified on each type and source of material.

C. Instruct employees and subcontractors of need to perform hand excavation when exposing or working near ground utilities and services in vicinity of proposed work.

D. The following activities are subject to the Hold Points. Submit a Construction Work Plan (CWP) for each Work activity.

1. Before the commencement of operations:

a. Installation of movement detection systems

b. Installation of groundwater monitoring devices

2. After the commencement of operations:

a. Monitor and repair damage to movement detection systems

b. Repair damage to groundwater monitoring devices

c. Notification of non-compliance with Section 01 56 19, Construction Noise and Vibration Control

E. Determine adequacy of the test reports or certifications in accordance with the Contract Documents. Add additional testing, as required, to confirm requirements with the Specifications.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittals, for submittal procedures.

B. Submittals prior to Excavation

1. Plans and procedures for rough grading, excavation, rock excavation, fill, structure excavation and backfill, subgrade preparation, borrow, and removal and disposal of excess and unsuitable materials.

2. Plans for haul routes, public streets to be used, traffic control and other incidental work necessary to complete the rough grading, excavation, embankment fill, structure excavation and backfill, subgrade preparation, borrow and removal of unsuitable materials

3. Submittals specified in Section 01 35 29, Health, Safety, And Emergency Response for Contaminated and Hazardous Sites and Section 01 35 43 Environmental Procedures for Contaminated and Hazardous Materials.

4. Trench Excavation and Fill Plan: Proposed excavation methods, procedure and equipment to be used.

5. Structure Excavation and Backfill Plan

a. Proposed excavation methods, procedures and equipment

b. Proposed backfill methods, procedures and equipment

6. Working Drawings:

a. Layout, configuration, and sequencing of excavations

b. Procedures for construction staging

c. Procedures for adjusting excavation and backfilling procedures in accordance with actual ground conditions encountered and field measurements.

7. For City of Los Angeles Work, comply with Section 306 of Brown Book and Bureau of Engineering Special Order 001-0912.

8. Method Statements

a. Means and methods statements

1) For assuring the stability of the excavation process at all times, including during shut-down periods.

2) For assuring that groundwater levels remain within specified levels, and that seepage limits are not exceeded while performing excavation and carrying out other activities required to construct the work.

b. Method of handling and disposing of excavated materials.

c. Procedures for taking deformation and groundwater measurements during excavation

C. Certificates:

1. Certified laboratory test reports for fill and backfill materials, whether imported or obtained from Metro property, documenting:

a. Sieve analyses in accordance with ASTM D422

b. Compaction testing in accordance with ASTM D1557

c. Moisture and density results in accordance with ASTM D4254

d. Liquid limit, plastic limit, plasticity index in accordance with ASTM D4318

2. Certification of geotextile material compliance with AASHTO M 288

3. Certification of proper disposal of excavated materials

1.06 DEFINITIONS

A. “Soil" includes any type of rock materials present in the subsurface.

B. Rock excavation is the excavation of material requiring the use of heavy mechanical breakage. Rock excavation shall include all rock in ledges, and bedded deposits,

cemented and conglomerate deposits exhibiting the physical characteristics as indicated in the Geotechnical Baseline Report.

C. Subgrade - Lowest elevation of excavation required for indicated construction.

1.07 WORKSITE CONDITIONS

A. Indicated locations of existing utilities, facilities, and systems are approximate.

B. Soils as indicated in Geotechnical Baseline Report (GBR).

C. The Work during the Wilshire/Fairfax Station excavation involves special excavation and monitoring and recovery of paleontological resources.

1. Special Excavation will be required within Paleontological Monitoring Zone as indicated in the GBR. Comply with Special Excavation specified herein, and Controlled Station Excavation specified in 01 35 92, Paleontological Coordination, for monitoring and recovery of archeological and paleontological resources

2. The Field Paleontological Monitor will be in direct proximity to or in the excavation and have visual contact with excavator operator, to observe paleontological resources uncovered during Special Excavation. Provide Field Paleontological Monitor with safe working space.

D. Some soil and groundwater contains hazardous gases as described in the GBR. Continuously test excavations for gases, and in accordance with Section 01 35 23, Worksite Safety Requirements.

E. Some soils are impregnated with asphalt. Refer to GBR for limits of asphalt impregnated soils. Asphalt impregnated soils are designated as contaminated soils.

F. Where soft siltstone (Fernando Formation) is encountered, these materials may be prone to water slaking when exposed to rain or other water sources. Bearing capacity of subgrade in such wet materials may become unsuitable if subjected to excessive disturbance by construction equipment.

G. Some soils contain hazardous materials. Refer to GBR for locations of hazardous materials. Refer to Section 01 35 43, Environmental Procedures for Contaminated and Hazardous Materials for handling, storage and disposal requirements for contaminated and hazardous media.

PART 2 - PRODUCTS

2.01 BACKFILL MATERIALS

A. Fill and backfill - Suitable material from on-site excavation or off-site borrow as approved.

1. Suitable fill materials may be obtained from on-site excavation and rough grading operations if laboratory test results demonstrate that the materials meet or exceed the criteria established in this Section. If sufficient suitable materials are not available to meet requirements, obtain the material from outside sources.

2. Materials from on-site excavations, which may otherwise be suitable for use as fill, may contain excess moisture in their natural state, or may take on excess moisture during handling and stockpiling that would render them unsuitable for use as fill. Dry material as necessary to attain the required minimum standard.

3. Nesting of rock pieces that will create voids is not permitted.

4. Measured by ASTM D2974, not contain excessive fines or unsuitable products of demolition, and contain no rocks or lumps over 3-inches in greatest dimension.

5. Plasticity index of 15 or less and a liquid limit of 30 or less and expansion index of 30 or less..

6. Suitable materials from structure excavation not used as structure backfill may be deposited as fill or backfill material.

7. Remove from site materials not meeting requirements and classified as unsuitable. Legally dispose off-site all materials not meeting requirements and classified as unsuitable.

B. Structural Backfill:

1. Sand equivalent value of not less than 20 as determined by ASTM D2419.

2. Conform to the grading in Table 1:

Table 1 - Structural Backfill

Sieve Sizes	Percentage Passing
3”	100
No. 4	35-100
No. 30	20-100
No. 200	0-12

3. Free from stones or lumps exceeding 3 inches in greatest dimension, organic or other undesirable material.

C. Impervious Backfill

1. Comply with the material requirements in Table 1 except there shall be 15% plus or minus, 2% minus 200 sieve material present and as approved for such purpose.

2. Do not apply Sand Equivalent requirement to the impervious material used for structure backfill.

D. Pervious Backfill

1. Material consists of gravel, crushed gravel, crushed rock, natural sands, manufactured sand or combinations thereof.

2. Conform to the following grading requirements of Table 2, except for sacked material at wall drain outlets:

Table 2 - Pervious Backfill Material

Sieve Sizes	Percentage Passing
3/4”	100
3/8”	80 – 100
No. 100	0 – 8
No. 200	0 – 3

E. Embankment Backfill:

1. Sand Equivalent value of not less than 10 as determined by ASTM D2419.

2. Plasticity index not greater than 10 and a liquid limit not greater than 30.

3. Conforming to the following grading in Table 3:

Table 3 - Embankment Backfill

Sieve Sizes	Percentage Passing
4”	100
3”	85-100
No. 200	0-30

4. Free of stones or lumps exceeding 3 inches in greatest dimension, organic or other undesirable material.

~~4.~~**5. Embankment backfill for backfilling station excavation below city streets shall meet the above requirements and in addition, no material shall be retained on 1 ½” sieve, minimum R Value tested under California Test Method 301 shall be 25.**

F. Imported Materials:

1. Free from deleterious material and debris.

2. Low expansion potential with expansion index of less than 30.

3. Maximum particle size less than 3 inches and less than 30 percent retained on the 3/4-inch sieve for subgrade use.

G. Utility Backfill:

1. Comply with Section 306 of Brown Book and SSPWC.

2.02 GEOTEXTILE

A. Geotextile: Impermeable geotextile membrane.

B. Membrane to meet following requirements:

1. Woven geotextile resistant to ultraviolet and biological deterioration, rotting, and naturally occurring basics and acids

2. Stable within a pH range of 2 to 13

3. Meeting requirements for Class 1 Stabilization & Separation applications as outlined in AASHTO M-288-06

4. Minimum strength requirements as indicated in Table 4

Table 4 - Minimum Strength Requirements

Property	Test Method	Minimum Requirement
Tensile Strength	ASTM D-4632	315 lbs
Elongation @ Break	ASTM D-4632	15%
Puncture Strength	ASTM D-4833	120 lbs

C. Transport and store geotextile membrane in accordance with vendor recommendations.

D. Furnish fabric in rolls wrapped with protective covering to protect against ultraviolet radiation, abrasion, dust, dirt, mud, debris and other deleterious effects and substances.

E. Mark or tag each roll of fabric in the shipment with the name of manufacturer, type, length, width, date, and place of manufacture and production identification number.

F. Protect geotextile rolls with a water-proof cover if stored outdoors. When stored outdoors, keep roll a minimum of 1 foot above ground level.

PART 3 - EXECUTION

3.01 GENERAL

A. Remove material encountered within indicated limits.

B. At all times during the execution of this work, maintain safe and stable excavations. Where required by California Construction Safety Orders, employ side slope layback, benching, or shoring.

C. Use Special Excavation Methods at the Wilshire/Fairfax Station in the Paleo Zone defined in the GBR. If fossil resources are identified, refer to section Section 01 35 92, Paleontological Coordination for required Controlled Excavation to be implemented

D. Subgrade

1. Where excavation subgrade is exposed to rain or other water sources, stabilize the subgrade such that it is not subject to excessive disturbance by construction equipment.

E. Protect structures in place without undermining or causing movement.

F. Drainage and Dewatering:

1. Refer to Sections 01 35 35 - Water Pollution Control and Section 31 23 19 - Dewatering

2. Control grading around excavations and structures so that ground is pitched to prevent water from running into excavated areas or damaging structures.

3. Maintain excavations free of water where foundations, floor slabs, equipment support pads or fill material are to be placed.

4. Provide, operate, and maintain an adequate system to remove water from the excavation and construction operation, as necessary.

5. Locate elements of the system to allow continuous water removal without interfering with other construction activities.

6. Protect newly graded areas from erosion.

G. Provide unobstructed access to all fire hydrants, water valves, and meters, and leave clearance to enable free flow of stormwater in all gutters, conduits, and natural watercourses.

3.02 SITE GRADING

A. The work includes all operations in connection with rough grading and disposal of excess materials in connection with the preparation of the site(s) for construction of the stations, site improvements, and other facilities.

B. Grading: Perform as required by the Contract Drawings.

1. Rough grading shall be considered incidental to construction of structure excavations and embankment fills.

2. Prior to rough grading, complete clearing and in accordance with Sections 02 41 00 – Staging Area Clearing and Demolition.

3. Drawings may indicate both existing grade and finished grade required for construction of Project.

a. Stake all units, structures, piping, fills and cuts, roads, parking areas and walks and establish elevations upon completion of site clearing.

b. Perform other construction staking work required.

4. Do not place any embankment fill or sub-ballast on the ground surface for embankment fills or on base of excavations without prior approval of the excavated and rough graded areas..

5. Smooth and level subgrade by removing depression or humps by grading.

3.03 EXCAVATION AND BACKFILLING TRENCHES

A. For excavation of trenches and required support of utility trench excavations, refer to Standard Specification for Public Works Construction.

B. Provide and place backfilling for trenches to meet applicable agency requirements.

C. Protect existing surface and subsurface features on-site and adjacent to site as follows:

1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.

2. Protect and maintain bench marks, monuments or other established reference points and property corners.

a. If disturbed or destroyed, replace at Contractor expense to full satisfaction of Metro and controlling agency.

b. If disturbed or destroyed, reset property corners in accordance with applicable surveying law for the State of California after completion of rough grading and prior to commencing final excavation or grading operations.

3. Verify location and protection of existing utilities.

a. Omission or inclusion of utility items on drawings does not constitute warranty as to non-existence or definite location. Locations of utilities shown on the drawings are provided for the Contractor's information only and the Contractor shall be responsible for verifying the location of all utilities to its own satisfaction.

b. Secure and examine local utility records for location data. Make all attempts to locate utilities including potholing if necessary prior to commencing excavations.

1) If utilities cannot be located, pothole anticipated location(s) by hand methods. When utilities are located, complete excavation with caution in order to prevent their damage.

2) When utility lines indicated on the Drawings or unknown utilities are encountered within the area of operations, notify Metro and utility

owner immediately. Take all required measures to protect the utilities and prevent damage.

c. Take necessary precautions to protect existing utilities from damage due to any construction activity.

D. Excavation in areas that have or may have underground facilities:

1. Delineate with white paint, flags or other methods area to be excavated and contact Underground Service Alert to request that facility owners mark the location of underground utilities.

2. Identify temporary survey markings using colored markings in accordance with Underground Service alert requirements.

3. Facility owners will field mark approximate location and number of subsurface installations affected by excavation using following colors:

a. Safety RED - Electric power, distribution, transmission installations, and municipal electric installations.

b. High Visibility Safety YELLOW - Gas distribution and transmission installations, oil distribution and transmission installations, and installations for and transporting dangerous materials, products, and steam.

c. Safety Alert ORANGE - Telephone and telegraph installations, police and fire communication installations, and cable television installations.

d. Safety Precaution BLUE -Water installations and slurry pipelines.

e. Safety BROWN- Sewer installations.

f. Do not use colors listed above for Contractor's temporary markings such as survey points; use U.S.A. designated PINK color.

4. When excavating within two feet of utility markings, California law requires hand excavation be used to expose utilities; inform employees and Subcontractors, who perform excavation, of requirements of the law. The law includes excavation as any operation that moves dirt.

5. If any excavation that exposes or potentially exposes an existing underground utility or structure indicated as “protect in place,” “to remain” or having similar indication, or any unknown utility or structure found and deemed to require special methods by Metro, perform excavation and place structural backfill to protect utility.

a. Do not disrupt any service until utility owner has determined the required action on such lines.

6. Backfill excavations used to locate underground utilities in accordance with the following:

a. Use embankment fill to backfill excavation to within 12 inches of the top of excavation. Place in lifts not exceeding 8 inch loose depths. Compact layers to 90 percent relative density per ASTM D1557 using materials containing no material greater than 3 inches in maximum dimension.

b. Place the uppermost 12 inches of compacted fill in two approximately equal lifts. Compact each lift to 95 percent relative density per ASTM D1557 using materials containing no material greater than 1 inch in maximum dimension.

3.04 SPECIAL EXCAVATION IN PALEO ZONE

A. Excavate in shallow increments to remove earth in no more than 6-inch lifts within the Paleo Zone defined in the GBR.

B. A field Paleontological Monitor will be in direct proximity to the excavation and have visual contact with excavator operators during Special Excavation. Provide Paleontological Monitor with safe working space.

C. Use smooth blade buckets to minimize potential damage to paleontological resources.

D. When archaeological and paleontological resources are discovered during any excavation stage, notify Metro immediately, cooperate with Paleontological Monitor, and perform Controlled Excavation to recover the resources in accordance with Section 01 35 92, Paleontological Coordination

3.05 PREPARATION OF SUBGRADE FOR FOUNDATIONS AND FOOTINGS

A. After stripping and grubbing operations, strip off any loose or soft earth materials until a uniform, firm and unyielding subgrade is exposed.

B. Extend depth of over excavation to the bottom of any undocumented fill or at least 2 feet below footings, whichever is deeper.

C. In areas where unsuitable materials are encountered in the subgrade, remove and replace with suitable materials, place and compact in accordance with this Section.

D. Do not carry excavations lower than shown for foundations.

3.06 PLACEMENT OF BACKFILL BENEATH PIPING AND PAVING:

A. When backfilling outside of structures requires placing backfill material under piping or paving, place the material from bottom of excavation to underside of piping or paving at the density required for fill under piping or paving as indicated in this Section.

B. Compacted material shall extend transversely to the centerline of piping or paving a horizontal distance each side of the exterior edges of piping or paving equal to the depth of backfill measured from bottom of excavation to underside of piping or paving.

C. Provide compacted bedding or subgrade material under piping and paving in accordance with applicable standards and codes.

D. Correct deficiencies resulting from insufficient or improper compaction of such Material throughout the Contract period.

3.07 ROCK EXCAVATION

A. Unless otherwise specified, rock shall be removed to a depth of 1 foot below subgrade and backfilled with structural fill.

B. If developed in well-graded sizes with a maximum dimension of no greater than 3 inches, the fines from the rock excavation may be used for backfill.

C. If rock excavation does not yield sufficient fines, select material shall be used for backfilling.

D. Additional select material as may be required due to the roughness of rock excavation shall be considered as incidental to rock excavation and direct payment for this material will not be made.

3.08 PROTECTION OF FINISHED GRADE

A. Protect graded areas against action of elements prior to acceptance of work.

B. Keep graded areas free of trash and debris until final inspection and acceptance by Metro.

C. Take precautions to protect subgrade under new and existing foundations from becoming wet and undermined during construction due to presence of surface or subsurface water or due to construction operations.

D. Provide drainage system and re-establish grade where settlement or erosion occurs.

E. Do not operate equipment supported directly on the finished grade unless it can be demonstrated through compaction testing that the equipment selected can be supported without creating softening, rutting or degradation of the finished grade.

F. Maintain ditches and drains to provide drainage at all times.

3.09 REMOVING AND DISPOSING OF MATERIALS

A. Secure all necessary disposal permits.

B. Dispose of materials in accordance with appropriate federal, state and local regulations.

C. Remove obstructions and undesirable materials from Worksite.

D. Remove surplus excavated materials, and excavated materials that do not satisfy specified fill and backfill requirements from Worksite

E. Maintain stockpiles and excavations in such a manner to prevent movement or damage to structures on-site or on adjoining property that are not noted in plans as being demolished.

F. Dispose of waste materials, legally, off site. Burning, as a means of waste disposal, is not permitted.

G. Place excavated material, conserved for embankment or backfills, only within the construction easement, right-of-way, or approved working areas.

3.10 EXCAVATION AND GRADING ROADS, PARKING AREAS AND DRIVEWAYS

A. Prepare natural, filled or excavated road bed material prior to placement of subbase or base material, pavement, curbs and gutters, driveways, sidewalks, or other roadway structures in accordance with Standard Specification for Public Works Construction.

3.11 CONSTRUCTION OF EMBANKMENTS

A. Construct embankment at locations and to lines of grade indicated. Completed embankment fill and cut shall correspond to shape of typical cross section or contour indicated.

B. Place fill and backfill as promptly as work permits but not until completion of the following:

1. Rough grading as indicated to achieve the bottom elevation for the embankment. This work shall be considered incidental to construction of the embankment.

2. Subgrade or rough grading preparation has been approved.

3. Recordings of the final locations, elevations and limits of structures, utilities and other underground features that remain in place and will be covered by the embankment.

C. Before embankment fill is placed, scarify to a minimum depth of at least 6-inches and up to 18-inches, as required to obtain the specified density for all fill areas and,

1. Where more than 12” of fill is to be placed, bring moisture to near optimum moisture content and compact to at least 90 percent of maximum dry density as determined by ASTM D1557.

2. Where 12-inches or less of fill is required, bring moisture to near optimum moisture content and compact to 90 percent of maximum dry density as determined by ASTM D1557.

D. Provide material, in accordance with Table 3, Embankment Backfill.

1. Ensure that fill is free from roots, organic matter, trash, and frozen material

2. Ensure that stones larger than 3 inches are not placed in embankment fill.

E. Place material in layers not greater than 8-inches loose thickness. Compact each lift to at least 90 percent of maximum dry density as determined by ASTM D1557 before placing the next lift. Jetting or puddling will not be permitted.

3.12 REMOVAL OF EXISTING TIEBACK ANCHORS

A. Refer to the GBR for frequency and locations of existing tieback anchors that interfere with shaft/station excavation.

B. Remove existing tiebacks as encountered within station/shaft excavation.

1. Expose tendon of interfering tieback anchor completely at the shaft/station excavation line before cutting, and use torch or shear to cut tendons.

2. Cut one strand at a time for multi-strand anchors.

3. Only use torch cut for steel rod anchors.

4. Do not cut, pull, or deform existing tieback anchors with heavy equipment prior to proper disconnection of the anchor at the excavation line.

3.13 ABANDONED OIL WELLS

A. If an abandoned oil well is encountered during excavation, notify Metro, CAL/OSHA representatives, and California Division of Oil and Gas (CAL/DOG).

B. Refer to Section 01 35 43, Environmental Procedures for Contaminated and Hazardous Materials

3.14 PREPARATION OF SUBGRADE

A. Scarify subgrade at approved excavation bottom to a minimum of 6 inches.

B. For scarified layer, condition moisture content to near optimum moisture content and compact to at least 90 percent of maximum dry density as determined by ASTM D1557.

C. Do not place anything on subgrade until approved.

D. Where unsuitable materials are encountered in the subgrade, such as weak or pumping soils, remove and replace with structural backfill placed and compacted to at least 95 percent of maximum dry density as determined by ASTM D1557.

E. Where excavation subgrade is exposed to rain or other water source, stabilize the subgrade such that it is not subject to excessive disturbance by construction equipment.

3.15 PLACEMENT OF SUBBASE AND IMPERVIOUS GEOTEXTILE MEMBRANE

A. Where subgrade consists of asphalt impregnated soils and at locations where subgrade requires stabilization, place subbase and geotextile membrane to protect subgrade and limit the upward migration of asphalt into the base aggregate layer placed beneath structures.

1. Provide sub base material, in accordance with Impervious Backfill.

2. Place subbase to a minimum compacted layer thickness of 4 inches. Compact to at least 95 percent of maximum dry density as determined by ASTM D1557.

3. Make adequate provision for thorough drainage of layer.

4. Do not place sub base material when temperature is less than 40 F and when subgrade to receive material is frozen, wet, loose, or soft.

5. Use vibratory equipment for compacting layer. Do not use water except as a means to reach optimum moisture.

6. Correct deficiencies resulting from insufficient or improper compaction.

B. Placement of Geotextile Membrane over Subbase

1. Place geotextile smooth and free of tension, stress, or wrinkles. Assure intimate contact between the geotextile and soil. Place geotextile loose enough to conform to the soil surface.

2. Replace or repair all geotextile that is torn, punctured, or muddy. Remove damaged area and provide a patch of the same geotextile material, repairing and placing it in accordance with manufacturer's recommendations to maintain impermeable barrier.

3. Cover geotextile as soon as possible after being placed, but not later than 2 calendar days after placement.

4. Remove and replace geotextile left uncovered for more than 2 calendar days.

3.16 BACKFILLING OF STATIONS AND SHAFTS

A. Preparation

1. Remove any trash and debris.

2. Remove shoring and bracing where applicable and as directed by Metro.

3. Obtain Metro approval for start of backfilling

4. Place backfill as promptly as work permits.

B. Placement of Aggregate Base Course

1. Provide aggregate base aggregate material, in accordance with Section 32 11 00, (Aggregate) Base Course.

C. Placement of Structural Backfill

1. Place material in all areas required for structural backfill using equipment of a type and size capable of providing the specified density.

2. Place fill material in lifts not exceeding 8 inches loose thickness. Compact each lift to at least 90% of maximum dry density as determined by ASTM D1557 before placing the next lift. Jetting or puddling will not be permitted. Make adequate provision for thorough drainage of all backfill.

3. Maintain ditches and drains to provide drainage at all times. Protect newly graded areas from erosion.

4. Do not place fill or backfill material when temperature is less than 40 F and when subgrade to receive material is frozen, wet, loose, or soft.

5. Use vibratory equipment for compacting granular material; do not use water except as a means to reach optimum moisture.

6. Correct deficiencies resulting from insufficient or improper compaction of backfill throughout the Contract period.

D. Placement of Structural Backfill against Walls and Other Concrete Structures

1. Do not backfill around any part of structure until each part has reached specified 28-day compressive strength.

2. Do not start backfilling until concrete forms have been removed, trash removed from excavations, pointing of masonry work, concrete finishing, damp proofing and waterproofing have been completed.

3. Place backfill around piers and columns on all sides to approximately the same elevation at the same time. Place backfill in front of abutments and walls first to prevent the possibility of forward movement.

4. Do not operate earth-moving equipment within 5 feet of walls of concrete structures. Compact backfill adjacent to concrete walls with pneumatic tampers or other approved equipment that will not damage the structure

5. Take special precautions to prevent any wedging action against the concrete. Destroy slopes bounding excavation by stepping or roughening to prevent wedge action.

6. Correct deficiencies resulting from insufficient or improper compaction of such Material throughout the Contract period.

3.17 TESTING

A. For each soil material type used perform following laboratory test; ASTM D422 and ASTM D1557.

B. For embankment, perform testing to determine Field Dry Density every 1,000 cubic yards or 2 vertical foot in accordance with ASTM D1556 or ASTM D2922 and ASTM D3017. Tested areas are acceptable when tests results indicate compacted density is a minimum of the values specified for maximum dry density and +/- two percent of optimum moisture content as determined by ASTM D1557 for that specified lot.

C. For structural backfill, perform testing to determine Field Dry Density every 100 cubic yards or 2 vertical foot in accordance with ASTM D1556 or ASTM D2922 and ASTM D3017. Tested areas are acceptable when tests results indicate compacted density is a minimum of the values specified for maximum dry density and +/- two percent of optimum moisture content as determined by ASTM D1557 for that specified lot.

D. For small area earthwork and backfilling such as manholes, fire hydrants, light poles, etc., perform a minimum of one field density test to verify the compaction methods of the backfill operations. Tested areas are acceptable when test results indicate compacted density is a minimum of the values specified in SubSection of maximum dry density and +/- two percent of optimum moisture content as determined by ASTM D1557 for that specified lot.

END OF SECTION 31 20 00

SECTION 32 12 00

FLEXIBLE PAVING (ASPHALT PAVING)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Preparation, placement, and compaction of asphaltic concrete, including prime coat, tack coat, base course, and wearing course.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 31 20 12 Earthwork

~~C.~~**D.** Section 32 11 00 (Aggregate) Base Course

~~D.~~**E.** Section 32 13 00 Rigid Paving

1.03 REFERENCES

A. SSPWC

1. Standard Specifications for Public Works Construction 2009 edition or latest accepted edition by local authorities

2. SSPWC 2009 Edition, Section 203 and Subsections 302-5 and 303-5 as modified by City of Los Angeles Brown Book and AASHTO Standard T245.

B. ASTM

1. ASTM International (formerly American Society for Testing and Materials)

C. State of California, Department of Transportation (Caltrans)

1. California Test 379 Method of Determining Asphalt Content of Bituminous Mixtures by Use of the Troxler Nuclear Gage

2. California Test 382 Method of Test for Determination of Asphalt and Moisture Contents of Bituminous Mixtures By the Ignition Method

1.04 QUALITY ASSURANCE

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

B. Use asphalt concrete producer regularly engaged in production of hot-mix for hot-laid asphalt concrete pavement. As approved by the local authority (in City of Los

Angeles – by Bureau of Engineering **in City of Beverly Hills – by Public Works and Transportation Department**).

C. Perform field job control tests in accordance with the test method and at the frequency specified in the following Part 3.

D. Maintain in good operating condition equipment used for handling materials, mixing, placing, and compacting.

1. Metro or its designee may reject equipment found to produce work that does not meet requirements indicated in the contract documents.

E. Density tests shall be performed by the Contractor's independent laboratory. The Metro or its designee may also perform testing at random selected locations.

F. Site Samples

1. Density of asphaltic concrete will be measured using nuclear density methods in accordance with ASTM D 2950 at the time of placement.

2. Provide Metro or its designee access for sampling stockpiles, hot bin analyses, and other tests.

G. Asphaltic products and solvents shall be compliant with the latest regulations of the South Coast Air Quality Management District regarding regulations governing permissible content of volatile organic compounds (VOC).

H. Notify City of Los Angeles for inspection 48 hours before starting asphalt concrete paving on public property.

I. Protect concrete pavements and walks, curbs and bases, and other improvements adjacent to the operations with suitable materials. All damage caused by the Contractor’s operations shall be repaired or replaced as required.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Test and Evaluation Reports

1. Test reports from an independent laboratory for materials and mix designs or proof that mix designs and all materials for use as asphaltic concrete pavement to be approved by Metro.

2. Submit test results of sampling and testing, and inspection records within 24 hours of asphaltic concrete placement.

C. List of equipment to be used for the placing, spreading, and compaction of asphaltic concrete paving. Only equipment approved by Metro shall be used.

D. For asphalt concrete to be placed in Public Right-of-Way of the City of Los Angeles, the contractor should submit the AC mix design **daily samples** to the ~~City~~ **Standards Division** for approval prior to placement.

E. Manufacturer's product data.

F. Site Quality Control Submittals

1. Submit proposed mix design for each asphaltic concrete mixture and seal coat to be used in the work, covering the specific materials to be used in.

~~1.~~**G. Test and Evaluation Reports for Heavy Traffic Binder Engineered Asphalt Binder PG76-10 and Asphalt Concrete Mixture with an Engineered Asphalt Binder PG76-10 shall be performed in accordance to Wilshire Bus Rapid Transit Project Addendum 4 as attached.**

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials shall meet requirements of referenced standards.

B. Base Course Material

1. Crushed Miscellaneous Base as specified in Section 32 11 00, (Aggregrate) Base Course.

C. Asphalt

1. Steam refined paving asphalt per SSPWC Section 203, grade as follows

a. Roadway areas (aside from wheel stops)

1) PG 70-10. For wheel stop locations see Section 32 13 00, Rigid Paving.

b. All other parking areas

1) PG 64-10.

c. Where Rubberized AC exists

1) ARHM-GG PG 64-16

D. Asphalt Emulsions: CSS-1h per SSPWC Section 203-3

E. Asphaltic Concrete Mixture

1. Conforming to Type C2 per SSPWC Section 203-6.4 and Table 203-6.4.3 (A).

F. Prime Coat: Grade SC-250

G. Tack Coat: Grade PG 64-10

~~G.~~**H. Asphalt Binder for High Stability Hot Mix Asphalt Concrete: see Addendum 4 of Wilshire Bus Rapid Transit Project attached.**

2.02 MIX DESIGN

A. Design of asphaltic concrete mixes shall be provided, and shall be obtained from a qualified independent testing laboratory or agency, properly equipped to design asphaltic concrete mixes. Costs of obtaining mix designs shall be at the Contractor's expense.

2.03 FIELD QUALITY CONTROL

A. Asphalt content shall be within plus or minus 0.50 percent of the mix design content. Conformance with asphalt content requirements shall be determined by California Test 382 or 379 from samples taken from the mat behind the paving machine. Minimum testing frequency shall be one test for every 500 tons, or fraction thereof, for each asphaltic paving mix placed each day.

PART 3 - EXECUTION

3.01 PREPARATION

A. Trucks used for transporting asphaltic concrete mixtures shall have smooth, clean, tight metal beds. Beds shall be sprayed with a minimum amount of paraffin oil or other approved release agent. Before loading with asphaltic concrete, drain off excess oil.

B. Protection of In-Place Conditions

1. Verify utility locations before driving stakes or pins.

C. Surface Preparation

1. Subgrade, aggregate base, curbs, gutters, and drains shall be approved by Metro or its designee before asphalt-paving operations are started.

3.02 FLEXIBLE PAVING

A. Construction procedures and requirements shall conform to SSPWC Section 302-5, Asphalt Concrete Pavement.

B. Asphalt pavement shall be of the thickness shown on the drawings. Total thickness shall be attained per SSPWC Section 302-5.5, Distribution and Spreading.

3.03 FIELD QUALITY CONTROL

A. Field Compaction Test

1. Roll material until it reaches minimum 95 percent relative compaction based on field density tests using a properly calibrated nuclear asphalt-testing device.

B. Other Field Tests

1. Compaction – SSPWC 2009, 302-5.6.2, one set of two (2) per each 500 tons or fraction thereof per shift.

2. Marshall density and flow test - one set of four (4) per each 500 tons or fraction thereof per shift per day.

3. Record temperature of mix once immediately before placement from at least one out of every five trucks.

4. Grade Control – SSPWC 2009, 302-5.6.2 once per each 500 tons placed.

C. Prime Coat

1. SC-250 asphalt applied at 0.10 to 0.25 gallon per square yard per SSPWC 302-5.

D. Tack Coat

1. PG 64-10 paving asphalt applied at an approximate rate of 0.05 gallons per square yard per SSPWC 302-5.

3.04 MAINTENANCE OF PAVEMENT

A. Upon completion of final rolling, traffic shall not be permitted on the finished pavement for at least six hours, and until the asphalt concrete has cooled sufficiently to withstand traffic without being deformed.

B. Finished pavement shall be maintained in finished clean condition until the Work is accepted by Metro.

3.05 PROTECTION

A. Be responsible for any damage caused by the Contractor's employees or equipment and make necessary repairs. Cover building and other surfaces with paper or other protection, where required. Repair or replace, as required, all damage caused by the Contractor's operations.

END OF SECTION 32 12 00

Attachments:

5 pages from Wilshire BRT Addendum 4

A – pg 4 of 6 item 9 Asphalt Binder for High Stability Hot Mix Asphalt Concrete (1 page)

B – Specification for Heavy Traffic Binder (4 pages)

Wilshire Bus Rapid Transit – Curb Lanes, and Wilshire Boulevard Middle Lanes
W.O. Nos. E1907532, and W.O. E1907525
Federal Project No. CA-03-8015

7. **Add** the following note to the Notice to Contractors, on Project Plan Index No. D-34265, Drawing No. C-2, after Note 37:

   "Note 38. In addition to the coordinated work with METRO for METRO's utility work, the Contractor may need up to 250 calendar days of coordinated work with utility companies for adjustment of maintenance holes and vaults to grade at Wilshire Blvd. from ST. Andrews Pl. to Mansfield Ave., Wilshire Blvd. from Cloverdale Ave. to Ogden Dr., and Wilshire Blvd. from San Diego Way to San Vicente Blvd. The Contractor shall include 250 calendar days of coordinated work with utility companies for adjustment of maintenance holes and vaults to grade. **"**

8. **Add** the following note to the Notice to Contractors, on Project Plan Index No. D-34265, Drawing No. C-2, after Note 38:

   "Note 39. The Contractor shall include all costs associated with Plan Modifications 2 (Notes 33 through 38) listed above, in the appropriate bid items of the Schedule of Work and Prices in Part I of the Bid Proposal. **"**

WSE AMENDMENT 1

9. **Replace** Note 2 for HIGH STABILITY HOT MIX ASPHALT CONCRETE on Project Plan Index Number D-34265, Drawing No. C-3 (Sheet 4), with the following:

   "2. ASPHALT BINDER FOR HIGH STABILITY HOT MIX ASPHALT CONCRETE SHALL CONFORM TO REQUIREMENTS FOR PG 76-10 PERFORMANCE GRADING IN CONFORMANCE WITH ASSHTO M 320-10, AND SHALL ALSO BE AN ENGINEERED ASPHALT BINDER ABLE TO PROVIDE ADEQUATE FIELD PLACEMENT AND COMPACTION. THE ENGINEERED ASPHALT BINDER AND ASPHALT CONCRETE MIXTURE WITH AN ENGINEERED ASPHALT BINDER SHALL MEET THE SPECIFICATION FOR HEAVY TRAFFIC BINDER ENGINEERED ASPHALT BINDER PG 76-10 AND FOR ASPHALT CONCRETE MIXTURE WITH AN ENGINEERED ASPHALT BINDER PG 76-10. "

10. **Add** the attached **"PCC Sidewalk Removal and Construction Area table, detail and note"** on Project Plan Index No. D-34265, Drawing No. C-6 (Sheet 7) and Drawing No. C-23 (Sheet 24) to further clarify the areas for removal and construction of PCC sidewalk (1 page).

11. **Change** the **description** of the **Construction Note Item No. 2** on Project Plan Index No. D-34265, Drawing Nos. C-6 through C-39 (Sheets 7 through 40) from "TYPE C INTEGRAL CURB & GUTTER, a=2'; b=13"; cf=6" " to **"TYPE C INTEGRAL CURB & GUTTER, a=2'; b=13"; cf=variable height" "**

Wilshire Bus Rapid Transit – Curb Lanes, and Wilshire Boulevard Middle Lanes
W.O. Nos. E1907532, and W.O. E1907525
Federal Project No. CA-03-8015

12. **Add** the following note on Project Plan Index No. D-34265, Drawing Nos. C-23 through C-39 (Sheets 24 through 40):

    "The elevation of the top of new curb to match the elevation of the top of the existing curb, unless specified otherwise on the plan."

13. **Add** the following note on Project Plan Index No. D-34265, Drawing Nos. Nos. C-6 through C-39 (Sheets 7 through 40):

    "Bus Stop Shelters are to be removed and installed by third party. The Contractor shall contact CBS Decaux two weeks prior to removal of bus pad or roadway area in front of an existing bus stop shelter. The Contractor shall also contact CBS Decaux two weeks prior to starting construction of the curb lanes at locations where bus pads are called out on the plan. The City will provide contact information for CBS Decaux after award of the contract."

14. **Replace** the Detail A1 on Project Plan Index Number D-34265, Drawing No. C-41 (Sheet 42) with the attached revised **"Detail A1"**, which includes placement of weep holes and geotextile fabric within the paver crosswalk areas (1 page).

15. **Add** the attached **"Detail A9"**, which shows the proposed weephole layout in the paver crosswalk areas, on Project Plan Index Number D-34265, Drawing No. C-41 (Sheet 42) (1 page).

16. **Add** the following note on Project Plan Index Number D-34265, Drawing No. C-41 (Sheet 42).

    "Include all costs of weepholes and geotextile fabric within the paver crosswalk areas in bid item nos. 39 and 104 of the Schedule of Work and Prices in Part I of the "Bid Proposal". "

17. **Change** the call out from " 4" PCC OVER 8" AB " to **" 4" PCC OVER 4" CMB "** on Details H1 and A8, on Project Plan Index Number D-34265, Drawing No. C-46 (Sheet 47).

18. **Add** the following note on the project plan sheets for AUTOMATED TRAFFIC SURVEILLANCE AND CONTROL SYSTEM (ATSAC) **"(ATSAC Sheets 1, 2 and 3) "**:

    "After utility markings and one week prior to trenching for installation of ATSAC conduits and one week prior to roadway removal at the areas of the proposed ATSAC conduits, the Contractor shall contact Manoocher Adhami of LADOT at (213)972-8664 for observation of ATSAC in order to assess whether there is need to change the alignment of the proposed ATSAC conduit."

Wilshire Bus Rapid Transit – Curb Lanes, and Wilshire Boulevard Middle Lanes
W.O. Nos. E1907532, and W.O. E1907525
Federal Project No. CA-03-8015

III. Davis Bacon Wage Determination:

The latest Federal Wage Rates (27 pages) published on January 11, 2013 is attached herein for your information.

Sincerely,

Digitally signed by James Zabala
DN: cn=James Zabala, o, ou, email=james.zabala@lacity.org, c=US
Date: 2013.02.05 11:30:42 -08'00'

Ted Allen, P.E., Division Engineer
Department of Public Works
Bureau of Engineering
Project Award and Control Division

WSE
AMENDMENT 1

BUREAU OF ENGINEERING

WILSHIRE BLVD. BUS RAPID TRANSIT CURB LANES
W.O. E1907532
And
WILSHIRE BLVD. MIDDLE LANES
W.O. E1907525
PROJECTS

FEDERAL PROJECT NO.
CA-03-8015

JANUARY 2013

SPECIFICATIONS FOR HEAVY TRAFFIC BINDER ENGINEERED ASPHALT BINDER PG 76-10 AND ASPHALT CONCRETE MIXTURE WITH AN ENGINEERED ASPHALT BINDER PG 76-10

City of Los Angeles
California

Department of Public Works
Bureau of Engineering

ENGINEERING
SERVING THE PRESENT; DESIGNING FOR THE FUTURE

Addendum No. 4 page 1 of 4

Table EBM A			
CITY OF LOS ANGELES **GENERAL SERVICES DEPARTMENT** **SPECIFICATION FOR HEAVY TRAFFIC BINDER** **ENGINEERED ASPHALT BINDER PG 76-10** **CRUDE SOURCE: NORTH AMERICA**			
Tests	**Method**	**Specifications**	
Original Binder	**N/A**	**MIN.**	**MAX.**
Original Asphalt Flash Point, Cleveland open Cup (°C)	**AASHTO T48-06 (2010)**	**230**	—
Brookfield Viscosity @ 135 °C Original, (Pa·s)	**AASHTO T316-11 Speed: 20 rpm, Spindle: SC4-21 Test Temperature: 135 °C**	**0.600**	**1.300**
DSR @ 76°C, Original Binder G*/Sin δ, (kPa)	**AASHTO T315-12, Geometry: 25 mm Steel Plate, Frequency: 10 rad/s**	**1.10**	**2.50**

Tests	Method	Specifications	
RTFO on Residue	**AASHTO T240-09**	**MIN.**	**MAX.**
Brookfield Viscosity @ 135 °C RTFO Viscosity, (Pa·s)	**AASHTO T316-11 Speed: 20 rpm, Spindle: SC4-21 Test Temperature: 135 °C**	**0.950**	**2.100**
DSR @ 76°C, RTFO Residue G*/Sin δ, (kPa)	**AASHTO T315-12, Geometry: 25 mm Steel Plate, Frequency: 10 rad/s**	**2.30**	**5.00**
Absolute Viscosity @ 60 °C RTFO Residue, (poise)	**AASHTO T202-10**	**35,000**	**70,000**

Tests	Method	Specifications	
PAV Residue	**AASHTO R28-12, 2.10 MPa, at 100 °C for 20 hrs.**	**MIN.**	**MAX.**
DSR @ 37°C, PAV Residue G*Sin δ, (kPa)	**AASHTO T315-12, Geometry: 8 mm Steel Plate, Frequency: 10 rad/s.**	**1100**	**5000**
BBR S Creep Stiffness (MPa)	**AASHTO T 313-12, Test Temp. @ 60 s, at 0 °C**	**30**	**300**
BBR m-value = Slope	**AASHTO T 313-12, Test Temp. @ 60 s, at 0 °C**	**0.300**	**0.400**

Addendum No. 4 Page 2 of 4

Table EBM B

CITY OF LOS ANGELES
GENERAL SERVICES DEPARTMENT

SPECIFICATION FOR ASPHALT CONCRETE MIXTURE WITH AN ENGINEERED ASPHALT BINDER PG 76-10. CRUDE SOURCE: NORTH AMERICA. COARSE AGGREGATE: 100% CRUSHED AND ANGULAR IN SHAPE SAND (FINE AGGREGATE): Ua min. = of 45% per CAL. Test Method 234

MIX DESIGN

The asphalt concrete mix design shall be prepared in accordance with Brown Book 2009 version, City of Los Angeles, Department of Public Works section 203-6 by Marshall Test method (mechanical compactor shall be used).

Note: When using Engineered Binders as PG 76-10, the design criteria for Maximum Stability and Flow in Table 203-6.2 (Brown book) are waived.

The Job mix formula submitted by the contractor shall be within the Master Grading Band, Class B Dense medium Coarse Gradation Requirement as indicated below (GREENBOOK Section 203-6):

Percentage Passing

25.0mm	19.0mm	12.5mm	9.5mm	4.75mm	2.36mm	0.60mm	0.30mm	0.075mm	Binder %
100	87-100	70-87	55-76	35-52	22-40	8-24	5-18	0-7	4.5-5.8

ACCEPTANCE TESTING

Asphalt Concrete Mix design and daily samples shall be verified and tested for acceptance by Standards Division using Superpave Gyratory Compactor Method and shall meet the City of Los Angeles below requirements.

Tests per Standards Division in house procedure	Compaction Test Method	Specifications	
SUPERPAVE	**AASHTO T312-12**	**MIN.**	**MAX.**
Modified Marshall Stability, Ø = 150 mm, @ 60 °C, (Lbs) Precondition in water 4 hrs at 60 °C	N_{design} = 65 Gyrations Ram Pressure = 600 ± 18 kPa Angle of Gyr. = 1.25 ± 0.02 deg	18,000 lbs.	
Indirect Tensile Strength Ø = 150 mm, @ 60 °C (psi) Precondition in water 4 hrs at 60 °C	N_{design} = 65 Gyrations Ram Pressure = 600 ± 18 kPa Angle of Gyr. = 1.25 ± 0.02 deg	45 psi.	85 psi.
Pine Rutmeter Depth (mm) At 6900 Cycles, @ 60 °C Precondition in water 2 hrs at 60 °C	N_{design} = 65 Gyrations Ram Pressure = 600 ± 18 kPa Angle of Gyr. = 1.25 ± 0.02 deg	0.0 mm	1.6 mm
Percent Air Voids (%)	ASTM D3203-05 or AASHTO T269-97 (2007)	2.0	4.0

Addendum No. 4 Page 3 of 4

VERIFICATION OF REQUIRED WORKABILITY

Remarks:

The asphalt concrete mixture, Class B PG 76-10, shall exhibit in the field sufficient workability in order to provide for adequate field placement and compaction. In order to verify the required workability and compaction, prior to full production , the contractor shall construct in the project a test section 300 ft. long 13 ft wide, with the specified depth in accordance with the plans, with the bituminous mixture to be used in the project according to the approved Job mix formula. The Subgrade upon which the test section is to be constructed shall be representative of the project and approved by the Engineer or his representative. In addition, the equipment used in the construction of the test section shall be the same type and weight to be used on the remainder of the project. If the test section meets requirements, the Engineer will allow proceeding for full production.

If the initial test section or other additional required test section fail the above specifications and project's requirements, such sections shall be removed at the Contractor's expense. Additional test sections may be constructed if required, with the Project Engineer approval to verify the required workability and compaction, prior to full production.

Additionally the Vendor is subject to the following guidelines:

1-Before the product is used in the project the engineered asphalt binder PG76-10 shall be tested by Standards Division and approved by the Engineer.

A consistency range may be developed and established by Standards Division for the binder used in the project.

2-Asphalt concrete mixtures samples of the mixture to be used in the project shall be submitted by the contractor to Standards Division for testing and approval by the Engineer before the tests section is constructed.

3- During construction Standards Division will perform acceptance testing in accordance with Brown Book 2009 version, City of Los Angeles, Department of Public Works as modified by these specifications.

SPECIFICATIONS REVISED BY STANDARDS DIVISION, ROADS & HIGHWAYS SECTION, July 17, 2012

Addendum No. 4 Page 4 of 4

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SECTION 32 80 00

IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Furnishing and installing an automatically controlled irrigation system and associated equipment. This section only applies to irrigation systems within Metro's right-of-way.

1.02 RELATED SECTIONS

A.	Section 01 33 00	Submittal Procedures
B.	Section 01 43 10	Project Quality Program Requirements – Design / Build
C.	Section 01 66 00	Product Storage and Handling Requirements
D.	Section 01 78 23	Operation and Maintenance Data
E.	Section 01 78 39	As-Built Drawings and Current Status Documents
F.	**Section 01 78 43**	**Spare Parts, Illustrated Parts Catalog, and Replacement Materials**
~~F.~~**G.**	Section 08 71 11	Finish Hardware
~~G.~~**H.**	Section 31 20 00	Earthwork
~~H.~~**I.**	Section 33 00 01	Piped Utilities

1.03 REFERENCES

A. American National Standards Institute (ANSI)

1.	ANSI B16.3	Malleable Iron Threaded Fittings
2.	ANSI B2.2	Dry Seal Pipe Threads Specifications, Dimensions, and Gauging for taper and Straight Dry Seal Pipe Threads

B. American Society for Testing and Materials (ASTM)

1.	A53	Pipe, Steel, Black and Hot-Dip Zinc-Coated, Welded and Seamless
2.	ASTM B3	Soft or Annealed Copper Wire
3.	ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
4.	ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120

5. ASTM D2241 Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)

6. ASTM D2464 Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

7. ASTM D2467 Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

8. ASTM D2855 Making Solvent - Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

C. American Water Works Association (AWWA)

1. AWWA C500 Gate Valves, 3 Through 48 in. NPS, for Water and Sewage Systems

D. National Electrical Manufacturers Association (NEMA)

1. NEMA 4 Water Tight and Dust Tight – Indoor / Outdoor Enclosure

E. Standard Specifications for Public Works Construction (SSPWC), Latest Edition

1.04 QUALITY ASSURANCE

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

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Manufacturer's specifications for components of the irrigation system. Clearly mark the literature to indicate the specific types or models proposed.

C. Shop Drawings: Required for irrigation assemblies that are not detailed in Project Definition Documents or manufacturer's literature, and for revisions to system layout resulting from changes in site conditions. Include a list of materials and manufacturer's model numbers and descriptions of equipment.

D. Record Prints

1. Record accurately one set of prints of all changes in the Work constituting departures from the original Contract Drawings, including changes in pressure and nonpressure line locations.

2. Record the changes and dimensions in a legible manner to the satisfaction of Metro. Before final inspection of work, submit record prints to Metro for review and acceptance.

3. Dimension from two permanent points of reference (buildings, monuments, sidewalks, curbs, pavements). Record data shown on record prints day-to-day as the Project is being installed.

4. Show locations, depths and size, as applicable, of the following items:

   a. Point of connection.

   b. Routing of sprinkler pressure lines and nonpressure lines (dimension maximum 100 feet along routing).

   c. Gate valves.

   d. Sprinkler control valves.

   e. Quick coupling valves.

   f. Routing of control wires.

   g. Related equipment as may be directed.

5. Maintain record prints onsite.

E. Operation and maintenance manuals in accordance with Section 01 78 23, Operation and Maintenance Data.

F. Material Safety Data Sheets (MSDS): Manufacturer's Material Safety Data Sheets for each type of material used in Work.

G. Submit inventory / equipment list of all irrigation devices. Backflow prevention assembly device information to include location / address, type, size, and device serial number.

H. Submit current backflow prevention assembly device test / certification reports.

1.06 DEFINITIONS (NOT USED)

1.07 TURNOVER ITEMS

A. Controller Charts

1. Record prints require acceptance by Metro before charts are prepared.

2. Provide one controller chart, of maximum size controller door will allow, for each automatic controller.

3. Chart: Reduced copy of actual "record" print. In event controller sequence is not legible when print is reduced, enlarge to a readable size.

4. Mark chart to show area of coverage using a different color for each station.

5. When completed and accepted, hermetically seal chart between two pieces of 20 mils thick plastic, minimum. Install chart in controller enclosure using "hook and loop" fasteners.

6. Complete controller charts before final inspection.

B. Operation and Maintenance Manuals

1. Within 10 days before acceptance of construction, prepare and deliver to Metro required descriptive materials, properly prepared in two individually bound copies of the Operation and Maintenance Manual. Describe the material installed in sufficient detail to permit operating personnel to understand, operate, and maintain equipment. Include spare parts lists and related manufacturer's information for each equipment item installed. Include following information in the Maintenance Manual:

a. Index sheet stating Contractor's address and telephone, including names and addresses of local manufacturer's representatives.

b. Complete operating and maintenance instructions on major equipment.

c. Refer to Section 01 78 23, Operations and Maintenance Data.

C. Special Tools and Spare Parts

1. ~~Supply following items as part of Contract:~~**See Section 01 78 43 for details.**

~~a. Four percent additional sprinkler heads (minimum four heads, maximum ten heads) of each type and spray pattern shown.~~

~~b. Two wrenches for disassembly and adjustment of each type sprinkler head installed.~~

~~c. Two keys for each automatic controller.~~

~~d. Two couplers with 3/4-inch bronze hose bibb, bent nose type with hand wheel and brass hose swivels, and one coupler key for each five quick couplers installed.~~

~~e. One valve box cover key per ten valve boxes for each type of box used.~~

~~f. Backflow device valve handles.~~

~~g. One five-foot valve wrench where 2 1/2 inches and larger gate valves are installed. Deliver tools and spare parts to Metro at conclusion of Project final inspection.~~

D. Additional Documentation

1. At close of Project upon completion of Work, provide as-built record drawings in compliance with Section 01 78 39, As-Build Drawings and current Status Documents. Record information that is legible and in a manner, that is acceptable to Metro.

1.08 REGULATORY REQUIREMENTS

A. Requirements of other Federal, State, and Local Authorities having jurisdiction.

B. In event of discrepancy between referenced standards and plans and specifications, the more stringent requirements prevail.

PART 2 - PRODUCTS

2.01 DESIGN REQUIREMENTS

A. Utilize and identify reclaimed water valves and piping.

B. When feasible, provide minimum 10-ft clearance to all autromatic controllers, enclosures, gate valves and quick couplers.

C. When feasible, provide minmum 10-ft clearance to all backflow prevention assemblies and enclosures.

D. All landscaping must have permanent hard-wired irrigation system and controllers.

E. Metro's landscaping shall have a dedicated irrigation system, separate from any bike path irrigation system or any other private and / or public agencies responsible for maintenance.

2.02 PIPE AND FITTINGS

A. General pipe material for Buried Irrigation Systems: PVC except at risers and where indicated otherwise.

2.03 PIPING

A. Polyvinyl Chloride (PVC) Pipe: Schedule 40, complying with ASTM D1785 for schedule pipe and ASTM D2241 for class pipe.

1. Size: As indicated.

2. Rating: Schedule 40 for diameters under two inches, Class 315 for size two inches and up to three inches.

3. Pipe: Free from dents, wrinkles die or heat marks. Such defects are ground for rejection by Metro.

B. Galvanized Steel Pipe: Threaded, complying with ASTM A53, Schedule 40, hot-dipped galvanized.

C. Polyvinyl Chloride (PVC) Threaded Nipples: Schedule 80, complying with ASTM D1785.

2.04 PIPE FITTINGS

A. Polyvinyl Chloride (PVC) Pipe Fittings:

1. Schedule 80, Socket Type: ASTM D2467

2. Schedule 80 Threaded Type: ASTM D2464.

B. Galvanized Steel Pipe Fittings: Galvanized malleable steel Class 300, threaded, complying with ANSI B16.3, hot-dipped galvanized.

2.05 PVC PIPE JOINT COMPOUND AND PRIMER

A. Joint Compound: Slow drying, heavy duty type.

B. Solvent Cementing: Solvent cementing of plastic pipe and fittings shall be a two-step process, using primer and solvent cement applied per the manufacturer's recommendations. Cement shall be of a fluid consistency, not gel-like or ropy. Solvent cementing shall be in conformance with ASTM D2564 and ASTM D2855.

C. Primer: Tinted, compatible with joint compound; as recommended by manufacturer of PVC pipe.

2.06 SPRINKLER HEADS

A. Provide heads of type and size as indicated, with UV and impact resistant nozzles.

B. Use heads by one manufacturer only for each type of head installed.

C. Use heads on same lateral circuits that are balanced for matched precipitation rates.

D. Use separately controlled circuits where head or nozzle precipitation rate varies more than 20 percent from circuit average precipitation rate.

2.07 SWING JOINTS

A. Swing Joints: Triple, consisting of three 90° street ells and one Schedule 80 PVC threaded nipple.

B. Size: To match head inlet.

2.08 ELECTRIC VALVES FOR SPRINKLER SECTIONS

A. Valves: Provide valves for Sprinkler Sections of size and type as indicated.

1. Actuated by a low power, 2.0 watt, 24 Vac solenoid actuator.

2. internal parts to be removable from top of valve without disturbing valve installation.

3. Provide for optional factory or field installed pressure regulated module.

B. Remote Control Valves: Normally closed, 24 Vac, 60 Hz solenoid actuated globe pattern diaphragm type with valve pressure rating not less than 200 psi.

C. Master Control Valves: Same as remote control valves, installed with two unions.

D. Valve Body and Bonnet: Heavy cast brass, with nylon reinforced nitrile rubber diaphragm. Encapsulate solenoid coil in molded epoxy.

E. Provide valve with flow control stem and cross handle for regulating and shutting off water flow and bleed screw for manual operation without electrically energizing solenoid coil.

F. Provide Rainbird EFP-CP or Champion "Medalist" Series Valves or approved equivalent.

2.09 VALVE BOXES

A. 16 inches by 12 inches by 10 3/4 inches.

B. Manufacturer: Brooks Products, Christy Products, Associated Concrete Products, or approved equivalent.

2.10 AUTOMATIC IRRIGATION CONTROLLERS

A. Controller: Size and type as indicated.

1. Controller: Capable of operating 24 Vac electric remote control valves. Provide a UL listed 24 Vac transformer with controller if not an integral part of controller, Color-code station wiring with section indicator key visibly imprinted. Include pump start or master valve control with controller and circuit overload protection to prevent damage due to voltage surges.

B. Provide controller for complete automatic operation of irrigation system; commercial grade, in weatherproof, lockable box or cabinet, UL listed and with adequate number of stations to operate system. Provide stations with independent time controls with one-minute incremental settings up to 60 minutes maximum per station. Provide controllers to allow easily made changes on station timing and programs start time without tools or disassembling. Stations may be omitted. Provide rapid advance between stations and override on each station for manual operation. Provide for schedules up to one week and permit multicycle operation as often as every hour. Equip controller with Manual start switch for activation of semiautomatic watering cycle.

C. Controller housing: Heavy-gauge, vandal resistant steel, and finishes as indicated and approved by Metro. Weatherproof cabinet - NEMA Type 4. Gasket controller door and provide covered, heavy-duty lock for protection against theft and vandalism. Mount controller components on face panel for easy removal. Print operating instructions on face of controller for easy access when programming. Place Section location chart inside cabinet door.

D. Lock Cylinder and Master Keying: As specified in Section 08 71 11, Finish Hardware.

E. Controller Chart: As specified in paragraph 1.07A.

2.11 IRRIGATION CONTROL WIRE

A. Provide thermoplastic insulated, solid copper conductor conforming to ASTM B3, suitable for continuous operation at 24V.

B. Direct burial control wires to remote control valves - NEC Type UF or G.E. Co. No. SI-58-51 or approved equivalent. Size wire to each remote control valve to not exceed five percent voltage drop from impressed voltage, not less than No. 14 AWG.

C. Wire: Different colors for each remote control valve, minimum of eight colors, white for common wire.

D. Wire Splices Where Allowed: Rainbird Penn-Tite wire connectors, Scotchlok or approved equivalent.

2.12 BACKFLOW PREVENTER

A. Backflow Preventer: Size and type as indicated.

B. Backflow Preventer: Reduced pressure type backflow preventer for cold water, 125 pound class, with strainer.

2.13 GATE VALVES

A. AWWA C500, bronze body, bronze mounted, nonrising stem with solid wedge gates.

2.14 ELECTRICAL MATERIALS (LOW VOLTAGE)

A. Conduit below Paving: Schedule 40 PVC sized per irrigation details, or as required.

B. Wire: Common wire, white insulation with colored stripe. Stripe color - Different for each controller installed per station area. Control wire - One color other than white or green. Use a different color control wire for each controller installed per station area.

2.15 QUICK COUPLING VALVES

A. Quick Coupling Valves: Size and type as indicated.

B. Two piece brass body with self-closing, lockable rubber cover, one-inch size, rated for 125 psi.

C. Quick Coupling Valve: Rainbird No. 44 LRC, Champion 2PQCV-100VL, or approved equivalent.

2.16 CHECK VALVES

A. Brass or bronze construction, soft seat, either spring loaded or flapper type, testing to minimum 200 psi water pressure.

2.17 PROTECTIVE COATING FOR METALLIC PIPING

A. As specified in Section 33 00 01, Piped Utilities. Either cold applied mastic, tape composite system or coal tar epoxy.

2.18 INSULATING FLANGE ASSEMBLIES

A. Insulating unions or plastic insert type insulating joints as specified in Section 33 00 01, Piped Utilities.

2.19 MISCELLANEOUS EQUIPMENT

A. Landscape Fabric: Landscape fabric for valve box assemblies shall be 5.0-oz. weight woven polypropylene weed barrier. Landscape fabric shall have burst strength of 225. Puncture strength of 60 lbs. and capable of water flow of 12 gallons per minute per square foot.

B. Type: DeWitt Pro 5 Weed Barrier or approved equal.

C. Equipment such as flow sensors, rain sensors, wye strainers, and master valves shall be of the manufacturer, size and type as indicated.

2.20 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Verify large specimen plants have been planted before installing irrigation system.

B. Unless otherwise indicated, irrigation system shown on plans is diagrammatic. Install irrigation equipment in planting areas wherever possible. Do not install under paving unless necessary. With acceptance of Metro, make adjustments where necessary to conform to actual field conditions.

1. Irrigation System: Operational, with uniform and adequate coverage of areas to be irrigated before planting.

C. Service Connections: As indicated or designated by utility company; installed by others at no cost to Contractor. Notify Metro at least three weeks before time electrical and water services are required. Furnish labor and materials to connect to service connection.

D. Water Supply: Connect to water supply at locations indicated. Make minor changes caused by actual site conditions at no additional cost to Metro. Arrange for and pay costs associated with water meter installation.

E. Electrical Service: Make 110V connection to irrigation controller and 24V transformer service to the remote control valves.

F. Code Requirements

1. Before starting the Work of this Section, carefully inspect installed work of other trades and verify work is complete to point where irrigation system installation may commence properly. Verify irrigation system may be installed in accordance with pertinent codes and regulations, original design, referenced standards and manufacturer's recommendations.

2. Immediately notify Metro of conflicts between equipment or methods indicated or specified with local codes, before start of installation. If Contractor fails to give notification, assume responsibility for cost of revisions necessary to comply with code.

G. Grades: Before starting Work, carefully check grades to determine Work may proceed safely; keep within specified material depths with respect to finish grade.

H. Coordination with Work of Other Trades: Make necessary measurements in field to ensure precise fit of items in accordance with original design. Coordinate installation of irrigation materials with other Work. Coordinate piping locations and tree and shrub locations to avoid conflicts.

I. Maintain record drawing blueprint on site. Upon completion of Work, transfer as-built information and dimensions to reproducible prints.

J. Provide at least one qualified person, present at all times during execution of the Work, familiar with the type of materials being installed and the material manufacturers' recommended methods of installation and direct Work performed under this section.

3.02 EXCAVATING AND BACKFILLING

A. Perform excavation and backfilling as specified in Section 31 20 00, Earthwork. Restore existing surfaces to original condition, as determined by Metro.

B. Provide minimum 12-inch depth of cover over lateral lines, minimum 18-inch depth of cover over main lines, and minimum 24-inch depth of cover for pipe under roadways.

C. Existing Trees and Large Specimen Plantings:

1. Avoid injuring tree roots, trunks, and branches. Perform excavation and trenching within drip line of trees with hand tools.

2. Alter alignment of pipe to avoid tree roots two inches and larger in diameter.

3. Coordinate excavation and trenching activity within drip lines to allow backfiling within the same work day. Cover exposed roots within 8 hours of initial exposure. Provide temporary backfill at end of each work day if Work progresses into additional days.

4. Hand prune severed roots one inch and larger with sharp tools. Use angled cut.

D. Trenches: Provide trenches free of rocks, clods, and other sharp-edged objects.

3.03 ASSEMBLY OF PIPES

A. Metal Pipe: Do not bend or spring pipe. Make offsets or changes in direction with fittings. Cut threads with sharp, clean dies to conform to ANSI ASA Specification B2.2. Assemble pipes free from dirt and scale, ream and debur. Make up joints by applying oil base compound to male threads only. Remove excessive compound after make-up.

B. PVC Plastic Pipe:

1. Handle with care when loading, unloading, transporting and storing material to avoid damage. Store pipe and fittings under cover before using. Transport in vehicle with bed of sufficient length to carry pipe flat and fully supported. Store pipe in same manner. Notify Metro when each pipe and fittings shipment reaches the site for his observation. Immediately remove rejected materials from the site and replace with new shipment of different batch number.

2. Solvent Welding: Use non-synthetic brush to spread primer and solvent using no larger than pint-sized cans. Clean and refill cans each day. Cut pipe square, ream, chamfer outside end at 10 degrees. Clean and dry pipe and fitting socket. Scrub full length of inside socket and pipe end with primer, prime inside socket again. Immediately apply solvent to pipe end and to socket, then again to pipe end. Bottom the pipe in socket and turn 90 degrees. Hold joint together 30 seconds. Wipe off excess solvent. Allow to set 30 minutes before moving. Center load pipe with small amount of backfill to prevent arching and whipping under pressure, leaving joints exposed.

3. Threaded Connections: Use teflon tape on plastic threaded joints, minimum five full turns. Screw hand tight and another half turn by wrench. On PVC to metal pipe, work the metal connection first.

3.04 LAYING OF LINES

A. Clearances:

1. Provide minimum four inches clearance between each lines and minimum six inches clearance between other trades.

2. Do not install a line directly over another parallel line.

3. Install equipment so that lines or components can be serviced or replaced without disturbing another.

B. Do not lay pipe in trench containing water or at less than 32 degrees F. Center load immediately, leaving joints exposed.

C. Identifiers:

1. Identification Wire: 12 gauge bare copper, new or used, at bottom of trench for mainline PVC piping to provide a continuous conductor between gate valves. Wrap each end around valve body and bring up inside valve box with

minimum two feet of wire free. Scrape ends clean and wire to valves, providing a two-foot loop.

2. Tracer/Warning Tape: Before back fill of last 12 inches of trench. Place tracer/warning tape in trench to show location of buried PVC mainline.

3. Extend sleeves set in place under paving a minimum six inches beyond such paving and cap hand tight. No fittings. including couplings will be permitted under surfaces to be paved except where the length of the line under the paving exceeds 20 feet or where indicated, (i.e. parking lots).

3.05 VALVES

A. Valves, Manual and Electric: Locate in planter areas wherever possible and in areas indicated.

B. Master Control Valve: Locate immediately downstream of back flow preventer assembly. Install with two unions.

C. Quick Coupler Valves: Locate in planter areas wherever possible, in areas indicated.

D. Check Valves (anti-drain valves): Install per manufacturer's recommendations. Locate inline in lateral lines where indicated, and as required to prevent irrigation head drainage. Adjust each check valve as required to prevent drainage.

E. Locate valves so they are easily accessible for maintenance and replacement.

F. Valve Boxes:

1. Use bricks to provide a firm base around valve box.

2. Install with top cover flush with finish surface in paved areas, and as indicated for planted areas.

3. Provide clearance between top of valve and bottom of lid as indicated.

4. Provide minimum six-inch deep (minimum one cubic foot) layer of clean pea gravel under valves.

3.06 LAYING OF CONTROL WIRES (LOW VOLTAGE)

A. Lay wires in common trench with main lines wherever possible. Use plastic electrical tape and bind control wires in a bundle at 10 feet intervals.

B. Remote Control Wire: Continuous without splices between controller and valves.

C. Common wire and pilot wires are to be tagged with 1/4 inch wide embossed plastic labeling tape, showing controller and station number designation.

D. Splicing is allowed with 24-inch expansion loop only in an accessible electrical junction box with bolt down lid. Mark box marked on as-builts record drawings.

E. Encase wire under paving in Schedule 40 PVC pipe. Provide continuous wire runs without splices between control valves; splice only at control valves or accepted junction box locations.

3.07 BACKFLOW PREVENTER

A. Install as indicated.

B. Install unit 12 inches minimum above grade conforming to Los Angeles Municipal Code. Verify exact location with Metro before installation.

C. Use a certified backflow prevention device tester, registered with the DWPWS, local water company, or CA-NV AWWA or ABPA, and County Health Department to test assembly.

3.08 FLUSHING OF LINES

A. Flush main lines before attaching remote control valves of quick coupler valves and with pipe center loaded. Temporarily pipe water being discharged up and out of the trenches. Keep trenches dry for pressure tests to follow. Install valves after approval of flushing procedure by the City inspector.

B. Flush laterals before sprinkler heads are installed. Cap risers, apply pressure, remove caps in sequence starting at cap nearest the control valve. Replace caps before removing caps to follow. Continue to end of each lateral. Flush until foreign matter and mud is cleared of the system. Provide materials needed for flushing operations.

3.09 IRRIGATION HEADS

A. Layout of Heads and Staking: Stake head locations with marker flags before to installing swing joints. Notify Metro of discrepancies between drawings and site conditions. Do not exceed maximum spacing indicated, or exceed the GPM on the pipe sizes shown. If spacing demand additional or less materials, notify Metro before commencing Work.

B. Install heads as indicated.

C. Distance between heads and edge of adjacent curbs, paving, walls, or structures - equal to head diameter, or as indicated.

D. Install irrigation heads and risers on triple swing joints. Do not use side inlets on irrigation head bodies.

E. Install sprinkler heads flush with finish grade adjacent to walks, concrete mowing strips and curbs as detailed. Full heads in seeded lawn areas – Not less than four inches above finish grade. Lower heads to grade before completion of maintenance period or as directed by Metro.

F. Upon completion of installation, adjust heads to properly distribute water flow. Adjust adjustable sprinkler heads by fully opening sprinkler head farthest from control valve. Open manual adjustment of control valve slightly to obtain a 24-inch high spray at sprinkler head mentioned above. After this condition has been met,

adjust other sprinklers in that Section for equal height sprays, regulating control valve as required to maintain condition. Adjust control valve to obtain catalog rate pressure for sprinkler installed. Rotate individual heads to keep sprays within areas of lawn, shrubs and groundcover.

3.10 CONTROLLER INSTALLATION

A. Exact Locations of Controllers: As approved by Metro before installation. Coordinate electrical service with this location. Wall mount controllers within vandal resistant enclosure as indicated. Locate controller enclosure in shrub areas. Secure enclosure to slab with four 3/8-inch diameter by 4 1/2 inches long galvanized anchor bolts with washers; provide maintenance access. Install surge arrestors for field controllers.

B. Locate enclosure on concrete pad as indicated.

C. Grounding: Connect to existing grounding system or furnish and install a complete grounding, and bonding installation as required by prevailing code.

D. Seal openings to controller enclosure to deter entry by rodents.

E. Program irrigation system to operate during periods of minimum use of design area.

3.11 INSPECTION

A. At completion of installation, and before planting, inspect overall coverage of system. Demonstrate to Metro the working system with proper coverage and minimal overspray.

B. Completely check system within five days before final inspection. Properly align heads and adjust for coverage. Clear system of foreign materials. Properly adjust valves. Check sprinkler controller valve chart for accuracy.

C. At end of Plant Maintenance Period, make a final inspection of system with Metro.

3.12 TESTS

A. Make tests in presence of Metro. Give at least 48 hours advance notice of tests.

B. Hydrostatically test sprinkler lines normally under pressure as follows:

1. Mains and Supply Lines: One hour at 150 percent of static pressure.

2. Test each system as a unit or in sections, as directed by Metro; successfully meet specified requirements for each section before acceptance.

3. Trenches: Trenches must be dry so that leakage can be easily determined. Testing connections subject to approval by Metro.

4. Center load pipe with small amount of backfill to prevent arching and whipping under pressure. Leave joints exposed for inspection during pressure test. No

water permitted in pipe until pressure test has been accomplished and a period of at least 24 hours has elapsed for solvent weld setting and curing.

5. Test by capping each outlet and filling pipeline with water. Maintain specified pressure for four hours and determine leakage. Immediately correct leaks and subject system to same test. No pipe, fitting or joint showing leakage will be accepted. After piping has been tested to satisfaction of Metro, backfill pipe trenches before adjustment and testing of sprinklers and valves.

6. Furnish necessary force pump and other test equipment.

C. Automatic Sprinkler Controller: Test controller for seven days just before end of establishment period. Operate system automatically in manner indicated.

D. Testing: Do not cover installed Work before installation has been inspected and approved by Metro.

3.13 BACKFILL

A. After the Work has been installed, flushed, tested, and proven tight and accepted by Metro, backfill with fine materials. Do not allow rocks or other objects larger than one-inch diameter to fall in the first 6 inches of cover. Uncover Work covered before acceptance by Metro, to allow for acceptance if demanded by Metro.

3.14 LOWERING OF HEADS, VALVE BOXES, QUICK COUPLER VALVES, ETC.

A. Set equipment that may be damaged by mowing flush to finished grade, or as indicated, before final acceptance. Replace equipment damaged by final acceptance. Replace equipment damaged by mowing during Metro’s first 60 days of maintenance after the conclusion of the Irrigation Contractor's maintenance period at no cost to Metro.

3.15 CLEAN UP

A. Upon completion of Work, clean up excess materials, equipment and rubbish resulting from Work; leave premises in a clean, neat and orderly condition.

3.16 RECORD DATA ON IRRIGATION CONTROLLER CHARTS

A. Record data daily on electrostatic prints before covering. Deliver prints to Metro at time of installation inspection. Locate control valves, main line, quick coupling valves, gate valves, plugged ends, stubs, and triangulate to permanent and easily identified objects with dimensions. Show Metro right-of-way and other agencies, or other private property with Color-coding.

END OF SECTION 32 80 00

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SECTION 34 21 31

TRACTION POWER BLUE LIGHT STATION (BLS) SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work specified in this section consists of furnishing, installing, and testing of the Blue Light Station (BLS) System to form a complete coordinated system ready for operation throughout the Westside Subway Extension HRT tunnels and stations. BLS shall be similar in form and function to Metro current BLS units on the existing Metro Red and Purple Lines.

B. Blue Light Stations (BLSs) shall allow maintenance and fire department personnel to communicate with Rail Operation Center (ROC), to trip traction power distribution Contact Rail System (CRS), and initiate platform undercar deluge system.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

~~B.~~**C. Section 01 78 43 Spare Parts, Illustrated Parts Catalog, and Replacement Materials**

1.03 REFERENCES

A. National Fire Protection Agency (NFPA):

1. NFPA 70 National Electric Code

2. NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Systems

B. Energy Information Administration (EIA)

1. EIA RS-310 Rack Panels and Associated Equipment

1.04 QUALITY ASSURANCE

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

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Manufacturer's product specifications of Emergency Trip Control (ETC) system, including operating description, mechanical parameters, identification of contact and plating materials, and contact configuration and ratings

C. Technical cut sheets and typical wiring schematics of the BLS cabinet, including construction details, NEMA rating and door and latch details

D. Emergency Trip Station (ETS) panel construction and wiring details

E. ETEL telephone panel construction and wiring details

F. Deluge push button panel construction and wiring details

G. Equipment schematic, wiring and interconnection diagrams

H. Operating and Maintenance Manual including Spare Parts List

I. Test Plan, Test Procedures and Test Reports

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 TECHNICAL CHARACTERISTICS

A. Blue Light Station (BLS) Enclosure

1. The cabinet housing shall be constructed of steel, and shall incorporate one steel main locking door with a piano type hinge running the length of the door. A two inch flange shall be incorporated into the housing, extending from the cabinet perimeter to cover gaps between the block out and the cabinets. The housing shall incorporate supporting flanges for door, and constructed for the door to fit snugly.

2. A locking quick-opening three point latching door handle shall be supplied with door and shall be keyed. The Contractor shall provide locks and keys for each cabinet and panel specified. Locks shall be keyed in accordance with the master key system developed by Metro, and shall be coordinated with Metro maintenance personnel. Ten sets of keys shall be provided for each cabinet and panel to the Metro maintenance personnel.

3. Cabinets shall be painted international orange, and the BLS number shall be stenciled in black on the front of each door.

B. Emergency Telephone (ETEL)

1. A telephone panel for one Emergency Telephone (ETEL) shall be furnished and installed at each BLS location.

2. Instruments mounted on panels shall be provided as required.

C. Emergency Trip Station (ETS)

1. ETS panels shall be constructed per EIA RS-310 requirements. The engraved text shall be Helvetica medium, black epoxy filled. Power zone de-energization graphics shall be provided on the interior of each BLS enclosure and shall be

subject to the approval of Metro. Copies of these graphics in electronic format shall also be furnished to the Metro for later replacement or modification.

2. The ETS Pushbutton and Deluge Pushbuttons shall be mounted on an emergency trip panel with a barrier-type terminal strip. The ETS push-buttons shall be of the heavy-duty type with red mushroom-shaped button and manually operated plunger that latches and capable of being padlocked in a locked position. The ETS pushbuttons shall be spring loaded latch type where the padlock attachment springs into place when the button is pressed and must be moved to manually release the button.

D. Undercar Deluge pushbuttons shall be placed in the BLSs located at both ends of the platform on each track. The deluge push buttons shall activate the undercar deluge system. They shall also activate the ETS functions corresponding to the respective BLS. A clear plastic cover shall be provided for each deluge push button to prevent unintentional operation. The deluge pushbutton shall have engraved labeling “UNDERCAR DELUGE” and the track designation.

The undercar deluge system water flow switch shall also activate the ETS functions corresponding to the respective track/platform.

E. Voltage Tags on ETS and Communications Wiring. Where 125 V DC control power and 24 V DC SCADA or FACP communications wiring share terminals on the same ETS Pushbutton or Deluge Pushbutton, all terminals shall be rated for the larger voltage and all wires shall be tagged as 125 V DC or 24 V DC as applicable. The tags shall be easily visible for maintenance personnel to prevent the accidental interconnection of low voltage 24 V DC equipment with 125V DC equipment.

2.02 FUNCTIONAL REQUIREMENTS

A. Overall BLS system configuration and operation

1. Emergency Telephone (ETEL) at each BLS shall be used by the Metro staff personnel and be limited, by Class of Service restriction, to originating and/or receiving internal EPABX calls only, and/internal to Metro’s EPABX network only. In the event a call connection to a restricted telephone to the Public Switched Telephone Network is required, it may be connected either by a Metro’s EPABX system operator or via conferencing on another Metro’s unrestricted telephone.

2. Emergency Trip Station (ETS) is an integral part of the safety features of the traction power system. It shall provide trackside capability for de- energizing segments of the train propulsion Contact Rail System (CRS). Upon actuation; the switch shall open a contact in a supervised, fail-safe circuit, which in turn shall deliver trip signals to the specified traction power breaker equipment or the DC load-break switch for effecting de-energization of the appropriate Contact Rail segment(s).

3. The simple pushbutton will activate the Platform Undercar Deluge System in underground stations, as part of the Fire Suppression System. It will also activate the Emergency Trip System-ETS and be interlocked to prevent activation of the Deluge System before Traction Power is de-energized.

B. ETS Configuration and Operation

1. ETSs shall be provided with contacts, to control all dc feeder breakers (including adjacent traction power substation dc feeder breakers) and DC load-break switches, for tripping of track power at ends of identified track power zone(s).

2. A Systemwide ETC tripping matrix shall be provided.

C. Emergency Trip Control (ETC) System configuration and operation

1. Each ETS switch contact shall operate a Pushbutton Control Relay (PBR). Each ETS Pushbutton Control Relay shall contain both normally open and normally closed contacts as indicated on the contract drawings. The control contacts responsible for tripping the circuit breakers are all normally open (normally closed when energized), and are connected in series into the normally energized breaker control circuit.

2. The ETC system shall also provide electrical interlocks to prevent reapplication of power from the ROC via SCADA or from the field to the segment(s) involved, without a deliberate action from ROC (system reset), following a predetermined, step-by-step procedure. Resetting ETS from ROC shall not occur until the substation ETS circuits are reset manually or remotely via SCADA.

D. Emergency Trip Control (ETC) Interposing Relays

1. All affecting traction power breakers or DC load-break switches shall be tripped and locked out through the operation of the ETS interposing relay circuits located at the ETS relay control panel. Each interposing relay shall be furnished with form A and B contacts, which will be connected to the circuit breaker shunt trip and close control circuits. Interposing relays are normally energized by the ETC system.

E. Undercar Deluge Push-Button Operation (For All Underground Stations):

1. Undercar Deluge Push-button shall be provided with contacts, to control all dc feeder breakers (including adjacent traction power substation dc feeder breakers), for tripping of track power on the affected track at the end of the identified track power zone. The Deluge Pushbutton interface shall trip the dc feeder breakers by interfacing with the associated ETS Pushbutton Relay Control circuit.

2. Upon depressing the appropriate deluge pushbutton, activation of the associated solenoid valves shall occur via the Fire Alarm Control Panel (FACP) after all affecting traction power breakers and/or DC load-break switches, are tripped. The Deluge Pushbutton circuit shall be supervised by the Fire Alarm Control Panel and upon detecting a deluge pushbutton activation, it shall initiate the command to open the associated solenoid valves.

2.03 SUPERVISORY CONTROL REQUIREMENTS

A. Remote supervisory annunciation and control circuits shall be provided between ETS, and the Deluge system, and SCADA equipment.

B. SCADA interface circuits at each of the Traction Power Substations shall include, but not be limited to, the following:

1. ETC system reset control.

2. Tripped/reset status of each ETS switch and Deluge Pushbutton Switch.

3. ETS substation reset status.

C. The ETS system utilizes two groups of circuits, the Pushbutton Relay (PBR) circuit and the ETS Interposing Relay Circuit. The PBR relays are located in the substation relay control panels and are held energized via a continuous loop through normally closed contacts in the ETS pushbuttons located along the railway. When any pushbutton in a PBR group is depressed, the PBR relay drops out and the PBR relay contacts (which are closed when the relay is energized) open. The PBR relay contacts are wired into the appropriate substation interposing relay circuits to trip the corresponding circuit breakers.

D. The interposing relay circuits are also located in the substation relay control panels. The interposing relays are held energized and drop out when a PBR relay contact opens to trip the corresponding circuit breaker or load-break disconnect. There are also reset relays which are used to block re-energization of the interposing relays and these can be reset remotely or locally.

E. Since the ETS and Deluge pushbuttons latch in the depressed position and must be manually unlatched, the reset sequence following an ETS trip must be to first unlatch the ETS pushbutton manually at the button location, then reset the affected substations interposing relay circuit either locally by hand or remotely via SCADA. At this point, the trip contact from the interposing relay will reverse state and the blocking contact will also reverse state, allowing local or remote re-closure of the affected circuit breakers or load-break disconnect devices.

F. All ETS Pushbuttons, Deluge Pushbuttons, and Interposing Reset Relays are monitored by the SCADA system to indicate the relays state at the ROC.

G. The BLS/ETS at each mainline traction power substation shall be located on the outside wall in proximity to the entrance door of each TPSS and GBR.

2.04 EXISTING SUBSTATION ETC INTERFACE AT METRO PURPLE LINE

The ETC System for the Westside Extension shall be interfaced with the existing Metro Purple Line TPSS (S10W) located at Wilshire/Western Station. Submit detailed wiring plans for the ETC system interface and install additional equipment as required. Modify Metro's existing manuals if the existing TP Substation is modified.

PART 3 - EXECUTION

3.01 GENERAL

Ensure that a fully operational Blue Light Station (BLS) system that is compatible and integral with the Traction Power Equipment, wayside devices and the remote SCADA RTU is provided at each substation.

3.02 PERFORMANCE

The time from initiation of emergency trip switch to delivery of trip control signal to the Traction Power Equipment, and annunciation at local annunciation panel and the SCADA RTU shall be less than two seconds.

3.03 INSTALLATION

Equipment provided for the BLS system shall be installed in underground structure including tunnels, stations and cross-passages, and other locations as indicated on the Drawings.

3.04 TESTING

Operational testing shall be performed to verify functional performance of each of the subsystems. Metro FLSC shall be notified in advance to witness the testing in the field. The tests shall include:

A. Demonstration of proper functioning of hardware and application software where required.

B. Demonstration of user interface functions.

3.05 MANUALS

Supply Operating and Maintenance Manuals for all equipment provided for the BLS system. These manuals shall include:

A. Descriptions, specifications, theory of operation, DC relay catalog information, and layout drawings, back-panel and assembly wiring diagrams, and other electrical, electronic, and mechanical hardware data.

B. Instructions for preventative maintenance procedures which consist of examinations, tests, adjustments, and periodic cleaning to be performed under normal and abnormal operating conditions.

C. Guidelines for isolating the cause of an equipment malfunction and troubleshooting to localize faults.

D. Instructions for the set-up and operation of all equipment as it are configured in the BLS system.

3.06 TRAINING

Training courses shall be oriented toward providing Metro's personnel with a thorough understanding of the BLS system capabilities and comprehensive instruction in the operation and maintenance of the BLS system. Training shall include:

A. Equipment Training

Provide training covering all equipment supplied as part of the BLS system. The equipment training shall provide commissioning personnel with a thorough knowledge of the equipment and its operation, interface with other equipment, and capabilities and use of test equipment. The course shall provide personnel attending with a theoretical background and hands-on experience in troubleshooting, repair procedures, and preventative maintenance procedures. Courses shall include board-level troubleshooting and repair. Courses may also include component- level repair, where appropriate. Course participants shall operate actual equipment, learn how to use test equipment and fixtures to troubleshoot problems, and repair simulated failures.

B. Overall System Maintenance

The overall system maintenance course shall provide the course participants with an overview of, and hands-on experience with, BLS functional capabilities and overall system operation. The course shall provide participants with a working knowledge of the BLS equipment and its operation, interfaces, and use of test equipment for diagnosing troubles. The course shall provide sufficient theoretical background and hands-on experience in troubleshooting and repair procedures to permit participants to locate and repair system faults in a timely manner. The course shall utilize the BLS documentation and diagnostic manuals. The course shall cover all troubleshooting and debugging techniques available in the BLS system.

C. System Operations Training

This course shall familiarize the course participants with the procedures necessary to operate the BLS as an integrated entity, as compared to training on the operation of the constituent components of the BLS system. This course shall include training in the following:

1. System backup and restoration procedures.

2. Procedures for installing new or modifying existing equipment while system is in-service.

D. Training Schedule

Furnish a detailed outline of the training course before the approved scheduled date for the start of training.

3.07 SPARE PARTS PROVISIONING AND SUPPORT

A. Requirements

~~Provide one BLS complete and one BLS with deluge, complete.~~**See Section 01 78 43 for details.**

B. Modifications of Equipment

If it becomes necessary to modify Contractor-supplied equipment (such as to use a different type, size, or configuration of equipment) to meet the requirements of this Specification, at no cost to Metro, ~~provide~~ **propose** all additional spare parts and test equipment deemed necessary by Metro to maintain the modified equipment **as part of Section 01 78 43 List B submittal**.

C. List of Parts

Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

END OF SECTION 34 21 31

SECTION 34 24 19.13

CONTACT RAIL PROCUREMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Specifications for the design, manufacture, fabrication, inspection, testing, packaging, shipping, handling and delivery of contact rail system components, including:

1. Contact rail Sections
2. Splice-joint assemblies
3. Expansion-joint assemblies
4. Side-approach assemblies
5. End-approach assemblies
6. Anchor assemblies
7. Support insulators.
8. Warning signs and ultra violet inhibitor.
9. Coverboards, support brackets and fasteners

B. The Contractor shall review and use Metro Rail Design Criteria.

C. Specifications describe herein is for contact rail conductor consisting of a steel rail with extruded aluminum bars fastened on both sides of the rail web. However, aluminum composite conductor rail with stainless steel cap contact rail can be supplied subject to Metro's approval.

1.02 RELATED SECTIONS

A.	Section 01 33 00	Submittal Procedures
B.	Section 01 43 10	Project Quality Program Requirements – Design/Build
~~B.~~**C.**	**Section 01 78 43**	**Spare Parts, Spare Parts Catalog, and Replacement Materials**

1.03 REFERENCES

Any reference standard cited should follow the latest version or the latest equivalent standard consistent with the intent of this specification.

A. American Railway Engineering & Maintenance-of-way Association (AREMA)

1. AREMA Manual for Railway Engineering

B. American Society for Testing and Materials International (ASTM)

1.	ASTM A1	Carbon Steel Rails
2.	ASTM A36	Structural Steel
3.	ASTM A47	Malleable Iron Castings
4.	ASTM A123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
5.	ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
6.	ASTM A220	Standard Specification for Pearlitic Malleable Iron
7.	ASTM A325	Structural Bolts, Steel, Heat Treated, 120/105 kips Minimum Tensile Strength
8.	ASTM A563	Carbon and Alloy Steel Nuts
9.	ASTM A1011	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
10.	ASTM B317	Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, Structural Profiles, and Profiles for Electrical Purposes (Bus Conductor)
11.	ASTM B633	Electrodeposited Coatings of Zinc on Iron and Steel
12.	ASTM B695	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
13.	ASTM D149	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
14.	ASTM D229	Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation
15.	ASTM D256	Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
16.	ASTM D570	Standard Test Method for Water Absorption of Plastics
17.	ASTM D635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
18.	ASTM D638	Standard Test Method for Tensile Properties of Plastics
19.	ASTM D648	Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

20. ASTM D695 Standard Test Method for Compressive Properties of Rigid Plastics

21. ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

22. ASTM D1499 Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Plastics

23. ASTM D2000 Standard Classification System for Rubber Products in Automotive Applications

24. ASTM D2240 Standard Test Method for Rubber Property—Durometer Hardness

25. ASTM D3935 Standard Specification for Polycarbonate (PC) Unfilled and Reinforced Material

26. ASTM E162 Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source

27. ASTM E662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials

C. American National Standards Institute (ANSI)

1. ANSI B18.21.1 Lock Washers

2. ANSI B18.8.1 Clevis Pins and Cotter Pins

3. ANSI C29.1 Test Methods for Electrical Power Insulators

4. ANSI C29.5 Wet Process Porcelain Insulators (low/Medium Voltage)

D. American Iron and Steel Institute (AISI)

1. AISI Grade 1058

E. American Welding Society (AWS)

1. AWS D1.1 Structural Welding Code—Steel

F. National Fire Protection Association (NFPA)

1. NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Systems

G. The Society for Protective Coatings (SSPC)

1. SSPC SP6 Commercial Blast Cleaning

1.04 QUALITY ASSURANCE

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

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Shop Drawings **and product data** ~~showing location~~ of contact rail **assemblies, coverboard assemblies,** ~~joints,~~ contact rail pedestals, cuts and appurtenances in contact rail and schedule of contact rail cuts ~~which demonstrates minimization of waste.~~

C. Full-size camera-ready artwork of the warning sign~~.~~

D. ~~Anchor assembly bolt torque report~~**Design Calculations**

~~D.~~**E. Certificates of ~~.~~Compliance**

~~E.~~**F.** Test ~~results~~**Program Plan, Test Procedures, Test Reports including test equipment calibration**

~~1. Submit results of all source and field testing.~~

~~F.~~**G.** Spare Parts List

1.06 DEFINITIONS

A. Anchor Assembly. A longitudinal assembly of products including insulated anchor rods, clevises, spacers, anchor straps, mounting plates, and fasteners, which retains the contact rail in the longitudinal direction and prevents transmission of longitudinal forces to the insulators.

B. Connection Plate. Aluminum alloy shape that is attached to the contact rail to provide a physical means of connecting flexible jumper cable to the contact rail.

C. Contact Rail. A trackside conductor consisting of steel rail with aluminum bars attached on the webs, used to transmit electrical energy from power source to transit vehicle via current-collector shoes.

D. Contact Rail Assembly. The arrangement of products consisting of contact rail, splice bars and pin bolts, expansion joints, end approaches, dip rail sections, and fastening hardware.

E. Contact Rail System. The contact rail assembly, insulator assemblies, anchor assemblies, coverboard assemblies, and fastening hardware comprising the system used for the positive power source to the transit vehicle.

F. Coverboard Assembly. An arrangement of products including coverboard, support brackets and fasteners, which when installed, prevents accidental personnel contact with contact rail.

G. Current Collector Shoe. The part of the current collector attached to the vehicle that rides along the top of the contact rail.

H. End and Side Approaches. Special sections of contact rail used at the ends of contact rail sections that ramp the collector shoe from one elevation in full contact to another elevation out of contact with the contact rail, or vice versa. Side - Approach assembly has two types: Type "R" (right) and Type "L"(left). Each side-approach assembly is furnished disassembled.

I. Expansion Joint. An assembly used in the contact rail to accommodate thermal expansion and contraction of the rail.

J. Expansion Joint Shunt Cables. Cables attached to the contact rail at each end of the expansion joint to provide electrical continuity across the expansion joint.

K. Feeder Cable. Electrical conductors, which connect the traction power substations and gap breaker stations to the contact rail system.

L. Flexible Jumper Cable. Electrical conductor that physically connects the contact rail end of feeder cable to the contact rail.

M. Insulator Assembly. The porcelain insulator, base plate and "O" ring, rail clips, bolt, locknut and rail cushions comprising the assembly which supports the contact rail and insulates it from ground and structures.

N. Insulator Mounting Bracket. A device by which insulators are mounted on concrete ties.

O. Splice Bars. Connect end approaches to the contact rail or connect two sections of contact rail.

P. Jumper Cable. Electrical conductor that electrically connects two sections of contact rail.

PART 2 - PRODUCTS

2.01 CONTRACTOR-FURNISHED MATERIALS

A. Furnish all products, tools, and materials, equipment and labor required to complete all aspects of the work.

2.02 CONTACT RAIL CHARACTERISTICS

The contact rail shall have the following characteristics:

A. Service Life

1. Contact rail shall be capable of withstanding 5×10^7 passes of the current collector shoes based on:

a. Current-collector shoe material: Malleable iron ASTM A220, Grade 50005

b. Current-collector shoe surface: Flat, 5 inches along the contact rail and 3 inches in width

c. Shoe contact force: From 10 to 30 pounds

d. Maximum instantaneous load current per shoe: 1,800 A.

B. Electrical Resistance

1. The contact rail shall have the following maximum electrical resistances at 20°C (68°F):

a. Main line contact rail: 0.002 ohms per 1,000 ft

C. Current Carrying Capacity

1. The main line contact rail shall be capable of carrying 4,000 A dc minimum current. Contact rail current carrying capacity shall be based upon continuous load without exceeding a temperature rise of 40°C above 30°C (86°F) average ambient temperature in still air.

D. Fault Current Withstand

1. When installed on the specified support insulators placed 10 feet apart, the contact rail system shall be able to withstand a sustained fault current of 120,000 A dc for 100 milliseconds, with 200,000 A peak, without permanent deformation.

E. Tolerances

1. The contact rail shall be straight, within a tolerance of 1/64 inch in any 1 foot of length. Maximum sag with a concentrated load of 30 pounds at the midpoint between support insulators placed 10 feet apart, shall be 1/64 inch. The twist in any rail section shall be a maximum of 2 degrees.

F. Mechanical Load Withstand

1. When installed on the specified support insulators placed 10 feet apart, the contact rail shall be capable of withstanding a load of 250 pounds when applied at any point, with no permanent deflection when the load is removed.

2.03 CONTACT RAIL CONDUCTOR

A. Contact rail conductor shall consist of a steel rail with extruded aluminum bars fastened on both sides of the rail web.

B. Steel Rail

1. The steel rail shall be new, ASCE 85-pound section, manufactured in accordance with ASTM A1.

2. Rails shall be 39 feet long at 60°F (15.6°C), with a variation of ±7/16 inch.

C. Extruded Aluminum Bars

1. Extruded aluminum bars shall be ASTM B317, Alloy 6101, Temper T6.

2. Extruded aluminum bars shall:

a. Have uniform cross section

b. Have an internal contour that, when fastened to the steel rail, shall assure electrical contact between the steel rail and the aluminum bars under all operating conditions of thermal expansion and contraction.

c. Have an external contour that shall mate with the aluminum splice plate internal contour to assure electrical contacts for current flow and vertical and horizontal alignment of the contact rail.

d. Permit rail tongs to grasp the steel rail bottom and top for lifting the contact rail without damaging the aluminum extrusion.

D. Hardware

1. Hardware shall be as follows:

2. Bolts, nuts, and flat washers: ASTM A325

3. Spring washers: ANSI B18.21.1

4. Clevis and cotter pins: ANSI B18.8.1

5. Lock bolts and collars: ASTM A325 with brazier lock bolt head.

E. Hardware Finish

1. Hardware shall be coated after fabrication by one of the following methods:

2. Hot-dip galvanized in accordance with ASTM Al53

3. Zinc-electroplated in accordance with ASTM B633.

F. Oxide-Inhibiting Paste

1. Oxide-inhibiting paste shall be used at the interfaces between the steel rail and the aluminum bars. The Contractor shall submit product information/data sheets on the proposed product.

2.04 CONTACT RAIL FABRICATION

A. Contact rail sections shall be fabricated using the specified 39-foot steel rail and the extruded aluminum bars fastened to the web of the rail, with lock bolts spaced a maximum of 18 inches apart.

B. Fastening

1. Fastening shall maintain the aluminum bars and the steel rail in electrical contact over a temperature range of from -1.1°C (30°F) to 70°C (1580F).

C. Factory Assembly

1. The aluminum bar surface to be in contact with the steel rail shall be cleaned.

2. The surface of the steel rail to be in contact with the aluminum bars shall be free of mill scale, oil, grease, and other foreign matter, cleaning of the steel rail surface shall be in accordance with SSPC SP6.

3. The surface of the steel rail to be in contact with the aluminum bars shall be coated with oxide inhibiting paste in sufficient quantity so that when the aluminum bars are fastened to the steel rail, excess of oxide-inhibiting paste will come out between the steel rail and aluminum bars for the entire length of the joint.

4. Oxide-inhibiting paste shall prevent water entrance into the interface between the aluminum bars and the steel rails.

5. Immediately after application of the oxide inhibiting paste, the aluminum bars shall be- fastened to both sides of the steel rail web, using the specified lock bolts. Tools and installation methods and procedures shall be as recommended by the lock bolt manufacturer.

6. After final assembly, the aluminum bar ends shall be even with the steel rail end with a tolerance of from -9/16 inch to +0 inch at 20 °C.

7. Top contact surface of the contact rail shall be free from twists, waves, and kinks, and shall be cleaned by grinding with a radial grinding wheel or stone to ensure no rust, mill scale or surface irregularities remain.

8. Drilling of holes for splice joints at each end of each contact rail section shall be performed after the aluminum extrusions were attached to the steel rail.

9. A coat of lightweight machine oil shall be applied to the steel as a preservative after the aluminum extrusions have been assembled.

D. Identification

1. Each contact rail section shall have at both ends the manufacturer's name and the month and year of manufacture. Identification shall be die-stamped on the outer face of the aluminum bars, outside of the splice-joint area. Each contact rail section shall be identified as "Main Line".

2.05 CONTACT RAIL SPLICE-JOINT ASSEMBLIES

A. Splice-joint assemblies shall consist of two ASTM B3l7, Alloy 6101, and Temper T-6 extruded aluminum splice bars with the necessary lock bolts. Bars shall be a minimum of 22 inches long with 4 openings drilled to match the holes at the ends of the contact rails. Tolerances of hole center lines and diameters shall be such that butt splicing of adjacent contact rail sections is possible. Splice-joint minimum current carrying capacity shall be as specified for main line contact rail.

B. Alignment

1. Splice-joint assemblies shall align the contact rails vertically and horizontally and shall provide a contact surface to transfer electrical current between joined contact rails, with a minimum of electrical resistance across the interface between splice bar and contact rail. The contact surface shall have a contour that conforms to the external contour of the contact rail aluminum bar.

2.06 CONTACT RAIL EXPANSION-JOINT ASSEMBLIES

A. Expansion-joint assemblies will be placed between mainline contact rail sections at certain locations to allow for thermal expansion and contraction of the contact rails and to prevent undue strain on the support insulators. The expansion joints shall provide a flat surface in line with the top of the contact rails to allow unrestricted and smooth passage of the vehicle current-collector shoe. The expansion joints shall hold the ends of the contact rails in alignment so that there shall be less than 1/64-inch difference in the elevation of the joined rails at the contact surface.

B. The expansion-joint assembly shall maintain alignment of the contact rails both vertically and horizontally for contraction and expansion of up to 2,000 feet of contact rail under a temperature variation from +20 °C to +60 °C for the mainline sections. The expansion joint sliding surfaces shall be lubricated and, when assembled, shall yield to slippage at 200 pounds force applied longitudinally.

C. Components

1. Each expansion-joint assembly shall consist of three specifically-cut contact rail sections interconnected by two bolted expansion joint plates. Each expansion-joint assembly shall be identified with the manufacturer's name and the month and year of manufacture. Identification shall be die-stamped on each section of contact rail and tie bar.

D. Expansion-Joint Bars

1. Expansion-joint bars shall:

a. Be of cast malleable iron ASTM A47, Grade 32510, or ductile iron 65-45-12. Castings shall be free of scale, cracks, or any other defects that would be detrimental to the service for which they are intended. Finished surfaces shall be smooth.

b. Have an internal contour conforming to the steel rail contour.

c. Be either drilled and slotted or cast-cored.

d. Be lubricated and be equipped with grease fittings capable of applying lubricant to all sliding surfaces.

2.07 CONTACT RAIL END-APPROACH ASSEMBLIES

A. End-approach assemblies are special contact rail sections used at the ends of contact rail sections to lift the vehicle current-collector shoes onto the contact rail running surface, or to lower the current-collector shoes of the contact rail.

B. Dimensions

1. Two end-approach assembly lengths shall be provided. One shall have a nine-foot long ramp with a maximum slope of one degree, for use on the main line.

C. Fabrication

1. End-approach assemblies shall be fabricated from the steel rail specified for contact rail. Web of rail shall be cut and welded in accordance with AWS D1.1. Two splice plates, extruded aluminum bars, and required lock bolts shall be provided for each end-approach assembly. Each end-approach assembly shall be identified with the manufacturer's name, the month and year of manufacture, and "Main Line". Identification shall be die-stamped on the web of the steel rail. Alternative designs using cast parts or regular contact rail sections bent at the specified angles and cut to the specified lengths will be accepted subject to proof of performance in similar applications.

D. Welders' Qualifications

1. Prior to commencing work requiring welding, the procedure that will be used for prequalifying welders and welding procedures shall be submitted. For procedures other than those set forth in Paragraph 5.1 of AWS D1.1, a copy of procedure qualification test records shall be submitted.

2. A certified copy of the qualification test record or each welder, welding operator, and tacker who will be employed in the work shall be submitted.

2.08 CONTACT RAIL SIDE-APPROACH ASSEMBLIES

A. Unless required for proper transitioning of vehicle current collector shoes, side approach shall be as follow:

1. Side-approach assembly, Types L (left) and R (right), shall consist of two plates, clamps, and the required fasteners and splice plate. Side approach shall support the maximum train speed allowed during crossover move.

2. Plates: Steel, ASTM A1011

3. Clamps: Cast malleable iron, ASTM A47, grade 32510

4. Bolts: Lock bolt

5. Nuts, lock washers, plain washers, and cotter pins as required.

2.09 CONTACT RAIL ANCHOR ASSEMBLIES

Anchor assemblies shall consist of:

A. Strain insulators

1. Each strain insulator shall consist of an insulating rod with a clevis attached at each end. The insulating rod shall be of fiberglass reinforced polyester or epoxy resin. The devises shall be of malleable iron, ASTM A47.

2. Strain insulators shall be rated for a service voltage of 1,000 V and shall have a minimum resistance between devises of 2 X 10^9 ohms and a minimum ultimate tensile strength of 15,000 pounds.

3. Insulating rod color shall be light gray, Number 70.

4. Insulating rod shall have an ultraviolet stabilizer.

5. Insulating rod shall comply with the specified requirements for flame spread index, flammability, and smoke emission optical density for Type II support insulators.

B. Contact rail anchor clamps

1. Anchor clamps shall be of cast malleable iron, ASTM A47, Grade 32510. Anchor clamps shall be provided with eye bolts as indicated.

C. Anchor tie down brackets

1. Brackets shall be fabricated from steel angle ASTM A36.

D. Eye bolts, clevis pins, and cotter pins.

1. Eye bolts and clevis pins shall be self locking.

E. Finish

1. Anchor assembly metal parts shall be hot-dip galvanized after fabrication in accordance with ASTM A153.

2.10 SUPPORT INSULATORS

A. Support insulators shall be either Type I, porcelain, or Type II, fiberglass.

B. General Requirements

1. Support insulators shall be rated for a service voltage of 1,000 V dc. The creepage distance over the external surface of the insulator shall be not less than 8 inches, measured from the bottom of the rail clip to the insulator base on Type I, porcelain insulator, and from the bottom of the contact rail to the insulator fasteners on Type II, fiberglass insulators. Dimension between top and bottom of the insulator shall not vary more than 1/8 inch from indicated dimension. The minimum resistance between top and bottom of dry insulators shall be 1x10^9 ohms. The surface of the insulators shall be smooth, uniform, and free from defects such as cracks, flaws, voids, air pockets, and fractures. Insulators shall have a Radio-Influence voltage not greater than 50 microvolt at 1,000 kHz, with a low frequency test voltage of 10 kV applied.

C. Fault Current Withstand

1. Support insulators shall withstand, without damage, the mechanical stresses resulting from the fault currents specified for contact rail. Support insulators shall have cantilever strength of not less than 4,000 pounds.

D. Color

1. Surface color shall be light gray, Number 70.

E. Markings

1. Support insulators shall be marked with the manufacturer's name and model number.

F. Type I Support Insulators

1. Components

a. Type I support insulators shall consist of a complete assembly including insulator, rail clip, bolt, locknut, clip cushion, base, base 0-ring, and base cushion shim.

2. Materials:

a. Insulators shall be of porcelain, manufactured by the wet process method in accordance with ANSI C29.5. Porcelain shall be solid, free from defects, and thoroughly vitrified. Insulator surfaces shall be completely glazed.

3. Caps and Bases:

a. Caps (rail clips) and bases shall be of malleable iron ASTM A47, Grade 32510, hot-dip galvanized in accordance with ASTM A153. With maximum tightening, space between clips and contact rail shall allow free lengthwise movement of the contact rail during thermal expansion and contraction.

4. Rail Clip Cushions, Base 0-Rings and Base Cushions:

a. Clip cushions, base 0-rings and base cushions shall be of neoprene to the latest version of ASTM D2000, Specification 22BC415, or the latest equivalent, with a durometer hardness between 35A and 45A in accordance with latest version of ASTM D2240. Base cushion shims shall be 1/8 inch thick.

G. Type II Support Insulators

1. Components:

a. Type II support insulators shall consist of a complete assembly including two-piece, molded fiberglass reinforced polyester resin compound with an ultraviolet stabilizer insulator and a base cushion shim. The insulator top cap shall fit snug onto the insulator base and shall not be glued. A surface coating shall be used on both pieces to improve insulating properties, moisture and dirt resistance and service life.

2. Materials:

a. Type II support insulator compound shall have the following properties when tested in accordance with the referenced standards:

b. Dielectric Strength:

1) 200 volts per mill of thickness minimum, ASTM D149

c. Impact Resistance:

1) 8 foot-pounds per inch of notch, ASTM D256 Method A, IZOD

d. Flexural Strength:

1) 20,000 psi minimum, ASTM D790

e. Tensile Strength:

1) 8,000 psi minimum, ASTM D638

f. Compressive Strength:

1) 20,000 psi minimum, ASTM D695

g. Water Absorption:

1) 0.3 percent maximum weight increase in 24 hours at 23°C (73.4°F), ASTM D570.

h. Flame Spread Index (Is):

1) 15 maximum, ASTM E162

i. Deflection Temperature:

1) 190°C (374°F) minimum at 264 psi1 AISTM D648

j. Flammability:

1) Self-extinguishing, ASTM D635

k. Smoke Emission Optical Density (D3):

1) 200 maximum in 4 minutes, ASTM E662

l. Weathering:

1) 3,600 hours exposure, ASTM D1499.

3. Base Cushions:

a. Base cushions shall be 1/8 inch thick, of neoprene to the latest version of ASTM D2000, Specification 2BC415 or the latest equivalent, with a durometer hardness between 35A and 45A in accordance with ASTM D2240.

2.11 COVERBOARD CHARACTERISTICS

A. Coverboard shall have the following characteristics:

B. Construction

1. The coverboard and support brackets shall be manufactured from flame-resistant, low-smoke, low-toxicity, fiberglass reinforced plastic resin with a useful service life of 30 years. The materials used shall not separate or warp when exposed to the specified ambient conditions and shall have the required physical and electrical properties.

2. The coverboard design shall facilitate ready removal and replacement of the coverboard sections, when attached to the contact rail, without disassembly of the support brackets. All fasteners required to hold the coverboard in place shall be easily removable and reusable. The entire assembly shall be capable of being installed and maintained with standard hand tools, and without the need of special tools. Coverboard assembly shall be designed to resist sagging under its own weight, and rattling or distorting due to air turbulence caused by wind and passing rail vehicles.

C. Physical Properties

1. Water Absorption:

   a. 0.3 percent maximum weight increase in 24 hours at 23°C (73.4°F), ASTM D570.

2. Flame Resistance:

   a. 10 seconds maximum burning time ASTM D229 Method I.

3. Flame Spread Index (Is):

   a. 15 maximum, ASTM E162.

4. Smoke Emission Specific Optical Density (Ds):

   a. 200 maximum in 4 minutes, ASTM E662.

5. Weathering:

   a. 3,600 hours exposure, ASTM D1499.

6. Arc Resistance:

   a. 130 seconds minimum, ASTM D495

7. Heat Distortion:

   a. 188°C at 264 psi minimum, ASTM D648

8. Flexural Strength:

a. 20,000 psi minimum, ASTM D790

9. Tensile Strength:

a. 8,000 psi minimum, ASTM D638

10. Compressive Strength:

a. 20,000 psi minimum, ASTM D695

11. Impact Resistance:

a. 8 foot-pounds per inch, minimum, ASTM D256, Method A, IZOD.

12. Dielectric Strength:

a. 200 volts per mill of thickness, minimum, ASTM D149.

D. Mechanical Load Withstand

1. Mechanical load cycle and applied load tests with vertical loads of 250 pounds applied at any point between support bracket locations. Maximum deflection of a coverboard section under the stated conditions shall not exceed the dimensions given stated in the contract document.

E. Insulation Resistance

1. The insulation resistance between any point in contact with the rail and any other point on the surface of the coverboard assembly shall be 1,000,000 ohms minimum.

2.12 COVERBOARD SECTIONS

A. Material

1. Coverboard shall be molded by continuous pultrusion process, using continuous glass strand mat and roving reinforcement in a polyester resin with an ultraviolet stabilizer. Coverboard sections shall be colored gray.

B. Configuration

1. The coverboard assembly will be attached to the contact rail as indicated on contract document and shall present a continuous, uniform appearance.

2. The coverboard sections shall be fabricated in 10-foot lengths and will be supported on brackets spaced at a maximum of 5 feet apart. The gap between two coverboard sections shall not exceed 1/8 inch. Holes for attaching the coverboard to the support bracket shall be drilled. Holes and cut ends shall be coated with an ultraviolet inhibitor prior to delivery.

2.13 COVERBOARD SUPPORT BRACKETS

A. Material

1. Support brackets shall be of molded, fiberglass reinforced, polyester resin with an ultraviolet stabilizer. Color shall be as specified for coverboard.

B. Configuration

1. Support brackets shall support the coverboard, have a contour compatible with the coverboard, clamp directly to the contact rail, and have certain limiting dimensions as indicated on contract drawings. A bolted fiberglass clamp shall rigidly secure the support bracket to the base of the contact rail, under all specified loading conditions, without loosening or cracking. Bolts shall be in accordance with ASTM A325, or stainless steel of equivalent strength and threading. Inserts and washers shall be compatible with bolts used.

C. Hardware Finish

1. Bolts, inserts, and washers other than stainless steel shall be coated after fabrication by one of the following methods:

2. Hot-dip galvanized in accordance with ASTM A153

3. Zinc-depositing in accordance with ASTM B695.

2.14 COVERBOARD EXPANSION JOINTS

A. Coverboard expansion joints shall allow for the expansion and contraction of the contact rail and the attached coverboard, as indicated on contract drawings with no resultant gap in the coverboard. The expansion joint assemblies shall conform to the electrical and physical properties specified for the coverboard. The expansion joint assembly shall present a continuous, uniform appearance with the sections of the coverboard and will be supported on brackets as indicated on contract drawings. The coverboard expansion joint assembly shall be manufactured of the same fiberglass-reinforced polyester resin as the coverboard.

2.15 COVERBOARD FASTENERS

A. Fasteners shall be provided to secure the coverboard to the support bracket as indicated on contract drawings. The fasteners shall consist of retaining pins held in place by cotter pins. The retaining pins shall be manufactured of non conductive material in accordance with ASTM D3935 and shall have an ultimate tensile strength of 8,000 psi. Color of retaining pins shall be as specified for coverboard. The cotter pins shall conform to ANSI B18.8.1 and shall be of stainless steel.

2.16 SPARE PARTS

A. ~~Spare parts shall be provided as specified on Section 34 01 03. All parts shall be made available at completion of system acceptance~~ **Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its**

Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 GENERAL PRODUCTION

A. Contact rail system, including contact rail assembly, insulator assembly, anchor assembly, expansion joint assembly, coverboard assembly and associated hardware production prior to qualification testing and inspection submittals and other pre-production submittals review and approval by Metro is prohibited.

B. Manufacture all contact rail system using the same methods used to produce the qualification test pieces.

C. Contact rail system shall not be shipped until all components meet all of the quality requirements specified herein and Metro has approved the production testing and inspection results.

3.02 PRODUCTION INSPECTION AND TESTING

A. General:

1. This section specifies the factory test requirements for the contact rail system components.

B. Description

1. Testing shall be performed to demonstrate that contact rail system components meet the requirements of these specifications.

2. Cited References

a.	ANSI C29.1	Test Methods for Electrical Power Insulators
b.	ASTM D149	Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
c.	ASTM D256	Impact Resistance of Plastics and Electrical Insulating Materials
d.	ASTM D495	High Voltage, Low Current, Dry Arc Resistance of Solid Electrical Insulation
e.	ASTM D570	Water Absorption of Plastics
f.	ASTM D638	Tensile Properties of Plastics
g.	ASTM D648	Deflection Temperature of Plastics under Flexural Load
h.	ASTM D695	Compressive Properties of Rigid Plastics

i. ASTM D790 Flexural Properties of Plastics

j. ASTM D1499 Operating Light-and-Water Exposure

3.03 TESTS REQUIRED

A. Two kinds of tests are required: qualification tests and quality control (production) tests.

B. Qualification Tests

1. Tests performed prior to production to verify that the components proposed meet the requirements of these specifications.

C. Quality Control (Production) Tests:

1. Tests performed during production to verify that manufactured components meet the requirements of these specifications.

3.04 AUTHORITY NOTIFICATION

A. The Authority shall be notified not less than 30 days in advance of dates scheduled for any tests.

3.05 TESTING EQUIPMENT

A. Testing equipment shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Copies of calibration certificates shall be submitted with each test report.

3.06 DOCUMENTATION

A. In conjunction with the specified tests, the following documentation shall be submitted for approval:

B. Test Program Plan

1. A test program plan shall be submitted. In this plan, the Contractor shall identify his approach for accomplishing qualification and quality control (production) tests. The projected schedule for test procedure submittal, test execution, and test results report submittal shall also be included.

C. Test Procedures

1. A test procedure shall be submitted describing the test objective, the equipment and instrumentation to be used, the procedure to be implemented, and the anticipated, as well as acceptable, results.

D. Test Report

1. A report of test results shall be submitted, including original data calculations, test procedure reference, test equipment identification, test personnel, date of

test, specified requirements, actual test results, non-conformances if any, and interpretation of the results.

3.07 QUALIFICATION TESTS

A. Qualification tests shall be conducted on the required components prior to commencing any fabrication. Qualification tests on specific components may be waived by Metro providing that satisfactory evidence, including certified qualification test reports, is submitted prior to NTP. The evidence shall adequately prove that satisfactory qualifications tests have been conducted on components of identical design to that specified in these Technical Provisions. The qualification tests shall include but not be limited to the following:

B. Contact Rail

1. Contact Rail dc Resistance

2. Splice-Joint Assembly dc Resistance

3. Splice-Joint Assembly Thermal Cycle:

   a. Use the same test specimen used for the splice joint assembly dc resistance test.

   b. Subject the test specimen to 10 thermal cycles.

   c. Each thermal cycle shall consist of contact rail stabilization temperature at 24°C (75.2°F),heating to 93°C (199.4°F), cooling to 24°C (75.2°F), cooling to 0°C (32°F), and heating to 24°C (75.2°F).

   d. Obtain resistances for each temperature after the temperature becomes stabilized, using the same procedure specified for contact rail.

   e. Dc resistance obtained in any thermal cycle, resistance of an equal length at the same temperature shall not exceed the calculated resistance of un-jointed rail.

4. Contact Rail and Splice-Joint Heat Rise

5. Fault Current:

   a. Certify, by submitting calculations or by certified testing report, that as installed, furnished components can withstand without damage the forces of a sustained fault current of 120,000 A dc for 100 milliseconds, with 200,000 A dc peak.

6. Expansion-Joint Assembly Wear Cycle:

   a. The test specimen shall consist of an expansion joint assembly fastened to at least 40 inches of contact rail at each end. Prior to the start of the test, the lengths of the two expansion joint gaps at each end of the center piece shall be the same.

b. At the start of the test and at the end of every 500 cycles, spread the top of the test specimen with equal amounts of hydrated lime and iron powder until completely covered.

c. Iron powder shall pass a No. 80 sieve.

d. Starting from the indicated position, the test specimen shall be alternately compressed 4 inches and expanded 4 inches for a total of 8 inches per cycle for 30,000 cycles without maintenance or servicing of the assembly.

e. After the cycling test, a 25-pound weight shall be applied vertically on top of the center piece of the assembly at 3 inches from the gap. The vertical difference between the top of the contact surfaces (top of contact rails) shall not exceed 1/64 inch.

7. Sag:

a. The test specimens shall consist of two 39-footlong sections of contact rail of each size spliced together by the associated splice-joint assemblies and complete with coverboard.

b. Test specimen shall be supported from the test bed by the support insulators to be furnished. Supports shall be located not less than 5 feet from the center of splice and at 10-foot intervals along the specimen.

c. A 30-pound vertical load shall be applied on the center line of the top of rail over a maximum distance of 5 inches along the rail at the following locations in turn. The deflection of the rail shall be measured at each point of load application.

1) At center of splice

2) At 10 feet from center of splice

3) At 20 feet from center of splice

8. Mechanical Load Withstand:

a. The test specimens shall be those used for the specified sag tests.

b. A 250-pound vertical load shall be applied on top of rail over a maximum distance of 5 inches along the rail, at the same locations in turn as specified for the sag tests. Rail deflection shall be measured before load application and following load removal at each point of measurement in order to determine the presence of any permanent deformation.

C. Support Insulator

1. Electrical Resistance Test:

a. Immerse support insulator in water at room temperature for 72 hours. Remove and dry thoroughly. Provide contact to top and bottom of insulator via copper electrode and wet clay pad or wet blotter. Measure

resistance, top to bottom, using 1,000 volt dc megohmmeter. The insulator shall have the minimum specified resistance.

2. Dielectric Strength Test:

   a. Test support insulator sample in accordance with ASTM D149, Method A, Short Time Test. Apply voltage between top and bottom in air at ambient temperature and humidity, increasing at approximately 1,000 volts per second up to 15,000 volts. Apply this voltage for 3 minutes. The insulator shall not break down during the time the 15,000 volts are applied.

3. Routine Flashover Test:

   a. Test support insulators in accordance with ANSI C29.1, Low-Frequency Dry and Wet Withstand Voltage Tests. Acceptance:

      1) Dry: 30 kV, 60 Hz, 1 minute minimum

      2) Wet: 20 kV, 60 Hz, 10 seconds minimum

4. Radio Influence Voltage Test:

   a. Test support insulator in accordance with ANSI C29.1 to demonstrate compliance with the requirements specified.

5. Mechanical Loading:

   a. By analysis, determine the worst case loading on support insulators, both static and dynamic, and demonstrate capability of the insulator to withstand this loading.

6. Flammability and Smoke Development:

   a. Test samples of Type II support insulator molding compound to demonstrate compliance with the requirements specified in 2.10.G.2 for flame spread index, flammability, and smoke emission optical density.

7. Arc Resistance Tests:

   a. Test samples of Type II support insulator molding compound to demonstrate compliance with the requirements specified in 2.10.G.2 for tracking and arc resistance.

D. Anchor Strain Insulators

1. Tensile Strength:

   a. Test in accordance with ASTM D638. Ultimate strength shall be 15,000 pounds.

2. Impact Resistance:

a. Support the insulator rod at 22 inches as a simple beam. Drop a 50-pound weight from a 4-foot height to the mid-span of the rod. The rod shall sustain the impact without fracture.

3. Water Absorption:

a. Rod shall have no more than 0.3 percent weight increase in 24 hours at 23°C when tested in accordance with ASTM D570.

4. Electrical Resistance:

a. Immerse rod in water at room temperature for 48 hours. Wipe the surface dry. Measure the resistance between the two ends. Resistance shall be not less than 2 $x10^9$ ohms.

5. Dielectric Strength:

a. Dielectric strength shall be not less than 2,000 V per inch of rod when tested in accordance with ASTM D149.Tests shall be performed with anchor strain insulators installed as indicated, with contact rail placed on the specified support insulators spaced 10 feet apart.

6. Flammability and Smoke Development:

a. Test samples of anchor strain insulators rod molding compound to demonstrate compliance with the specified requirements for flame spread index, flammability, and smoke emission optical density.

E. Coverboards and Brackets

1. Accelerated Aging and Weathering Test

a. Samples of material used for coverboard and support brackets shall be tested in accordance with ASTM D1499. The total time of exposure shall be 3,600 hours. At the end of the exposure time there shall be no visible evidence of deterioration such as warping, cracking, delamination, or other defects.

2. Electrical Insulation Resistance Test

a. After successful completion of the mechanical load test, measure the insulation resistance between any point in contact with the steel rail and any point on the surface of each coverboard, using a 1,000-volt Megohmmeter. The insulation resistance shall be a minimum of 1,000,000 ohms.

3. Mechanical Load Test

a. The load cycle test described herein shall be performed. After the test the protective coverboard, expansion joints, and support brackets shall show no cracks, splits, points of stress or breaks, and shall have a permanent deformation of no more than 1/4 inch. Using the test setup described herein in 4.6.I.G, place lengthwise at the midpoint between supports, a

250-pound weight with a bottom surface 6-inches wide by 12-inches long. Allow the weight to remain in place for 30 seconds and then remove it for 60 seconds. Repeat this cycle 50 times. The maximum permissible deflection with the weight applied is 1-1/2 inches. Repeat this test on coverboard expansion joints.

4. Flammability and Smoke Development Test

    a. Samples of material used for coverboard and support brackets shall be tested to demonstrate compliance with the requirements for flame spread index, flammability and smoke emission optical density, as specified in Section 6.4.2.5 of NFPA 130.

5. Arc Resistance Test

    a. Samples of material used for coverboard and support brackets shall be subjected to the arc resistance test for a minimum of 130 seconds to demonstrate compliance with the ASTM D495.

6. Heat Distortion Test

    a. Samples of material used for coverboard and support brackets shall be subjected to a minimum of 188°C at 264 psi in accordance with ASTM D648.

7. Flexural Strength Test

    a. Samples of material used for coverboard and support brackets shall be subjected to a minimum of 20,000 psi in accordance with ASTM D790.

8. Tensile Strength Test

    a. Samples of material used for coverboard and support brackets shall be subjected to a minimum of 8,000 psi in accordance with ASTM D638.

9. Compressive Strength Test

    a. Samples of material used for coverboard and support brackets shall be subjected to a minimum of 20,000 psi in accordance with ASTM D695.

10. Impact Resistance Test

    a. Samples of material used for coverboard and support brackets shall be subjected to a minimum of 8 foot-pounds per inch in accordance with ASTM D256, Method A, IZOD.

11. Water Absorption Test

    a. Samples of material used for coverboard and support brackets shall be tested to demonstrate compliance with the requirements given in this specification.

12. Dielectric Strength Test

    a. Samples of material used for coverboard and support brackets shall be subjected to a minimum of 200 volts per mill of thickness in accordance with ASTM D149.

3.08 QUALITY CONTROL (PRODUCTION) TESTS

A. Procedures

1. Production tests shall be performed using the approved qualification test procedure. The following minimum number of production tests shall be performed:

2. Contact Rail:

    a. Test dc resistance of one 39-foot section of contact rail from every 500 sections or fraction thereof.

    b. Test dc resistance, thermal cycle and heat rise of one from every 500 splice joint assemblies or fraction thereof.

3. Support Insulator:

    a. Test five support insulators from every 1,000 or fraction thereof, as specified for qualification tests, less the flammability and smoke development tests.

4. Anchor Strain Insulators:

    a. Test one strain insulator thereof, as specified for the flammability and smoke from every 100 or fraction qualification tests, less development tests.4.7.2.

5. Coverboard and Brackets

    a. Perform the mechanical load test and insulation resistance test, and visual inspection and dimensional verification check on five of each identifiable lot of 500 sections, or fraction thereof, of coverboard and on five sections of expansion joints. Different support brackets of a lot of 1,000, or fraction thereof shall be used with each coverboard section and expansion joint.

B. Basis for Rejection

1. If any of the specified production tests fails, 10 additional specimens from the same lot shall be tested. If any of these additional specimens fails to pass the test, the entire lot will be rejected.

3.09 QUALITY ASSURANCE

A. Quality Assurance Program

1. Provide and maintain a Quality Assurance (QA) Program to regulate methods, procedures, and processes to ensure compliance with the Contract requirements. The QA Program, including QA written procedures, shall be submitted for review.

2. The requirements of this QA Program shall apply to all activities related to quality of items, including designing, purchasing, inspecting, handling, assembling, installation, testing, storing, and shipping.

B. Quality Assurance Organization

1. The QA organization shall be clearly defined. Management responsibility for QA shall be set forth on the Contractor's policy and organization chart.

C. Evidence of Compliance

1. The Contractor may use certificates of compliance for certain equipment or materials and products in lieu of the sampling and testing procedures. Certificates of compliance shall be accompanied by certification of test results or shall state that such results are on file and will be furnished to the Authority on request.

D. Calibration/Certification of Measuring Equipment and Tools

1. An effective time- or usage-cycled calibration certification program shall be demonstrated. Validity of measurements and tests shall be ensured through the use of suitable inspection, measurement, and test equipment of the range and type necessary to determine conformance of items. Calibration certifications shall be recorded and be part of the QA records.

E. Quality Assurance Records

1. Adequate records shall be maintained in a readily retrievable manner to provide documented evidence of quality and accountability. These records shall be maintained, completed, and available to the Authority at all times during the term of the Contract and for a three year retention period thereafter.

F. Verification

1. The QA operations shall be subject to Authority verification at any time, including: surveillance of the operations to determine that practices, methods, and procedures of the program are being properly applied; inspection to measure quality of items to be offered for acceptance; and audits to ensure compliance with requirements of the Contract documents.

G. Qualification and Certification of Personnel

1. The QA personnel performing inspections and tests shall be qualified for such work by virtue of those skills which are obtained by experience or training.

Manufacturing personnel performing special processes, such as welding and brazing, shall be certified under AWS standards.

2. Records of personnel certifications shall be maintained and monitored by the QA personnel. These records shall be made available to the Authority for review, upon request.

H. Special Processes

1. Processes that control or verify quality, such as heat treating, welding, plating, and nondestructive testing, shall be performed by certified personnel and in accordance with approved documented procedures.

I. Procurement quality Assurance

1. The methods to be used for the selection and control of suppliers shall be defined.

J. Inspection and Test

1. Inspect and physically or functionally test all items to be delivered. Inspection and testing instructions shall provide for reporting nonconformance or questionable conditions to the Authority.

2. Inspection shall occur at appropriate points in the installation sequence to ensure compliance with process specifications, drawings, test specifications, and quality standards. The Authority may designate inspection hold points into the installation or inspection planning, upon review of Contractor's efforts.

3. In-process tests, including tests of raw materials, shall be performed and documented.

K. Receiving Inspection

1. The receiving inspection activity shall provide for the inspection of incoming materials. These inspection measures shall be used to preclude the use of nonconforming materials and to ensure that only correct and accepted items are used and installed.

L. Production Operations

1. Machining, wiring, batching, shaping, and other basic production operations of any type, together with all processing, fabricating and -installation of any type, shall be accomplished under controlled conditions. Documented work instructions shall be the criteria for all production, processing, and fabrication work. The QA program shall effectively monitor the issuance of and compliance with work instructions. Quality inspection procedures shall be used where applicable. Criteria for approval and rejection shall be established and shall be subject to approval.

M. Shipping Inspection

1. The QA program shall provide and enforce procedures for the proper inspection of all products deliverable to the Authority, to assure completion and conformance prior to shipment.

N. Statistical Sampling Plans

1. Statistical sampling used in inspection shall be fully documented, based on generally recognized and accepted statistical practices and shall be approved by the Authority.

O. Identification and Inspection Status

1. A system for identifying the progressive inspection status of equipment, materials, components, subassemblies, and assemblies as to their acceptance, rejection, or non-inspection shall be maintained.

P. Identification and Control of Items

1. Item identification and traceability control shall be provided. Where specified, items having limited calendar or operating life or cycles shall be identified and controlled to preclude use of items whose shelf life or operating life has expired.

Q. Handling, Storage, and Delivery

1. Provide for adequate work, surveillance, and inspection instructions for handling, storing, preserving, packaging, packing, marking, and shipping.

R. Corrective Action

1. Ensure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, and defects in equipment and material shall be promptly identified and corrected.

S. Non-conformances

1. Establish, document, and maintain an effective and positive system for controlling nonconforming material or work including procedures for its identification, segregation, and disposition. Dispositions for the use or repair of nonconforming material shall require approval by the Authority.

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SECTION 34 42 19.13

MICROPROCESSOR CONTROL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Contractor may elect to provide microprocessor-based logic for interlocking control or other functions described in Section 34 42 13.26 – Circuit and Logic Requirements, the provisions of this section shall apply. Microprocessor control equipment shall be rack mounted, and installed in TC&C locations as described in Section 34 42 13.56 - TC&C Room Layouts. The equipment shall meet applicable specifications of the AREMA Communications and Signals Manual. The equipment shall be provided complete with the isolation and power regulation devices to ensure its performance and reliability upon installation.

1.02 RELATED SECTIONS

A. Section 01 33 00 Submittal Procedures

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

C. Section 01 78 43 Spare Parts, Illustrated Parts Catalog, and Replacement Materials

~~C.~~**D.** Section 34 42 13.19 General Automatic Train Control Requirements

~~D.~~**E.** Section 34 42 13.26 Circuit and Logic Requirements

~~E.~~**F.** Section 34 42 13.36 Systems Support

~~F.~~**G.** Section 34 42 13.99 System Test Program

~~G.~~**H.** Section 34 42 16.16 External Wire and Cable

1.03 REFERENCES

A. Where not conflicting with the requirements of these specifications, the following standards shall be adhered to:

1. NFPA 70 National Electrical Code
2. AREMA Communications and Signals Manual
3. NEMA ST 20 Dry-type Transformers for General Applications
4. UL 489 Molded-case Circuit Breakers and Circuit Breaker Enclosures
5. Electronic Component Standards JEDEC, MIL-STD 883; and

6. PC Board Standards — IPC-A-600, FR4-VO Class 2, NEMA LI 1, UL 796, and FS QQ-S-571.

7. Federal Communications Commission (FCC) Rules, Part 15 (Spurious RF Emissions).

8. IEEE Standard — 1483-2000

9. ANSI/TIA/EIA — Standard 422-B

1.04 QUALITY ASSURANCE

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

B. Regulatory Agency Approvals – Comply with all applicable federal, state, and local laws, regulations, and codes including those referenced in Subsection 1.03 – References.

C. The manufacture, test, and installation of the ATC system microprocessor-based assembly shall conform to the requirements of the approved Quality Assurance Program.

1.05 SUBMITTALS

A. Refer to Section 01 33 00, Submittal Procedures.

B. Material and Circuits - Submit product information for each type of circuit card/module/subsystem to be used for this Contract concurrent with or prior to assembly. Include all product data, assembly drawings, circuits, parts lists, PC. board layouts, support calculations, and describe proposed application for this Contract.

C. Prototype Circuit and Application Logic for a TC&C Location - Generate application logic diagrams shown in standard relay logic using standard AREMA signal practices and submit these diagrams for approval. Include with the submittal all information necessary to interpret the diagram and its interface with the wayside equipment. This includes but not limited to:

1. Input/output (I/O) assignments and associated plug connector pin assignments;

2. I/O LED assignments;

3. Documentation showing all hardware selectable switches (DIP, program plug, etc.); and identification of the options or conditions associated with each.

4. Wayside interfacing circuits.

5. List of abbreviations and variable names and their function.

6. Identification of subroutines and their function (if applicable).

7. Identification of any timing requirements with interfacing equipment.

8. All timer settings.

9. Recorded variables.

10. Any programmer's comments.

D. Application Logic Software- Submit the items listed below on a CD-ROM 30 days prior to design review.

1. Software design documentation:

2. Software structure overview;

3. Configuration control plan;

4. CASE-diagrams showing the software functionality;

5. Test reports of formal software verification of safe software sections;

6. Test reports of semi-formal software verification of non safety-critical software sections;

7. Manuals of software components;

8. Application logic source code;

9. Backup compiled programs; and

10. Provide compiler software, compatible with all current supported Windows operating system versions. Submit one set of graphical software simulator for the Metro's use in evaluating the program application logic.

E. Application Logic for all TC&C Locations - After approval of prototype TC&C location, individually submit the application logic for all other TC&C locations. Microprocessor logic diagrams submittals for each TC&C location shall be part of the complete circuit and detail package for that location. See Section 34 42 13.26 – Circuit and Logic Requirements for additional information. Include documentation and interfacing information as identified above for each TC&C location submittal. Submittal for each TC&C location shall be made at each of the documentation levels identified below. Each submittal or re-submittal shall identify revision dates and history for logic diagrams and EPROM's or FLASH memory devices with check sums.

1. Design Review Submittals

2. As-Built. In addition to the logic diagrams, at the As-Built level, the Contractor shall include any additional documentation associated with the logic. This includes Boolean source code (if Contractor's programming method includes Boolean code), assembly language or machine language, notes inserted in the program about special operating or software features at each TC&C location and identification of individual logic components by serial number.

F. Support Equipment - See Section 34 42 13.36 – Systems Support for requirements.

1.06 DEFINITIONS (NOT USED)

PART 2 - PRODUCTS

2.01 GENERAL

Contractor may elect to provide vital and non-vital microprocessor-based solid-state equipment for interlocking control and other functions. Functions of the microprocessor equipment to be supplied include vital interlocking, cab signaling logic control, and wayside event recording. Such equipment shall meet all applicable requirements of the AREMA Communications and Signal Manual of Recommended Practices. The microprocessor-based solid-state equipment shall be Alstom Signaling iVPI or similar or other equivalent microprocessor-based vital controller.

A. Modular Design - Equipment shall be rack mounted in card files module complete with accessories and shall be modular in design.

1. Plug-in printed circuit cards (or modules, containing such) shall be used wherever possible and they shall be keyed or configured such that a card cannot be installed in the incorrect position.

2. Electronic components, except primary surge protection and voltage adjusting resistors shall be mounted on plug-in circuit cards or plug coupled subassemblies (modules) to facilitate testing and maintenance.

B. Connections - Connections to external nonelectronic vital signal apparatus shall be on binding posts or other solderless connectors. Connections to external electronic vital and non-vital signal apparatus shall be by Metro-approved plug couplers.

C. Inputs/Outputs (I/O):

1. Inputs - The microprocessor system shall provide vital and non-vital inputs. A visual indication, such as a LED, shall be provided for each input on the input board. It shall illuminate continuously when the input is activated. Vital inputs for the equipment shall have an option to selectively de-bounce each input. Vital inputs shall be electrically and physically vitally isolated from each other.

2. Outputs - The microprocessor shall provide vital and non-vital outputs. A visual indication, such as a LED, shall be provided for each output on the output board. It shall illuminate continuously without use of a pushbutton when the output is activated. Vital outputs shall be electrically and physically isolated from the logic power supply. If output is used to drive double break circuitry, the output shall be physically and electrically isolated from each other. Electrically isolated shall be interpreted to mean a minimum of 2000 V rms.

3. Vital link - If the Contractor's design requires more than one microprocessor per TC&C location, the microprocessor system shall provide vital serial links or Ethernet links or better between the processors. Serially transmitted data

between subsystems shall be updated every second maximum to ensure integrity of the communication link.

4. Identification - A label shall be provided for each input and output indication which denotes the respective function of each to facilitate troubleshooting and maintenance.

D. Event Recording - Event recorders shall be provided for vital microprocessor systems to record changes in state of logic variables and registers within the vital systems and their devices. Each recorder shall be capable of recording up to 1 week of events.

E. Internal Diagnostics - The processor subsystem shall incorporate vital self-checking tests to ensure that the equipment and program are functioning as intended. The checks shall be integral parts of both hardware and software to provide for a secure system.

1. A vital processor shall not allow false information to persist long enough to allow an unsafe condition to occur, or allow false information to be transmitted to external devices which will create a hazardous condition. Processor shall use a vital "kill" relay circuit to de-energize all outputs in the event of a safety related I/O or processor failure. The "kill" circuit shall de-energize all outputs in a time less than the fastest activation time of any external device connected to a vital output. The kill circuit shall use vital circuit design techniques to assure that no false signal that could be generated by any other device in the relay housing i.e. power supplies, audio or coded equipment, or harmonics of these devices shall energize the output power relay.

2. Contractor shall provide visual indicators, such as LEDs, to demonstrate that the system is functioning as intended; similarly provide failure and diagnostic indications. Indicators shall isolate a failure to a particular function, or the interface between two functions.

3. Transmission of false information from a non-vital to a vital subsystem shall not affect the safety of the vital subsystem.

4. System outputs shall be positively monitored with independent current/voltage sensors and compared to the requested value. The "kill" circuit shall de-energize all outputs and shutdown the system when the outputs fail to correspond to the required state or a more restrictive state. Diagnostic checks shall act on current (fresh) data only. Memory locations used to determine the proper states of inputs and outputs shall be cleared or overwritten prior to being reused during each cycle of tests to ensure the integrity of the check. The diagnostic checks shall be independent of the application logic for the system. The system shall attempt an automatic restart after executing safety checks.

5. Diagnostics shall check to assure synchronized tasks shall execute correctly in the proper order. Checks shall shutdown the system in the event the processor is overloaded.

6. Any microprocessor system failure, including loss of power, shall result in the system entering its most restrictive state and shall not cause any unsafe condition.

F. Power Supply - Each microprocessor unit shall be energized from an uninterruptible power source or battery backup power.

G. Access - A method of security shall be provided to allow only authorized user access. The system shall not interfere with operation of the wayside vital processor system.

H. Timers - Provisions shall be made in the design to adjust the vital and non-vital timer settings associated with the logic without changing the program or - recompiling. Adjustable vital timers shall include a means of sealing the time setting.

I. Trouble-Shooting Connection - The microprocessor system shall be capable of interconnection to a portable device that permits interrogation (via keyboard/keypad) and observation (via monitor/display) of internal logic bits during testing and normal operations. This interface shall use English-Text and Arabic numeral nomenclature with explanation of faults in easy to read text. Operator interface shall be via menu driven commands with an on-line HELP feature to describe use of commands.

J. The microprocessor system shall be designed to operate in the presence of the following noise sources:

1. Lightning surges and voltage surges from external power distribution systems;

2. Transients from nearby power lines, propulsion return currents, back EMF from operating relay coils, arcing contacts, RF noise such as hand-held radios; and

3. I/O wiring from the I/O card file (module) to external terminal strips.

K. The microprocessor control system shall be capable of interfacing with the existing TC&C location. See Section 34 42 13.33 – Interface Requirements for details.

L. Contractor shall ensure that new ATC equipment installed at Wilshire/Western location is backwards compatible and capable of interfacing with existing equipment located at Wilshire/Normandie location and Wilshire/Vermont location. This shall be accomplished without the need to change any existing equipment at Wilshire/Normandie and Wilshire/Vermont locations.

M. Microprocessor system shall be capable of receiving vital remote link inputs, processing those inputs as necessary in its applications logic, and then sending vital remote link outputs via the vital remote link.

N. Vital Link within TC&C location – Contractor shall use Ethernet connection over fiber optic cable per Section 34 42 16.16 – External Wire and Cable or four-wire, optically isolated RS-422 standard for vital communication link between multiple

microprocessors within the TC&C location. Other serial link standards (such as RS-485) may be used if approved by Metro.

O. Vital Link with adjacent TC&C location (i.e. Inter TC&C location-to-TC&C location) – Contractor shall use 12 fiber core cable, per Section 34 42 16.16 – External Wire and Cable, for vital communication link between microprocessors located in adjacent TC&C locations.

P. SCADA interface - Cooperate with the Subcontractor in providing needed support to define, develop, and test interfaces between ATC System and SCADA subsystems. The SCADA interface to with ATC System equipment shall utilize RS-232 standard serial protocol or Ethernet connection or better. Other serial link standards (such as RS-422 and RS-485) may be used if approved by Metro. Use of media converters on such interface shall be minimized, if possible.

Q. Parts shall be available for a minimum of ten (10) years after Final Acceptance.

2.02 APPLICATION LOGIC

The Contractor shall ensure that all Metro Rail Design Criteria requirements, AREMA best practices, and circuit and logic requirements, see Section 34 42 13.26 – Circuit and Logic Requirements, listed elsewhere in these specifications shall be incorporated into application logic. The logic shall be defined in terms of traditional relay logic and shall be converted to Boolean algebraic expressions. The Boolean expressions shall then be submitted to a high level compiler provided by the Contractor that converts Boolean algebra to machine language or application code. The application code shall reside in EPROM that shall be plugged into sockets in the microprocessor or in FLASH memory. The microprocessor shall execute the application code and perform vital and non-vital interlocking control tasks. Contractor shall develop all executive and application programming for the interlocking configurations per the requirements of the Contract Documents.

A. Furnish two (2) spare copies of the executive and application logic EPROM or FLASH memory devices for each TC&C location securely labeled with program identification, date and checksum. **See Section 01 78 43 for details.**

2.03 SIMULATOR

Contractor shall provide a graphical simulator which works in conjunction with the compiler and allows testing of a completed program prior to its loading in the system hardware. Commands shall be provided by mouse, track ball or similar device in the graphical portion of the simulator to emulate the operation of the designed system. The simulator shall execute the logic using the same algorithm as the run-time system. Commands shall include setting and clearing "relays" or ”Registers”, whichever applies, executing logic equations, and advancing system time. Logic statements and the system clock shall be stepped individually or together at any desired increment. The simulator package shall not require any additional logic other than the Operating System of the Metro's PC to operate the simulator. Contractor shall furnish to the Metro 3 copies of the latest version of the simulator on CD-ROM with the prototype TC&C location for review. The simulator shall be capable of simulating the application logic submittals for each of the microprocessor control TC&C location. The simulator shall provide commands that display:

A. Logic statements as they are executed.

2.04 DEVELOPMENT SYSTEM

Provide a development system or computer aided application system which includes aaa hardware, software (compiler and simulator), and operation instructions to enable Metro technicians to make changes to the application software and program new EPROM or FLASH memory. Boolean expressions and other application data for programming vital and non-vital logic shall not require specialized knowledge of computers or programming language. Programming shall only require knowledge of interlocking operation and design and either the ability to program software "relay" or Boolean equivalent of the circuits to configure or reconfigure control or indication circuits.

A. Contractor shall provide a software utility, separate from the compiler that will assist in performing independent verification of the application logic output. The utility shall also identify all vital logic equations and/or addresses that have been modified as a result of a program revision.

B. Label each executive and application EPROM or FLASH memory device as follows, as appropriate:

1. TC&C location;

2. Program ID;

3. Checksum;

4. Revision number or level; and

5. Date.

2.05 SPARE PARTS

A. Propose recommended lists of test equipment and spare parts necessary for trouble-shooting and maintenance of the equipment included in this Contract. Metro or its Designee will select such equipment as it requires. Refer to Section 01 78 43 List B submittal.

PART 3 - EXECUTION

3.01 NOISE MITIGATION

Contractor shall suppress or prevent noise from entering into the system using the following practices:

A. Use lightning arrestors and secondary surge suppressors to protect against lightning and other voltage surges in accordance with AREMA Signal Manual, Part 11.2.1;

B. Ensure that AC ground through the capacitor is provided for all components of the microprocessor system.

C. Connect shields on serial communication cables to earth ground on one end only;

D. Provide required load to unused outputs, only if deemed necessary;

E. Ensure proper pickup and dropaway relay currents per relay specifications when interfacing relays to I/O cardfiles (modules);

F. Install standard suppression on all relay coils;

G. Use twisted pair wires for all inputs (both vital and non-vital);

H. Shorten wire harnesses from I/O cardfiles (modules) to external terminal strips and dress these wires away from the CPU;

I. "Oversize" power supplies and design associated power busses to minimize noise produced by voltage drop of transient currents. External filtering may be used to reduce transient current noise on the power bus;

J. Separate connections to external apparatus from internal wiring carrying processor signals;

K. Keep cabling between cardfiles (modules) as short as possible to minimize induced noise; and

L. Group microprocessor-based system racks together.

3.02 TEST

Contractor shall test the microprocessor control and all associated equipment per the requirements of Section 34 42 13.99 - System Test Program.

3.03 MAINTENANCE

To facilitate maintenance, diagnostics shall be organized such that detectable failures will energize LED indicators mounted on the edge of PC boards (modules) which will allow a technician to determine system operating status and errors. The operation of any diagnostics or monitoring of the operation of the microprocessor shall not. Under any circumstances, have the ability to change or impact any vital software routines.

END OF SECTION 34 42 19.13

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