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Metropolitan Transportation
Authority
One Gateway Plaza
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Los Angeles, CA

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CONSTRUCTION COMMITTEE
JULY 17, 2024

SUBJECT: OFFICE OF THE INSPECTOR GENERAL COMPARISON OF METRO RAIL DESIGN CRITERIA TO 11 CITIES ALONG THE SOUTHEAST GATEWAY LINE

ACTION: RECEIVE AND FILE

RECOMMENDATION

RECEIVE AND FILE Office of the Inspector General Comparison of Metro Rail Design Criteria to 11 Cities Along the Southeast Gateway Line.

ISSUE

The Metro Office of the Inspector General (OIG) initiated a study to determine what differences exist between the Metro Technical Specifications and Rail Design Criteria (MRDC) for the design of construction projects and the typical design specifications of cities in Los Angeles County to warrant the creation of costly permitting packages, lengthy permitting review processes, permitting fees, contractor frustrations, and schedule delays resulting therefrom, and if improvements can be made in consistency between the two specifications to reduce these impacts.

BACKGROUND

The OIG's Construction Change Order Spot Check Program focuses on approved change orders and modifications that exceed $500,000. In the course of performing our review of change orders, it appears that the change orders are subjected to review by cities, permitting fees, and can result in schedule impacts. Change orders can result from several circumstances including differences in design specifications of Metro and the city where Metro construction is occurring. The Southeast Gateway (SEG) Line alignment will be going through Los Angeles, Huntington Park, Vernon, Bell, Cudahy, Downey, South Gate, Paramount, Bellflower, Cerritos, and Artesia (the "11 Cities"). Those cities' specifications were chosen as examples to study. The OIG, along with its consultant, Mott MacDonald, endeavored to compare the MRDC with the design specifications from those SEG Line 11 Cities.

DISCUSSION

Focus on Section 3 of the MRDC.

The MRDC consists of 12 sections. Each section covers the criteria for the disciplines involved in the planning, design, construction, and operation of Metro facilities. In comparing the 11 Cities design criteria with the MRDC, there are many sections that the MRDC covers in detail that are absent from the 11 Cities criteria. This is because the 11 Cities are not doing rail construction. In the absence of any relevant design criteria from the 11 Cities, the design of these Metro facilities is governed by the MRDC. These relevant rail-related MRDC sections include Environmental Considerations, Guideway and Trackwork, Architectural, Mechanical, Electrical, Systems, Operations, Yards and Shops, and Safety Security Systems Assurance. Section 3 of the MRDC provides criteria for the design of transit alignments, track subgrades, drainage systems, right-of-way clearances, access control, service roads, streets, parking facilities, site work, and utility relocations. Notable references that provide a basis for Section 3 criteria include the Manual of Uniform Traffic Control Devices (MUTCD), Caltrans Standard Plans & Specifications, Caltrans Highway Design Manual, and the AASHTO Policy on the Geometric Design of Highways and Streets. Section 3 of the MRDC provides the most detailed information for direct comparison to the 11 Cities' criteria. Therefore, the focus of the review was on Section 3 of the MRDC to the 11 Cities specifications.

Consultant findings on differences between the MRDC and the SEG Line cities.

Uniform design and construction standards, conformed from the MRDC and the criteria of the 11 Cities, would be valuable to guide the development of the SEG Line project and improve project delivery costs and schedule.

Based on a high-level review by the OIG expert consultant of the MRDC to the SEG Line 11 Cities' specifications inconsistencies are rare. Out of over 5,000 specifications compared, only 21 (about .5%) were found to be different.

The 21 specifications identified as different, which the consult refers to as "exceptions", are set forth in Attachment A to the attached report. Importantly, these inconsistencies account for an incredibly small percentage of the total design criteria. The MRDC and the 11 Cities specifications are essentially 99.5% the same.

Potential Cost and Schedule Savings

1. <u>MRDC Updating</u>. Material conflicts between Metro designs and a city's requirements can create change orders. Change orders are costly and cause delays. Because of this, Board Deputies have asked the Inspector General what the differences are between our design specifications and other cities. This report substantially answers that question. The study by this independent expert consultant in the construction industry confirms that there is less than a 1% difference between most cities and the Metro specifications. While change orders can occur due to several reasons, such as differing site conditions, utility relocations, and other reasons, change orders due to differing specifications should be very limited with respect to any inconsistent specifications, so long as Metro's MRDC remains current and consistent with new laws, regulations and best practices.

   <u>Recommendation 1:</u> For this reason the OIG recommends that Metro continue to make a

strong effort to make all updates to its MRDC promptly as requirements change and include best practices to ensure cities can trust Metro's MRDC to reflect legally correct and good quality requirements.

2. Permitting Process. Much of a permitting process is to confirm that the Metro specifications are consistent with the reviewing city's specifications. The permitting process is costly. Metro pays a consultant to compile permitting packages comprised of specifications for a project, schematics, and other voluminous information. The city's personnel time is burdened; they charge Metro to review the packages, and those fees are charged against the budget of the project. Review of the thousands of specifications are performed by a city as time and availability allows, that is a potentially lengthy process. Contractors have expressed frustration with the process and used it as a basis to charge Metro. Since we have confirmed that the deviation of Metro's MRDC from most cities' specifications is less than a 1% deviation, it does not warrant a review and permitting process for the entire other ninety-nine percent (99%+) of the project specifications.

   Recommendation 2: Metro should endeavor to be self-permitting for all aspects of a project that are substantially consistent or more stringent standards than a city where we are performing construction.

   Recommendation 3: The permitting process, if used, should be limited to those nonconforming specifications that are a lower or materially different standard than what a city requires. Again, this is less than 1% of the specifications of a project. This would also result in less burden on the cities where we build. It might also result in more proposers for Metro projects at a lesser cost. It would save money and schedule time on a project. This would mean more funds would be available for safety-related construction, amenities, and higher-quality products for the construction.

   This would not result in any less transparency on the projects to the public or the cities. The full set of specifications could still be made available to the cities to review as they wish. A city would have to have faith in Metro that when it brings to them the exceptions to permit, that is all the exceptions. Self-permitting for the conforming specifications involves of some trust by the cities' permitting authorities, and that trust must be earned by Metro by having an MRDC that is accurate, up to date, and addresses typical city concerns and certifying that the exceptions brought forward are verified as the only significant variances.

Recommendations Recap -

The OIG recommends a frequent and regular review and update of the MRDC to ensure consistency with local cities design criteria.

The OIG also recommends that excerpts from reference criteria in the MRDC be removed from the MRDC and replaced with citations referencing to the governing source criteria that form the basis of the MRDC. It should be clearly noted that newer versions of the source criteria, published prior to the start of a notice to proceed with project design, shall govern. Any updates to referenced source criteria after the notice to proceed should be discussed with the affected city.

Lastly, the OIG recommends that self-permitting occur for the specifications that conform to a city's specifications, and an accelerated, abbreviated permitting process be established for the SEG Line project and for other Metro projects in the future, for the non-conforming "exception" specifications related to the project.

This report does not have a financial impact on the Agency, but action taken on the recommendations has the potential to reduce costs related to construction planning, design, and permitting and improve Metro efficiency.

EQUITY PLATFORM

Of the 11 Cities, nine cities have areas Metro has identified as Equity-Focused Communities. Those are Bell, Bellflower, Cudahy, Downey, Huntington Park, Los Angeles, Paramount, and Southgate. In the opinion of the OIG, we considered whether these design criteria presented any equity-related issues on their face. The OIG did not receive any data concerning community impacts. These low-income equity-based communities along the Southeast Gateway Line will benefit from having increased access to Metro Light Rail. The OIG observed no obvious disparate impacts created by the design criteria on small businesses or low-income persons, or by the implementation of the design criteria in a manner that impacted a disadvantaged community beyond what is typical and usual when conducting any construction.

IMPLEMENTATION OF STRATEGIC PLAN GOALS

The Office of the Inspector General review and comparison of MRDC to the 11 Cities design criteria is in support Metro's Strategic Plan Goal #5: Provide responsive, accountable, and trustworthy governance within the Metro organization and CEO goals to exercise fiscal discipline to ensure financial stability. The OIG mission includes reviewing expenditures for fraud, waste, and abuse in Metro programs, operations, and resources.

NEXT STEPS

Our preliminary review with management regarding the OIG's report and recommendations was generally positive. Management's response is attached. Management will continue to review the recommendations and implement as appropriate whether to utilize self-permitting or in another form that will increase the path forward on construction projects.

ATTACHMENTS

Attachment A - Report on Comparison of Metro Rail Design Criteria to 11 Cities along the Southeast Gateway Line
Attachment B - Management's Response

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Metro

Comparison of Metro Rail Design Criteria to Cities along Southeast Gateway Line

AE56750008 - Task Order #2

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Los Angeles County Metropolitan Transportation Authority

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Contents

ACRONYM	DEFINITION
AASHTO	American Association of State Highways and Transportation Officials
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
AHJ	Authorities Having Jurisdictions
ANSI	American National Standards Institute
APTA	American Public Transit Association
APWA	American Public Works Association
AREMA	American Railway Engineering and Maintenance Association
CBC	California Building Code
CEQA	California Environmental Quality Act
CLSM	Controlled Low Strength Material
CPUC	California Public Utilities Commission
DBE	Design Basis Earthquake
EX	Exception
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HVAC	Ventilating, and Air-Conditioning
IBC	International Building Code
LABOE	Los Angeles Bureau of Engineering
LACMTA	Los Angeles County Metropolitan Transportation Authority
LAMC	Los Angeles Municipal Code
LID	Low Impact Development
LOS	Level of Service
LRFD	Load and Resistance Factor Design
LRT	Light Rail Transit
MCA	Master Cooperative Agreement
MDE	Maximum Design Earthquake
MRDC	Metro Technical Specifications and Rail Design Criteria
MRT	Metro Rail Transit
MSF	Maintenance and Storage Facility
MUTCD	Manual of Uniform Traffic Control Devices
NE	No Exception
NTP	Notice to Proceed
OIG	Metro Office of the Inspector General
SB	Senate Bill
SEG Line	Southeast Gateway Line Transit Corridor Project
VMT	Vehicle Miles Traveled

Executive Summary

The Los Angeles County Metropolitan Transportation Authority (LACMTA or Metro) serves as the planner, coordinator, designer, builder, and operator of the public transportation system for Los Angeles County. The Metro Office of the Inspector General (OIG) in its periodic audit of construction change orders of rail projects has discovered some inconsistences between the **Metro Rail Design Criteria (MRDC)** and the design criteria of local authorities having jurisdiction (AHJ) within Los Angeles County.

The Southeast Gateway (SEG) Line project is a planned light rail corridor that will traverse through 11 cities along its alignment. The cities of Los Angeles, Huntington Park, Bell, Cudahy, Downey, South Gate, Paramount, Bellflower, Cerritos, Vernon, and Artesia, plus the County of Los Angeles are collectively referred to in this report as the "SEG Line Cities". The OIG determined that it is best practice and beneficial to determine commonality between the MRDC and the SEG Line Cities' criteria prior to issuance of the construction contract.

A unified design and construction standard, conformed from the MRDC and the design criteria of the SEG Line Cities would be valuable for delivery of the construction contract. Mott MacDonald was retained by the Metro OIG to assist Metro in comparing the relevant sections of the MRDC to the SEG Line Cities design criteria and to produce a report and spreadsheet detailing any variances. From the high-level analysis, we addressed potential gaps and made recommendations for building an integrated set of documents and specifications for the upcoming SEG Line construction contract.

The request from the OIG to the Mott MacDonald team was to perform the task at a high-level within a limited scope, time, and budget; therefore, the evaluation and comparison performed on the two sets of documents under this task are at a high-level and should be as expected, an initial study report to guide towards future development of a unified design and construction standard. Metro OIG's three main objectives for this task and our delivery approach are as follows:

Understand

- Gather the latest MRDC.
- Gather SEG Line Cities design criteria.
  - The OIG's request for information from the SEG Line Cities and their responses are the basis of data used; however, the Mott MacDonald team initialed contact with cities when their responses needed additional clarity.
- Analyze and understand the MRDC and SEG Line Cities design criteria.

Identify

- Identify the relevant design and construction criteria from the MRDC.
- Identify the appropriate SEG Line Cities design criteria for comparison.
- Evaluate the documents for variances.

Report

- Develop and populate a spreadsheet comparing the SEG Line Cities design criteria and the MRDC.
- Generate methodology to evaluate and resolve the discrepancies.
- Write a report summarizing findings and recommendations.

The spreadsheet with over five thousand MRDC identified items for comparison is included in this report as Appendix A2, and a smaller list of specific exceptions where criteria differ between the MRDC and SEG Line Cities in Appendix A1. In general, we have categorized the items as performance or prescriptive based criteria. The performance-based items are “resolved” items, unless stated otherwise, because the typical language in the MRDC either defers to the AHJ criteria or more stringent governing codes and criteria. The prescriptive criteria are compared against the appropriate SEG Line Cities criteria when available. The Greenbook is relied on by many cities; therefore, the Greenbook was compared to the MRDC.

Construction and policy restrictions from the SEG Line Cities were generally not evaluated because we are not privy to the requirements, and they were not provided in discovery. The granular detailed information needed to perform this work cannot be achieved in this high-level review. To investigate construction and policy restrictions of the SEG Line Cities would require more extensive resources and time. We recommend further evaluation in detailed design or as a significant separate continuing effort.

The immensity of data needed to be compared and validated between the MRDC and the SEG Line Cities’ criteria, codes, regulations, and restrictions is a daunting endeavor; however, having the two sets of documents in conformance and any conflicts mitigated is vital for the successful implementation of the SGL construction contract. The framework and initial evaluation developed in this task should be used to guide the continuation of this effort to completion, but “best practice” would seek resolution prior to the start of final design and construction.

1 Introduction

1.1 Project Summary

The Southeast Gateway Line (SGL) is a new light rail transit (LRT) corridor connecting southeast LA County to downtown Los Angeles. The SGL corridor includes a 14.5-mile-long segment connecting Pioneer Station in the City of Artesia to Slauson Station along the A Line in unincorporated Florence-Firestone. It includes nine stations, five parking facilities, and a new 21-acre Maintenance and Storage Facility (MSF) within the City of Bellflower. A separate 4.5-mile segment is proposed from Slauson to Union Station, which will include 3 additional stations in the Art/Industrial District, Little Tokyo, and Union Station. Together, both segments makeup the 19-mile Southeast Gateway Line providing a one-seat ride from Artesia to downtown Los Angeles.

1.1.1 Existing Railroad Right-of-Way

The SGL corridor is largely located within an existing Pacific Electric railroad right-of-way that is now owned by the Los Angeles County Metropolitan Transportation Authority (LACMTA). Most of the existing right-of-way was double track while in service, except for single-track bridges. The line was discontinued in 1958 and a Caltrans survey in 1981 reported that the SGL line had been reduced to a single track, with several at-grade crossings removed and in poor condition. Improvements along the existing railroad right-of-way, now owned by LACMTA, will be governed by Metro Rail Design Criteria (MRDC).

1.1.2 Existing City Right-of-Way

The SEG Line corridor traverses through Los Angeles, Huntington Park, Bell, Cudahy, Downey, South Gate, Paramount, Bellflower, Cerritos, Vernon, and Artesia. Those 11 cities plus the County of Los Angeles collectively are referred to in this report as the “SEG Line Cities.” The SEG Line Cities are served by seven major freeways and a grid of major arterial roads. Many of these roads include on-street parking, bus stops for local and regional transit operators, and an extensive network of bicycle and pedestrian facilities.

Most roadway intersections within the project area are controlled by traffic signals or stop signs. Many of the existing at-grade crossings that intersect the proposed LRT alignment are controlled by crossing gate arms or warning signs and this is where the project will interact most with the SEG Line Cities. Improvements within the existing SEG Line Cities right-of-way will be governed by a mix of design criteria from each city and the criteria within the MRDC.

1.2 Goal of Analysis

1.2.1 A Unified Design and Construction Standard

The Metro Office of the Inspector General (OIG) in its periodic audit of construction change orders of rail projects has discovered some inconsistences between the MRDC and the design criteria of local agencies' having jurisdiction (AHJs) within Los Angeles County. A unified design and construction standard, conformed from the MRDC and the criteria of the SEG Line Cities would be valuable to guide the development of the SGL construction contract and improve project delivery.

1.2.2 Main Objectives

Metro's three main objectives for this task and our delivery approach are as follows:

Understand

- Gather the latest MRDC.
- Gather the SEG Line Cities design criteria.
- Analyze and understand the MRDC and SEG Line Cities design criteria.

Identify

- Identify the relevant design and construction criteria from the MRDC.
- Identify the appropriate SEG Line Cities design criteria for comparison.
- Evaluate the documents for variances.

Report

- Develop and populate a spreadsheet comparing the SEG Line Cities design criteria to the MRDC.
- Generate methodology to evaluate and resolve the discrepancies.
- Write a report summarizing findings and recommendations.

1.2.3 Delivery Approach

There is an immense amount of data in both the MRDC and the SEG Line Cities Criteria. Validating and comparing these data is a daunting task but having a unified design and construction standard is vital for the successful implementation of the SGL construction contract. The request from the OIG to the Mott MacDonald team was to perform the task at a high-level within a limited scope, schedule, and budget; therefore, our delivery approach matched this recommended level of effort accordingly and will serve as an initial study report to guide the future development of a unified design and construction standard.

Our team approach was to drill down into the most critical aspects of evaluating these various criteria. To analyze and **Understand** the MRDC, we started first by classifying the entirety of the MRDC into the following categories:

- Performance Criteria
- Prescriptive Criteria
- Standard Criteria

We then considered the most relevant scope of work to the SEG Line Cities; namely, that which occurs within each Cities right-of-way along the at-grade crossings of the LRT alignment. We then identified commonalities in the SEG Line Cities Criteria, which allowed our team to **Identify** the most relevant criteria to evaluate.

2 Outreach to SEG Line Cities

2.1 Metro OIG Outreach

Prior to starting analysis of the MRDC and SEG Line Cities criteria, Metro OIG reached out to each of the SEG Line Cities as well as Los Angeles County. The initial outreach between the SEG Line Cities and Los Angeles County gathered information through public record request. These requests generally inquired about city municipal standard criteria and requirements specifically related to rail design and construction, as well as other related design criteria necessary to obtain a permit for these public works. City responses were then collected and sent to Mott MacDonald along with a table summarizing all individual city responses to the initial information request.

After the initial outreach, responses were received from all cities except for Los Angeles and Paramount. For the city of Los Angeles, we were able to review criteria posted online. The cities that responded largely stated they did not have their own standards or criteria for most, if not all, items related to rail design and construction. Based on their responses, design and construction references were generally made to the *Standard Plans and Specifications for Public Works Construction* (the Greenbook), the *American Public Works Association* (APWA), and Caltrans standards. The cities that responded with their own standards included Artesia, Downey, South Gate, and Vernon, as well as Los Angeles County. The standards provided from these cities, however, are not all encompassing and largely contain items that are either secondary or unrelated to rail design and construction.

2.1.1 Initial Approach

The initial approach of the Mott MacDonald team was to submit secondary information requests to the various cities without duplicating the initial effort from Metro OIG. Therefore, the team took note of the initial outreach efforts and submitted informal information requests to the Public Works and Engineering departments, instead of submitting formal public record requests through the City Clerk. This second round of requests ultimately resulted in similar responses to the efforts of Metro OIG or no response at all. For cities that did not respond, the team assumed the information initially provided to Metro OIG was all that was available.

2.1.2 Summary of Results

A summary of responses from the SEG Line Cities is provided below:

City of Artesia – The City of Artesia provided its Master Cooperative Agreement (MCA), which the City negotiated with Metro, the Artesia Active Transportation Plan, general plan bikeways and truck routes, and the following standard plans: Driveway, concrete sidewalk, backfill and asphalt pavement repair; and the following City municipal codes: lighting, fences walls and hedges, landscaping, open space and recreation (OS-R), and noise. Upon Mott MacDonald's request for further information, Karen Lee (Special Projects Manager) stated the following: "The City negotiated with Metro in its Master Cooperative Agreement (MCA) that Metro would honor the specs resulting from the Artesia Downtown Specific Plan."

City of Bell – The City of Bell stated that the City uses the Greenbook. Mott MacDonald attempted to contact the City through their online "Contact Us" form but received no response.

City of Bellflower – The City of Bellflower stated that the City has no records responsive to Metro OIG's request. Mott MacDonald then reached out to the City of Bellflower's Inspector, Frank Preciado, who stated that the City has no standards aside from driveway aprons and that most things will fall under the Greenbook. He also mentioned that the City has a permit writer who has their own requirements.

City of Cerritos – The City of Cerritos stated that the City has no records in response to Metro OIG's request and that they defer to the American Public Works Association (APWA) standard plan and specifications. Upon Mott MacDonald's request for further information, the head of the City's Engineering department stated that there were no standards for railroad crossings and would therefore require all rail projects to be reviewed and approved by the lead City engineer. However, as a general rule, rail works should meet Federal Highway Administration and Caltrans standards. All other standards and work should be referenced in the APWA Greenbook. One example was provided for a deviation to the above standards; standard water lid valves need to be made in Mexico or USA. Valves are not accepted if made in any other country. Additionally, the City has different preferred work hours depending on what part of the city construction will take place in. The following examples were provided: the City prefers work in industrial areas to be carried out in the day, work by the Cerritos Mall to be carried out at night except for Thanksgiving to mid-January where no construction is allowed near the mall.

City of Cudahy – The City of Cudahy stated that the City uses the Greenbook along with Caltrans standards and other construction codes as applicable (e.g., CAMUTCD). The City also stated that Public Works Permit Requirements include the following: completed Public Works Permit application (along with correspondent fees), project plan for proposed improvements, traffic control plan (stamped and signed by a registered Professional Civil Engineer in the State of California), contractor's license, certificate of insurance, contractor's worker comp, contractor's business license, proof of coordination with utility companies and USA notification. Typical hours of operation for projects within the public right-of-way is 7am to 3pm. Aside from the listed items above, other requirements may also be required based on the proposed project and scope of work. Mott MacDonald attempted to contact the City of Cudahy through the Public Works Director, Aaron Hernandez, but received no response.

City of Downey – The City of Downey stated the following: "As a Public Works Department, we do not have standard criteria and requirements related to any rail design and construction, including those for tracks, stations, building access, grade crossings, fencing, duct banks, bridge supports, hauling, and earth monitoring." The City did, however, provide standard plans for Sewer and Water as well as a standard drawings for residential driveways or parkways 10' or more. Mott MacDonald was unable to contact the City of Downey through various email attempts as they were bounced back and labelled as spam by the City.

City of Huntington Park – The City of Huntington Park stated the City does not have its own City municipal standard criteria and requirements and therefore utilizes County standards. Mott MacDonald attempted to contact the City through their general contact email but received no response.

City of Los Angeles – The City of Los Angeles has a Master Cooperative Agreement (MCA) with Metro that outlines the roles and responsibilities for the design and delivery of transportation projects within the City limits. Relevant design criteria are also readily available online and has been summarized for each bureau within the Public Works department and the department of transportation below:

Bureau of Engineering

- Standard Plans
- Storm Drain Design Manual
- Architecture Manual
- Brown Book
- Street Design Manual
- Supplemental Street Design Guide
- Structural Design Manual
- Construction Manual
- Sewer Design Manual
- Survey Manual
- Special Orders
- Master Specifications Library

Bureau of Sanitation

- Low Impact Development (LID) Handbook

Bureau of Street Services

- Tree Spacing Guidelines
- Irrigation in the Public Right-of-Way
- Tree Planting Standard Plans

Bureau of Street Lighting

- Design Standards and Guidelines
- Blue Book

Los Angeles Department of Transportation

- Manual of Policies and Procedures
- Complete Streets Committee Policy and Design Guidance
- Supplemental Street Design Guidelines

City of Paramount – Metro OIG submitted an information request to the City of Paramount but had not received any information in return. Mott MacDonald sent a follow-up request for information to Adriana Figueroa with the City of Paramount who forwarded the request to Rafael Casillas from Willdan (the city's contracted engineering firm). Willdan stated that anything that falls within the City right-of-way typically follows the Greenbook and that general work conditions, construction requirements, and similar can be found in the City municipal codes. However, there is no wide ruling for all areas throughout the City and standards and requirements will largely depend on the location within the City that the work is being performed in. Additionally, depending on the location of work, activities will be subjected to differing requirements based on whether they are distinguished as a betterment activity or a construction activity. The engineer made a final comment that Willdan is hesitant to provide wide-ranging requirements and standards because the City and Willdan assess every project and tailor it for the City.

City of South Gate – The City of South Gate stated that the City uses their own water and sewer standards, but follows Caltrans, Greenbook, and CAMUTCD standards for most other works. Mott MacDonald attempted to contact the Public Works department but received no response.

City of Vernon – The City of Vernon was not initially contacted by Metro OIG but MM submitted an information request through the City's online portal, initially to the Director of Public Works and the Deputy Director. This request was forwarded to an engineering aide who directed MM to the Cities Standard Drawings online. Standard Drawings are available for the following items:

- Tree Planting Standard
- Standard Masonry Wall Barrier
- Standard Driveway
- Parkway Drains
- Curb Drains
- Manhole Drain and Cover
- Miscellaneous Curb
- Typical Trench Paving Section
- Standard Offset Requirements
- Standard Sidewalk Curb and Gutter
- Curb Ramps

Los Angeles County – Los Angeles County did not respond to Metro OIG's information request. However, relevant design criteria and construction specifications available online were used by the Mott MacDonald team. These include:

- Los Angeles County Standard Plans
- Hydraulic Design Manual
- Structural Design Manual
- Low Impact Development Standards Manual

3 Identifying Variances

3.1 Classification of Criteria

To analyze and **Understand** the MRDC, the project team classified the MRDC into the following categories:

- Performance Criteria
- Prescriptive Criteria
- Standard Criteria

This allowed our team to **Identify** the most relevant criteria from the MRDC to evaluate against the SEG Line Cities criteria.

3.1.1 Performance Criteria

Performance criteria define functional characteristics of a final product based on the operational environment. It <u>links</u> these functional characteristics to construction, materials, and other items under contractor control. This definition from the Federal Highway Administration (FHWA) implies that without this link, performance criteria would not be under contractor control. As such, our project team used engineering judgement to assume most of the performance criteria within the MRDC that were not linked to prescriptive criteria would not conflict with criteria from the SEG Line Cities. An example of performance criteria from the MRDC without this link is as follows:

- *Existing building relationships, future joint developments, as well as neighborhood ethnic and cultural characteristics shall all be taken into consideration by the Designer when site planning.*

For existing building relationships, a link to more prescriptive criteria, like minimum setbacks, was not provided. Therefore, the judgement from the project team was there is no exception to the SEG Line Cities criteria. Put more broadly, the project team used this same judgement for all performance criteria that were not linked to numerical criteria or material specifications that are under contractor control.

3.1.2 Prescriptive Criteria

Prescriptive criteria give details about product materials and instructions to the contractor for their installation. An example of a prescriptive criteria is the second sentence in the criteria below:

- *Plaza area drainage shall be designed to minimize surface water level and velocity to maintain a safe walking surface. <u>Minimum grade shall be 0.3 percent and maximum grade shall be 2.0 percent in open plaza areas.</u>*

The first sentence provides expectations of the surface water level and the desired outcome of the walking surface, which is performance criteria. In contrast to the first example, this performance criteria is linked to numerical requirements that prescribe in detail how the walking surface in plaza areas should be designed, which is prescriptive criteria.

3.1.3 Standard Criteria

Standard criteria reference materials, products, or construction methods based on requirements from another reference standard. An example of standard criteria is provided below:

- *The design of curb cuts and ramps shall be in accordance with the applicable provisions of the Americans with Disabilities Act (ADA) and Title 24, California Code of Regulations Part 2, "Regulations for the Accommodation of the Disabled in Public Accommodations."*

The assumption from the Mott MacDonald team was the design and construction requirements from the SEG Line Cities would also adhere to these same reference standards. Evaluation of the numerous requirements that makeup the ADA and other standard criteria is also outside the scope of this high-level analysis.

3.2 Relevant Project Scope

Initial outreach by Metro OIG inquired about all city municipal standard criteria and requirements related to any rail design and construction; including tracks, stations, streets, landscape, utilities, sidewalks, grade crossings, right-of-way, fencing, asphalt, concrete, curbs, gutters, drainage, catch basins, duct banks, sewers, water, storm drain, bridge supports, work hours, working conditions, building access, hauling, earth monitoring, or other related specifications and requirements to obtain a permit.

3.2.1 Intersection Improvements

The Mott MacDonald team sought ways to narrow the scope of the analysis to focus on comparing the most relevant criteria; namely, the intersection improvements that occur within each Cities right-of-way along the at-grade crossings of the LRT alignment. Typical improvements for these intersections are summarized as follows:

- Access Control
  - Active Warning Equipment
  - Medians and Channelization
  - Guardrails and Fencing
  - Traffic Signals
  - Track Circuitry and Signal Interconnects
  - Driveway relocations
- Approach Improvements
  - Bicycle/Pedestrian Improvements
  - Signage and Striping
  - Landscaping
  - Street Lighting
  - Bus stop relocations
  - Utility relocations
- Roadway Geometry
  - Horizontal alignment
  - Vertical profile
  - Curb bulb-outs
  - Dual curb ramps

Requirements for most of the above Civil scope of work are more specifically described within Section 3 of the MRDC. For items not addressed within Section 3, there are also references provided to Caltrans Standard Plans and Specifications, the American Association of State Highways and Transportation Officials (AASHTO) Policy on Geometric Design of Highways and Streets, the *Standard Plans and Specifications for Public Works Construction* (the Greenbook), amongst other relevant design requirements that form the basis of Section 3 of the MRDC. A thorough evaluation of the requirements within the MRDC against all the relevant design criteria for the intersection improvements is outside the scope of this analysis and additional means of narrowing the scope were pursued.

3.2.2 Greenbook

After gathering responses from the SEG Line Cities and collecting their design criteria, the Mott MacDonald team then identified commonalities amongst their responses. This provided an additional means of narrowing the focus of this analysis. The most common criteria referenced were the *Standard Specifications for Public Works Construction (the Greenbook), the Standard Plans for Public Works Construction, and the LA County Standard Plans*. These collectively makeup the “SEG Line Cities Criteria” for the purposes of this high-level analysis.

The Greenbook specifications largely include requirements for construction materials and methods and is thus difficult to compare against Metro Rail **Design** Criteria.

On the other hand, the Standard Plans for Public Works Construction and the LA County Standard Plans provide more relevant design criteria for comparison. More specifically, Section 100 includes design requirements for Street Improvements. The LA County Standard Plans are based on the Standard Plans for Public Works Construction and should serve as supplemental criteria. They are both structured in a similar manner and relevant criteria include Sewers and Sanitation, Flood Control and Storm Drain Facilities, Landscaping and Irrigation Systems, Street Lighting and Traffic Signals, and other General Facilities.

3.3 Analysis by Discipline

The MRDC is broken up into 12 sections, each covering differing criteria for the disciplines involved in the planning, design, construction, and operation of Metro facilities. There are many sections notably absent from the SEG Line Cities Criteria when comparing to the MRDC. These include Environmental Considerations, Guideway and Trackwork, Architectural, Mechanical, Electrical, Systems, Operations, Yards and Shops, and Safety Security Systems Assurance.

A matrix has been provided in Appendix A summarizing the analysis by discipline. The two dispositions used when evaluating the SEG Line Cities Criteria were either Exception (EX) or No Exception (NE). The EX disposition indicates a conflict between the individual MRDC specification and the SEG Line Cities Criteria. This means there was criteria for comparison but there was a difference in methodology, material specification, or some other relevant prescriptive criteria. The NE disposition indicates no conflict between the individual MRDC specification and the SEG Line Cities Criteria. That could mean alignment between the two criteria or no criteria for comparison. In the absence of any relevant design criteria from the SEG Line Cities, the design of these Metro facilities should be governed by the MRDC.

3.3.1 Environmental Considerations

Section 2 of the MRDC provides environmental compliance requirements during construction and operation of Metro projects. These include requirements for Traffic and Transportation, Land Use and Development, Urban Design, Noise and Vibration, Air Quality, Energy, Hazardous Materials, Hydrology, Biology, Cultural Resources, and Climate Change. Reference codes and standards for these requirements include California Green Building Standards Code and Metro Environmental Policy. Other requirements from Federal codes, ordinances, regulations, and applicable guidelines from the Federal Transit Administration (FTA) and American Public Transit Association (APTA) also apply. There are few, if any, comparable requirements from the SEG Line Cities Criteria for this high-level analysis. In the absence of such criteria, the requirements for environmental compliance should be governed by the MRDC.

3.3.2 Civil

Section 3 of the MRDC provides criteria for the design of transit alignments, track subgrades, drainage systems, right-of-way clearances, access control, service roads, streets, parking facilities, site work, and utility relocations. Notable references that provide a basis for these criteria include the Manual of Uniform Traffic Control Devices (MUTCD), Caltrans Standard Plans & Specifications, Caltrans Highway Design Manual, and the AASHTO Policy on the Geometric Design of Highways and Streets. This section of the MRDC provides the most direct comparison of the SEG Line Cities Criteria.

3.3.2.1 Utilities

The utilities criteria provided in the MRDC pertain to the upkeep, rehabilitation, and establishment of utilities that may be impacted by the project's construction activities. In the performance of work, due consideration shall be given to the needs of the transit system, the requirements and obligations of the utility organizations, traffic requirements, and the cooperative agreements between the Agencies or Companies and Metro. This section of the MRDC is written as a supplement to the criteria and standards of local AHJs. This is evidenced by statements taking various forms in the following sections:

- General (3.3.1)
  All designs involving maintenance, support, and relocation or other utility work shall conform

to the applicable specifications, criteria, and standard drawings of the concerned corporations or agencies.

- Sanitary Sewers and Storm Drains (3.3.2)

  Design and construction of Sanitary Sewer laterals to abutting properties shall conform to City and County of Los Angeles requirements or other applicable local codes. All sanitary sewer and storm drain discharges for both operation and construction of the Metro Rail Transit (MRT) shall be properly permitted and compliant with appropriate jurisdictional authority.

  Separation between sanitary sewers and water lines shall be per the applicable jurisdictional agency's design requirements. In general, maintain 10 feet minimum horizontal and 1-foot minimum vertical separation, or follow as required by the applicable jurisdictional agency's design requirements. The most stringent requirements shall apply.

- Water (3.3.3)

  All maintenance, relocation, restoration, and construction of water mains and appurtenances shall conform to current design standards and criteria, specifications and practices of the agencies having jurisdiction

- Gas (3.3.4)

  All work on, or adjacent to, gas lines shall conform to regulations and standards of The Gas Company.

- Electric Power (3.3.5)
  All maintenance, relocation, and restoration of electric lines throughout the transit system shall conform to the current practices of the electric company involved, the requirements of the Electrical Code of the concerned jurisdictions and agencies, and the National Electrical Safety Code.

  The preparation of designs shall be coordinated with and conform to design requirements of the electric utility company in whose jurisdiction the work occurs and coordinated with any other concerned governmental agencies.

- Telephone (3.3.6)

  All maintenance, relocation, and restoration of telephone lines throughout the transit system shall conform to current practices of the appropriate telephone company.

- Telegraph Telecommunications (3.3.7)

  All restoration of telegraph telecommunication lines shall conform to existing codes, plans, and standards of the local jurisdictional agency.

- Other Communication Cable Systems (3.3.8)
  Designer shall verify ownership, and after consultation with the owners, shall perform the necessary design work in accordance with the approved codes and standards of the companies and agencies affected.

- Fire and Police Alarm Systems (3.3.9)

  All work along the corridor will be performed by the respective owners of such systems or their designated representatives.

- Park Facilities (3.3.10)

  All relocation and restoration of underground utility lines, water mains, sewers, drains, catch basins, sprinkler systems, lights, pavements, and other improvements within parks shall conform to requirements of the local authority's park and recreation departments involved.

- Street Lights (3.3.11)

All relocations, temporary or permanent, and restoration of existing street light facilities shall be in accordance with the practices and requirements of the local agency having jurisdiction, Local Electrical Codes, and the National Electrical Safety Codes.

- Traffic Signals (3.3.12)
  All relocation, temporary or permanent, and restoration of these facilities shall be in accordance with the practices and requirements of the local jurisdiction. In addition, the *<u>Manual on Uniform Traffic Control</u>* *devices shall be followed. Local ordinances include the municipal codes and standard plans of all jurisdictions, and the following reference: City of Los Angeles Special Provisions and Standard Drawings for Installation and Modification of Traffic Signals.*
- Oil Pipe Lines, and Steam Lines (3.3.13)

  All oil transmission lines and steam lines belonging to private companies shall be relocated clear of the project site. All work shall be performed by the owner of said installation.
- Abandoned Utilities (3.3.14)
  Abandoned Utilities within the limits of excavation shall be cut and removed. Cut ends shall be plugged or capped. Abandoned lines larger than 15 inches in diameter remaining within the right-of-way shall be backfilled with sand, one sack cement slurry or controlled low strength material (CLSM).

  Pipes under railroad tracks is a key design element which was not found in the design criteria of the SEG Line Cities. **Figure 3.22**, as shown below, of the MRDC specifically states the design criteria. For any pipes under railroad tracks, this design criteria shall govern.

PIPES UNDER RAILROAD TRACKS

(Not to scale)

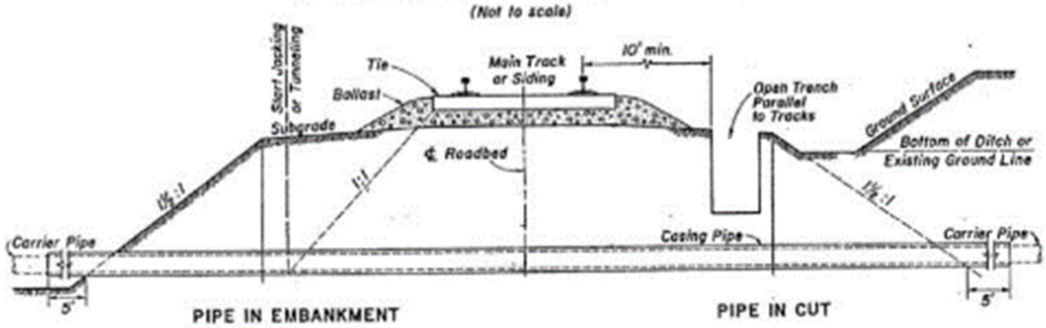


TABLE I

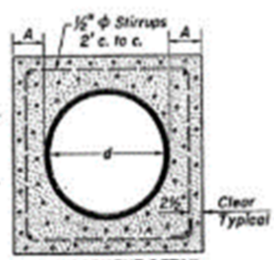
THICKNESS OF PIPE CASINGS FOR SUPPORTING TRACK

Inside Diameter	Corrugated Iron Pipe	Smooth Steel Pipe
Inches	U.S. Std. Gage No.	Min. Thick. Inches
4 to 10	14	1/8
12	14	3/16
15, 18	14	1/4
21, 24	12	1/4
30, 36	10	5/16
48, 54, 60	8	

TABLE II

CONCRETE ENCASEMENT FOR PIPES

d Inches	A Inches	Number of Longitudinal ½" Φ Bars
10, 12	4	4
15	5	4
18	5	8
21, 24, 27	6	8
30	7	12
33	8	12
36	9	12



REINFORCEMENT DETAIL

NOTES

1. *Force mains crossing main tracks and sidings shall be installed in pipe casings as per Table I.*
2. *Gravity drains crossing tracks do not require pipe casings. If concrete encasement is required for structural purposes, see Table II and detail above.*
3. *Casing may be corrugated iron, smooth steel, or concrete. Inside diameter of casing shall be at least 2" larger than outside diameter of carrier pipe and shall slope toward one end. See Table I.*
4. *Cast iron carrier pipe used without a casing shall be at least class 150 or equivalent.*

3.3.2.2 Right-of-way and Control of Access

The criteria in Sections 3.4 of the MRDC pertain to the composite total requirement of all interests and uses of real property needed to construct, maintain, protect, and operate the LACMTA system. This criterion is specific to the preferences of LACMTA and there are few, if any, comparable requirements from the SEG Line Cities. In the absence of such criteria, the requirements for right-of-way and control of access should be governed by the MRDC.

3.3.2.3 Streets

The criteria in Section 3.7 of the MRDC includes requirements for the design of publicly maintained facilities, including streets, sidewalks, driveways, bus pads, traffic signs, parking meters, and landscaping. Excerpts of notable criteria requiring further discussion and analysis are included in the following sections:

- Roadway Geometrics (3.7.3)

  B. Traffic Lane Widths

  The following criteria indicate the optimum traffic lane widths.

CASE	DESIRABLE	MINIMUM
Left Edge Line	2' from C&G	1' from C&G
Right Edge Line	2' 8" from Pvmt. Edge	1' from Pvmt. Edge
Interior thru lane 35mph & below	11' (10')	10' (9')
Interior thru lane 40mph & above	12' (10-11')	11' (10')
Interior thru lane with high truck or bus volume	12' (11')	11' (10')
Interior thru lane adjacent to bike lane	12' (11')	11' (10.5')
Left turn lane	12'	10' (10')
2-way left turn lane	12' (10')	10' (9')
Curb lane-No Parking	13' (11-13')	10'
Curb lane with parking	19' – 26'	18'

The above table is an outdated reference of the City of Los Angeles, Department of Transportation, Manual of Policies and Procedures, Section 531: Application and Design for Striping, Channelization, and Special Signing. The updated values as of 06/23/22 are shown in red for comparison. The MRDC in this case is requiring more stringent design criteria than local agencies having jurisdiction.

C. Number of Traffic Lanes

The lane configuration and signal timings shall, whenever possible, be designed to provide no worse than level of service D at signalized intersections in the P.M. peak hour during at least the year following completion of this project.

In 2013, the State of California passed Senate Bill (SB) 743, which mandates that jurisdictions can no longer use automobile delay in transportation analysis, commonly measured by Level of Service (LOS), under the California Environmental Quality Act (CEQA). The State has issued guidelines calling for the use of a broader measure called Vehicle Miles Traveled (VMT).

E. Curb Return Radii

City of Los Angeles	*25'*
Los Angeles Co. Master Plan Hwy.	*35'*
Other Los Angeles Co.	*25'*

The City of Los Angeles Supplemental Street Design Guide includes additional guidelines for the determination of minimum curb return radii. These include consideration of the street classification, design vehicle, and design speed. There is also discussion on the difference between effective turning radius that allows for smaller curb return radii.

F. Cross Slopes

Concrete and Asphalt Pavement	*2%*
Aggregate Surface Pavement	*3%*
Parking Areas	*1% min.*
	6% max.

The above values for concrete, asphalt, and aggregate pavements, while typical, are not always the minimum. The Highway Design Manual specifies the following: For resurfacing or widening (only when necessary to match existing cross slope), the minimum shall be 1.5 percent and the maximum shall be 3 percent.

For parking areas, Los Angeles Municipal Code (LAMC) 12.21A5 specifies a maximum 6.67% slope in any one direction for parking stalls.

G. Sidewalks

Minimum slope shall be 0.5%

The Los Angeles Bureau of Engineering (LABOE) Street Design Manual, Part E, specifies the following: The transverse slope, which is normally set at 2.5% percent, should direct drainage from the property line toward the roadway. The maximum transverse sidewalk slope permitted is 6% and the minimum is 1%.

The LAOBE standard plans S-444-0 specifies the following: The maximum sidewalk grade including the ¼-inch construction tolerance, is 2%. The minimum sidewalk grade including the ¼-inch construction tolerance, is 0.5%.

- Traffic Control Devices (3.7.7)

  D. Design Guidelines

  Type 170 controllers shall be utilized throughout the system unless otherwise required by local jurisdiction.

The LADOT Special Provisions and Standard Drawings for the Installation and Modification of Traffic Signals (Redbook), specifies the following: The contractor-supplied controllers shall conform to the latest LADOT material specification and addendum for the Model 2070 controller assembly, with either Type 332 or 337 cabinet as shown on the traffic signal plan, and all auxiliary equipment required to provide a complete functioning controller per LADOT Specifications 054-053-07.

- Landscape Areas and Street Trees (3.7.15)

  A. General

  Subject to local jurisdiction approval, street trees may be replaced on and two-for-one basis with 36" box standard.

On May 22, 2019, the City Council adopted as amended the Board of Public Works' (Board) proposed establishment of a Tree Replacement Guarantee (In-Lieu) Fee (Non- Refundable Deposit) to provide development and residential projects an additional permit option to satisfy the Department of Public Works' Tree Replacement Policy of "2 x 1" or "4X1" ratio (Tree Replacement: Tree Removal).

3.3.3 Guideway and Trackwork

Section 4 of the MRDC provides design criteria for clearance requirements, fencing, signage, horizontal and vertical track geometry, LRT grade crossings, and trackwork. The basis of this criteria are requirements from the California Public Utilities Commission (CPUC), recommendations from the American Railway Engineering and Maintenance Association (AREMA), and other requirements from Federal, State, and local jurisdictions. There are few, if any, comparable requirements from the SEG Line Cities Criteria for this high-level analysis. In the absence of such criteria, the guideway and trackwork design should be governed by the MRDC.

3.3.4 Structural and Geotechnical

The structural and geotechnical review undertaken focused on high-level review of Chapter 5 of the MRDC. Chapter 5 of the MRDC serves as a set of design criteria for structural and geo-structural components. Where appropriate, the MRDC refers to typical American Industry Standards such as AASTHO Load and Resistance Factor Design (LRFD), AASHTO Tunnel, International Building Code (IBC), ASCE 7 etc.

The Greenbook details structural and geotechnical construction specifications. This differs from the MRDC which is a design criteria manual. There are no expected variances with respect to geotechnical/structural design as the two documents have different purposes. Accordingly, the review undertaken focuses on any other variances between the MRDC and other typically used design criteria's (IBC/California Building Code (CBC), ASCE 7, AASHTO etc.) that any of the AHJs may incorporate.

Given the limited scope of this review, only a few variances were identified. These variances are based on a review of the MRDC and experience on other LACMTA projects:

- The structural load combinations specified in MRDC are based on AASHTO LRFD and Tunnel. These conflict with load combinations specified in the IBC/CBC with combinations on the MRDC generally being more stringent.
- For seismic design, the MRDC considers a 2-level approach; the Maximum Design Earthquake (MDE) and the Ordinary Design Earthquake (ODE) which correspond to event return periods of 2500 years and 150 years respectively. Each level has different performance requirements; life safety and collapse prevention for MDE and immediate return to service for ODE. The building code (IBC/CBC) considers a single event, the Design Basis Earthquake (DBE) which is equal to 2/3 the Maximum Credible Earthquake (return period of 2475 years).
- Each return period is associated with a different level of probabilistic ground motions. In general, the MRDC requires all surface structures (other than bridges) to be designed to IBC/CBC DBE level motions. In some instances, the MRDC (cl 5.5.3) requires these surface

structures to be designed considering ODE and MDE actions rather than DBE and may lead to overly onerous structural design.

3.3.5 Architectural

Section 6 of the MRDC provides architectural requirements and specifications for Metro rail stations and facilities. Requirements related to Metro's stations include area requirements, design of platforms, amenities, artwork, signage, advertising, landscaping, platform access, and guidelines for the selection of materials and finishes. Also included are the General guidelines for the design of Kiss and Ride/Park and Ride facilities, station, and ancillary facilities.

Building codes, regulations and criteria relevant to Metro Rail stations and facilities include FTA Access Board's Americans with Disabilities Act Accessibility Guidelines (ADAAG), California CCR Title 8, 19, 24, American National Standards Institute, Inc. (ANSI), California Building Code, LA City Building Code and Fire Code, LA County Building Code and Fire Code, and NFPA 101 and 130. Other guidelines included in the Architectural section pertain to station uniformity across all Metro Rail Stations related to station control, advertising, signage, and artwork. There are few, if any, comparable requirements from the SEG Line Cities Criteria for this high-level analysis. In the absence of such criteria, the architectural design should be governed by the MRDC.

3.3.6 Electrical

Section 7 of the MRDC provides requirements for the design of electrical systems in fixed facilities for Metro Heavy and Light Rail Transit systems, including, but not limited to, underground structures, tunnels, at-grade and elevated structures. Electrical system design also includes guideways, train control signal houses/bungalows, and enclosures, parking structures, and parking lots, but excludes electrical traction power for the operation of the train. The aim for the analysis was to identify key design variances between the MRDC and the SEG Line Cities Criteria. In the absence of relevant design criteria from the SEG Line Cities, the design for electrical systems in fixed facilities for Metro Heavy and Light Rail Transit shall be governed by the MRDC.

3.3.7 Mechanical

Section 8 of the MRDC provides design criteria for the design of heating, ventilating, and air-conditioning (HVAC) systems for both above ground and underground stations and tunnels. These include systems for platform exhaust, concourse exhaust, emergency ventilation, and HVAC systems for ancillary spaces. Typical application of these systems in enclosed stations or tunnels are largely governed by local and state building codes, mechanical codes, plumbing codes, and fire codes. In the absence of any City, County, or State code, other national codes from the American National Standards Institute, the American Society of Testing and Materials, or the National Fire Protection Association should be followed. There are few, if any, comparable requirements from the SEG Line Cities Criteria for this high-level analysis. In the absence of such criteria, the mechanical design should be governed by the MRDC.

3.3.8 System

Section 9 of the MRDC provides design criteria for the design of systems for rail operations, including fair collection, train control, communications, security, emergency detection, and traction power distribution. Typical application of these systems are largely governed by local and state building codes, mechanical codes, plumbing codes, and fire codes. In the absence of any City, County, or State code, other national codes from the American National Standards Institute, the American Society of Testing and Materials, or the National Fire Protection

Association should be followed. There are few, if any, comparable requirements from the SEG Line Cities Criteria for this high-level analysis. In the absence of such criteria, the systems design should be governed by the MRDC.

3.3.9 Operations

Section 10 of the MRDC provides design criteria for the design of basic systemwide operating and maintenance criteria established for LACMTA projects. There are few, if any, comparable requirements from the SEG Line Cities Criteria for this high-level analysis. In the absence of such criteria, the operations design should be governed by the MRDC.

3.3.10 Yards and Shops

Section 11 of the MRDC provides design criteria for the design of rail operations for a particular rail line or as a systemwide facility. There are few, if any, comparable requirements from the SEG Line Cities Criteria for this high-level analysis. In the absence of such criteria, the yards and shops design should be governed by the MRDC.

3.3.11 Safety Security Systems Assurance

Section 12 of the MRDC provides design criteria for the design of safety, systems assurance, and security issues. There are few, if any, comparable requirements from the SEG Line Cities Criteria for this high-level analysis. In the absence of such criteria, the safety security systems assurance design should be governed by the MRDC.

4 Conclusions

The Metro OIG in its periodic audit of construction change orders of rail projects has discovered some inconsistences between the MRDC and the design criteria of local AHJs. A unified design and construction standard, conformed from the MRDC and the criteria of the SEG Line Cities would be valuable to guide the development of the SGL construction contract and improve project delivery. The request from the OIG to the Mott MacDonald team was to perform the task at a high-level within a limited scope, schedule, and budget; therefore, our delivery approach matched this recommended level of effort accordingly and will serve as an initial study report to guide the future development of a unified design and construction standard.

4.1 General Alignment with SEG Line Cities Criteria

After review of the available documents for comparison and a high-level evaluation of these documents, the Mott MacDonald team provides the following insight.

- In general, the MRDC is in alignment with the available documents that makeup the SEG Line Cities' Criteria, which will govern the construction of the SGL light-rail project.
- The variances identified through this exercise are limited and if further detailed evaluation were to be performed, the variances would likely remain below 1%.

It should be noted that the MRDC is clearly written with the intent of avoiding conflicts with the criteria from local AHJs. This is evidenced by numerous instances within the MRDC stating the design shall conform to the requirements of the local AHJ and adhere to the most stringent criteria when there is a conflict with the MRDC. The MRDC thus serves as a supplement to the requirements of the local AHJ when none are provided.

4.2 Conflicting Criteria

Our high-level analysis identified many parts of the MRDC that are not addressed within the SEG Line Cities Criteria and in the absence of such criteria, the requirements within the MRDC should govern. Notable conflicts with relevant criteria to the SEG Line Cities have been included in Part 3 of this report. The MRDC provides clear instruction about how to resolve these conflicts, although the inclusion of outdated criteria may cause confusion to designers that results in costly change orders for LACMTA projects.

4.3 Overly Stringent Criteria

The resolution of conflicting requirements within the MRDC with the SEG Line Cities Criteria can also result in overly stringent criteria. This occurs because the MRDC requires conformance with the most stringent criteria when there is a conflict, which is a conservative approach that provides clear guidance on how to resolve conflicts. Here again, the inclusion of outdated criteria in the MRDC has resulted in more stringent criteria than local AHJs, as shown in Part 3 of this report, with cost implications for LACMTA projects.

5 Recommendations

The MRDC includes excerpts of criteria that were the basis for development of the MRDC. These excerpts are helpful guidance when no criteria exist from the SEG Line Cities. Unfortunately, the criteria within the MRDC have not been updated at the same frequency as criteria from the SEG Line Cities. This has resulted in the inclusion of outdated criteria within the MRDC that conflicts or provides more stringent criteria than the SEG Line Cities. Both outcomes have cost implications for LACMTA projects.

5.1 Update Excerpts of Reference Criteria

The Mott MacDonald team recommends that outdated excerpts of criteria be updated and to include references to the governing criteria that form the basis of the MRDC. Currently, most sections within the MRDC include a list of references that are the basis of the criteria but there is no link to these references and the body of the MRDC that contains the criteria itself. This leaves no way to determine what reference is the basis of individual criteria. Cues could be taken from academic research papers that provide MLA type references within the body of a report with an accompanying bibliography. It should be clearly noted that newer versions of the reference criteria, published prior to the start of notice to proceed (NTP) with final design, shall govern. Any updates to referenced criteria after NTP should be discussed with LACMTA.

5.2 Link Performance Criteria to Prescriptive Criteria

The Mott MacDonald team also recommends linking performance criteria to prescriptive criteria. A good example of this are the requirements within the MRDC related to curb return radii, shown in Part E of Section 3.7.3 below:

E. Curb Return Radii

City of Los Angeles	*25’*
Los Angeles Co. Master Plan Hwy.	*35’*
Other Los Angeles Co.	*25’*

In this case, geometric considerations, like road classification, the governing design vehicle, or the design speed, and other performance criteria like site characteristics are provided in Part A and might be overlooked when applying the requirements in Part E.

5.3 A Unified Design and Construction Standard

Ultimately, the resolution of conflicting and overly stringent criteria will require a unified design and construction standard, conformed from the MRDC and the SEG Line Cities Criteria. The analysis by the Mott MacDonald team should serve as an initial study report to guide the future development of this standard as revision and amendments to the MRDC will require further analysis. The MRDC update and adoption needs to align closely with the SEG Line Cities Criteria and Metro will need to establish an acceptable revision and adoption schedule of the MRDC prior to issuance of the final design and construction contract of the SGL project.

6 Discussion

6.1 Governance and Project Delivery

Ideally, the SGL project delivered under an updated MRDC should meet nearly all the technical design criteria of the SEG Line Cities; therefore, this provides an opportunity for Metro to explore different governance models. The City of Los Angeles currently has a Master Cooperative Agreement with Metro that could serve as a model for agreements with the SEG Line Cities. “The MCA is intended to establish City and LACMTA obligations, roles and responsibilities, and processes and procedures to support the efficient, timely and safe delivery of LACMTA's Transportation Projects.” The MCA with the City of Los Angeles also establishes a “Special Permitting Process” that is utilized to, “expedite City’s review of work performed by LACMTA in the public rights-of-way.” More progressive MCAs with the SEG Line Cities could consider self-permitting when there is significant agreement between the MRDC and the criteria from local AHJs This would help streamline jurisdictional coordination and ensure all stakeholders work effectively to deliver projects successfully. SEG Line Cities would still maintain a primary role in the enforcement of environmental regulations, like limitations on noise, access control, and work hour restrictions.

6.2 Self-permitting Authority

Transit agencies like Metro often seek self-governance because permitting requirements from local AHJs introduce additional costs and schedule delays. In a recent memo to the Sound Transit Executive Committee in Seattle, a Technical Advisory Group noted that AHJs use the entitlement and permitting process to require improvements beyond the core project scope and sometimes beyond what appears to be reasonable. As the permitting process takes place through the final design and construction phases, the specific issues that arise from more detailed designs submitted for permit cannot always be known at the time of environmental review or even at the Project Baseline milestone. In these circumstances, project teams find themselves in a position where if permit design information does not include an AHJ’s desired request, submittals may not be accepted. These betterment requests are often contentious and policy on scope control and escalation paths when disagreements occur are often unclear or applied inconsistently across projects. What is clear is that AHJs are granted deference in interpreting their own codes and the burden is on transit agencies to prove otherwise.[01]

Any future MCAs between LCMTA and the SEG Line Cities should consider self-permitting for those items that are consistent, without exception, between the MRDC and the criteria of local AHJ’s. Discussion and resolution of betterment requests should be negotiated up front and with more equal bargaining power. This approach would still involve AHJ outreach and participation from community stakeholders to ensure public support and commercial awareness of impacts to local businesses. A unified design and construction standard between the MRDC and the criteria of the SEG Line Cities has the potential to streamline jurisdictional coordination and ensure all stakeholders work effectively to deliver projects successfully.

01 Moises Gutierrez, Regarding TAG Recommendation #5: Strengthen and enforce an agency betterment policy, Sound Transit Authority, 2024

Appendix A1

MOTT MACDONALD

Rev 01.1 05/06/2024

Southeast Gateway Line - MRDC vs SEG Line Cities Criteria

Metro

Disclaimer:

1. See companion report explaining methodology for comparison of relevant criteria
2. For the purposes of this high-level analysis, the "SEG Line Cities" criteria includes the Standard Specifications for Public Works Construction (Greenbook), the Standard Plans for Public Works Construction, and the Los Angeles County Standard Plans
3. All performance criteria within the MRDC that were not linked to prescriptive criteria within contractor control (i.e. containing numerical measurements or material specifications) were assumed to have no conflict with SEG Line Cities Criteria

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
				No Exception= NE Exception = EX												Specs & Plans
ID	TYPE	SECTION	DESCRIPTION	LOS ANGELES	HUNTINGTON PARK	BELL	CUDAHY	DOWNEY	SOUTH GATE	PARAMOUNT	BELLFLOWER	CERITOS	ARTESIA	VERNON	VARIANCE	DOCUMENT/SECTION
333	Prescriptive Spec		Curb Return Radius: City of Los Angeles - 25'	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
334	Prescriptive Spec		Curb Return Radius: Los Angeles Co. Master Plan Highway - 35'	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
335	Prescriptive Spec		Curb Return Radius: Other Los Angeles County - 25'	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
336	Prescriptive Spec		Curb Return Radius: Parking areas - 15'	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
337	Prescriptive Spec		Cross Slope: Concrete and asphalt concrete pavement roads: 2%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
338	Prescriptive Spec		Cross Slope: Aggregate surface pavement: 3%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
339	Prescriptive Spec		Cross Slope: Concrete and asphalt concrete pavement roads: 2%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
340	Prescriptive Spec		Close Slope Parking areas: 1% min. 6% Max.	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
342	Prescriptive Spec		Sidewalk: Minimum slopes shall be 0.5%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
388	Prescriptive Spec	1	Subject to local jurisdiction approval, street trees may be replaced on and one-for-one basis with 36" box standard. The tree species shall be designated by the local jurisdiction. Tree location shall be coordinated with the location of other sidewalk features, such as streetlights, fire hydrants, station appurtenances, and underground utilities and basements.	EX												Los Angeles: BSS
400	Prescriptive Spec		Main storm drains	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
401	Prescriptive Spec		Parking lots	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
402	Prescriptive Spec		All longitudinal drains or subdrains that could flood the roadbed	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
405	Prescriptive Spec		All other areas	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
412	Prescriptive Spec		Subdrains: -0.5%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
413	Prescriptive Spec		Laterals: -0.5%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
414	Prescriptive Spec		Main Collectors: -0.5%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
415	Prescriptive Spec		Ditches: -0.5%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
421	Prescriptive Spec	2	Materials: All underground storm drains shall be reinforced concrete pipe (RCP). RCP located in track R.O.W. shall be provided with cathodic protection as necessary. High Density Polyethylene Pipe (HDPE) and Polyvinyl Chloride Pipe (PVC) may be used where its use is approved by the governing agency. Drain connections in structural walls and floors shall be Ductile Iron Pipe (DIP). Steel pipe shall not be used in the permanent underground drainage system.	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
450	Standard Criteria	D3b	Parallel-to-Curb Bus Bays: Parallel to curb base shall have 10-foot-widelanes and a length of 80 feet.	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	•LA - Bus pad length 120', B4807 •All other cities = greenbook, Length = 85'	LA city std plans greenbook
476	Standard Criteria	F	Curb Returns Parking Lots and Areas 1. For cabs, 20 feet (Inside Radius) 2. For buses, 30 feet minimum (inside radius), 50 foot minimum (outside radius clear). 3. For passenger cars 15.3 feet minimum (inside radius), 25.8' minimum (outside radius clear).	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	LA City Complete streets Guide Bus/Transit = 25' LA County Std 1130-1 = 17' min	

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478	Prescriptive Spec	H	Curbs and Gutters All Transit Property streets and parking lots shall have curbs and gutters. Curbs shall be 6-inch-high, barrier-type, with sloping face of 1 inch horizontal to 6 inches vertical. Gutters shall be 24 inches, sloped to roadway or parking lot cross-slope and grade. Curbs and gutters shall be cast-in-place Class A concrete, and shall be in compliance with City or Public Work Construction standard plans.	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	LA City, S-410-2, curb face batter 1-1/2 : 12 Greenbook 2021, 120-3, curb face batter 3:12	
1341	Prescriptive Spec		In order to meet the objectives of MRDC SSDC requirements for surface structures; for ODE level the response modification factor (R), and importance factor (Ie) shall be 1.0, and for MDE level the structures shall be treated as Category III risk buildings as defined in CBC (Ie = 1.25 and R = per CBC).	EX												

Appendix A2

MOTT MACDONALD

Rev 01.1 05/06/2024

Southeast Gateway Line - MRDC vs SEG Line Cities Criteria

Metro

Disclaimer:

1. See companion report explaining methodology for comparison of relevant criteria
2. For the purposes of this high-level analysis, the "SEG Line Cities" criteria includes the Standard Specifications for Public Works Construction (Greenbook), the Standard Plans for Public Works Construction, and the Los Angeles County Standard Plans
3. All performance criteria within the MRDC that were not linked to prescriptive criteria within contractor control (i.e. containing numerical measurements or material specifications) were assumed to have no conflict with SEG Line Cities Criteria

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		NA	FIRE LIFE SAFETY													
		1.0	GENERAL													
		2.0	STATION FACILITIES													
		3.0	GUIDEWAY FACILITIES													
		4.0	PASSENGER VEHICLE													
		5.0	VEHICLE YARD AND MAINTENANCE FACILITIES													
		6.0	SYSTEM FIRE/LIFE SAFETY FACILITIES													
		7.0	COMMUNICATIONS													
		8.0	RAIL OPERATIONS CONTROL (ROC)													
		9.0	INSPECTION, MAINTENANCE, AND TRAINING													
		1	GENERAL													
		1.1	INTRODUCTION													
		1.2	APPLICATION OF THE CRITERIA													
		1.3	METRO RAIL GENERAL CHARACTERISTICS													
		1.4	LAND USE													
		1.5	ENVIRONMENTAL CONSIDERATIONS													
		2	ENVIRONMENTAL CONSIDERATIONS													
		2.1	INTRODUCTION													
		2.1.1	Objective													
1	Performance Criteria		All Metro Projects covered by the Metro Rail Design Criteria (MRDC) shall be designed to be in compliance with Federal, State and local environmental regulations and law. These requirements are also stated within the approved project specific environmental documents and mitigations, as mandatory requirements for design. The designer shall consider the unique environmental conditions of Los Angeles County and the targets and measures outlined in Metro's board approved Moving Beyond Sustainability (MBS) Strategic Plan and Climate Action and Adaptation Plan (CAAP). This section establishes minimum design criteria to minimize the level of adverse effects to the environment by Metro Projects.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.2	Scope													
2	Definition		This section establishes the Environmental compliance requirements for all Metro Projects during construction and operational phases. Note that construction phase requirements are detailed in Metro's Division 1 General Conditions and Specifications.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.3	Codes and Standards													
3	Performance Criteria		The designer will consider that Metro Projects shall comply with applicable and current local, State and Federal codes, ordinances and regulations, and applicable Federal Transit Administration (FTA) and American Public Transit Association (APTA) guidelines. Each Metro Rail Project shall undergo an environmental review process, which, as applicable, will be included in the project environmental compliance documents and will include mitigation measures to be taken for each Metro Project. All construction and operation mitigation measures will be stated in project environmental compliance documents.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
4	Performance Criteria		Where the requirements stipulated in this document, or any referenced source, are in conflict, the stricter requirement shall govern.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
5	Performance Criteria		Unless specifically noted otherwise herein, the latest edition of the code, regulation, and applicable standard shall be used for final design. If a new edition or amendment to a code, regulation or standard is issued before the design is completed, the design shall conform to the new requirement(s) to the extent practical or required by the governmental agency enforcing the code, regulation, or standard changed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
6	Definition		The following outlines California Green Building Standards Code (CALGreen).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
7	Standard Criteria		Metro projects shall comply with the following code standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.3.A	CALGreen Mandatory													

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8	Standard Criteria		• California Code of Regulations (CCR), Title 24, California Green Building Standards Code, Part 11 (CALGreen) as of the Notice to Proceed (NTP) date. • All occupied structures less than 10,000 square feet shall adhere to, at a minimum, applicable Mandatory CALGreen measures, as well as applicable local Green Building Code requirements. • All occupied structures 10,000 square feet or greater shall adhere to state level CALGreen Tier 2 Code requirements including Tier 2 Prerequisites and Electives. To satisfy CALGreen Tier 2 requirements, refer to the provisions in Section 301.3 and A5.601 for nonresidential new construction, additions and alterations scope and application. • Should compliance with these requirements be determined infeasible due to limitations in project scope, the designer/ contractor shall submit a formal written request for a variance to these requirements, including justification and documentation for review and approval by Metro Environmental Services Department (ESD).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.3.B	CALGreen Tier 2 - Prerequisite Requirements													
9	Standard Criteria		To achieve CALGreen Tier 2 status, the designer/contractor shall meet the CALGreen Prerequisites. See A5.602.2 CALGreen Verification Guidelines and Tier 2 Checklist	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.3.C	CALGreen Tier 2 – Elective Requirements													
10	Standard Criteria		In addition to complying with mandatory measures in CALGreen Chapter 5 for nonresidential structures and buildings, and CALGreen Tier 2 prerequisite measures, the project design and construction shall select additional elective measures from Appendix A5 Nonresidential Voluntary Measures as described in A5.602.2 CALGreen Verification Guidelines Tier 2 Checklist, based on project design features	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.3.D	CALGreen – Documentation Author's / Responsible Designer's Declaration Statement and Compliance Verification Checklist													
11	Standard Criteria		• All occupied structures less than 10,000 square feet, the designer/contractor shall provide as part of each design package submittal a completed A5.602 CALGreen Mandatory Verification Checklist, with signed Documentation Author's / Responsible Declaration Statement. • All occupied structures greater than 10,000 square feet, the designer/contractor shall provide as part of each design package submittal a completed A5.602.2 CALGreen Tier 2 Verification Checklist with signed Documentation Author's / Responsible Declaration Statement. • The designer shall sign the Documentation Author's / Responsible Designer's Declaration Statement and provide completed verification checklist. • The Designer's Declaration Statement attests to the accuracy and completeness of the CALGreen checklist and projects meeting either mandatory or Tier 2 design compliance based on structure size requirement	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.4	Metro Environmental Policies													
12	Performance Criteria		For Metro Projects, the designer shall consider as a minimum the following strategies to demonstrate its commitment to planning and constructing Metro projects, operating and maintaining Metro's facilities and vehicles, and procuring products and services consistent with State and Federal laws and regulations and in a manner that protects human health and the environment but not neglecting the efficient delivery of quality public transit services within our financial ability: • Comply with all environmental, Federal, State, and local laws and regulations • Avoid environmental degradation by minimizing releases to air, water, and land • Prevent pollution and conserve resources by reducing waste, reusing materials, recycling, and preferentially procuring for environmentally-friendly products and materials • Ensure that the planning, design, construction, and operation of our facilities and services consider environmental protection and sustainable features • Consider alternative energy solutions such as promoting and tapping renewable energy sources to address energy and environmental challenges Metro shall review the general metrics to be included in the design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.4.A	Metro Demolition and Construction Debris Recycling and Reuse Policy													
13	Performance Criteria		As it applies to this criteria, all Metro rail projects shall at a minimum: • Give preference to recyclable and recycled products in the selection of construction materials to the maximum extent feasible during design and construction of Metro or Metro-funded capital projects. Selected materials used in the construction of all structures related to transportation projects should not adversely affect the performance, safety or the environment of the transportation system for which the material is used	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.4.B	Metro Sustainability and Energy Policy													
14	Performance Criteria		As it applies to this criteria, all Metro rail projects shall at a minimum: • Aggressively pursue renewable energy sources, take advantage of rebates and subsidies for energy and water conservation, wherever feasible, and implement energy conservation measures wherever feasible and fiscally prudent.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
15	Performance Criteria		• Construct all new facilities and projects, including new transit corridor projects, using energy-efficiency and conservation strategies.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
16	Prescriptive Spec		• For occupied buildings or structures over 10,000 square feet, projects must be constructed to achieve Leadership in Energy and Environmental Design (LEED®) Silver certification. All new construction projects shall achieve 75% or greater of the available points for the Water Efficiency category of LEED® or the most applicable sustainable design or construction rating system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.4.C	Metro Water Conservation and Use Policy													
17	Performance Criteria		As it applies to this criteria, all Metro rail projects shall at a minimum: • Use water conservation and efficiency guidelines outlined in applicable Leadership in Energy and Environmental Design (LEED®) reference books for all planning, procurement, design, construction, operations, and maintenance of our linear and non-linear facilities. Manuals of operation should be developed considering cost-effective and maintainable water efficiency and conservation technologies.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.4.D	Metro Green Construction Policy													

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18	Performance Criteria		The designer or progressive design-builder shall adhere to the Metro Green Construction Policy.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.4.E	Metro Renewable Energy Policy													
19	Performance Criteria		If a renewable energy component is required in the project, the designer shall adhere to the Metro Renewable Energy Policy. In summary, the following aspects will have been addressed prior to the design: • Cost/Benefit Analysis • Environmental Benefit • Land Use Efficiency • Peak Shaving Benefit • Hedging Benefit	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.1.4.F	Metro Tree Policy													
20	Performance Criteria		The designer or progressive design-builder shall comply with all requirements in the Metro Tree Policy.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.2	ENVIRONMENTAL CONDITIONS IN LOS ANGELES COUNTY													
		2.2.1	General													
21	Performance Criteria		This subsection summarizes the environmental criteria to be considered and used for all Metro Projects. The designer shall consider the environmental criteria specific to Los Angeles County, specified in subsequent sections.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.2.2	Climate													
22	Performance Criteria		The greater Los Angeles area climate is considered to be mild in temperature and humidity, and is in a reverse wind area. The designer shall consider systems compatible with current and future ranges of temperature, humidity, precipitation, thunderstorms, and wind velocity, where applicable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.2.2.A	Ambient Temperature													
23	Prescriptive Spec		The designer shall consider the following temperature levels in the design. Highest recorded: 113ºF (City of Los Angeles) 121ºF (County of Los Angeles) Yearly average: 45ºF to 84ºF (depending on the month) Lowest recorded: 20ºF	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
24	Performance Criteria		Electrical systems shall be designed to operate within the ambient conditions in which the equipment is located, including if there is failure of the mechanical ventilation equipment. For additional criteria details, refer to Metro Rail Design Criteria (MRDC) Section 9 – System	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
25	Performance Criteria		In the future, highs in ambient temperature are expected to exceed 120 degrees for up to or longer than 6-week durations. Design shall consider an adaptive approach that assumes progressively increasing durations of higher-than-present temperatures for the purpose of safety and comfort of passengers (as well as structural and electrical components). Relatedly, the design shall be considered in the context of expected design life and refurbishment schedules of any given installation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
26	Performance Criteria		To address the changing climate and its impact on design, the designer shall design with consideration of future climate data (from sources such as CalAdapt, the California Heat Assessment Tool, or other reliable resources) in addition to historical data. For any individual data point, the designer shall use the most stringent/extreme value as the basis of design, while applying (and documenting those applied) the principles of adaptive design and management to reduce cost and over-design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.2.2.B	Humidity													
27	Prescriptive Spec		The designer shall consider the following humidity levels in the design: Minimum: 5% Maximum: 100%													
		2.2.2.C	Precipitation													
28	Prescriptive Spec		The designer shall consider the following precipitation levels in the design: 1. Design for protection against rainfall shall be based on 11" annual rainfall with a rate of 1" per hour. Design to address groundwater seepage and flow from adjacent locations on a project basis. 2. Design for stormwater quality protection best management practices (BMPs) shall be based on the greater of the following: • The 0.75-inch, 24-hour rain event, or • The 85th percentile, 24-hour rain event, as determined from the Los Angeles County 85th percentile precipitation isohyetal map (www.dpw.lacounty.gov/wrd/hydrologygis) 3. For subways, design shall be based on dripping water. Devices or equipment in subway segments shall be installed above level of walkway. 4. Equipment or components exposed to the weather shall be designed for or protected against: • Falling rain • Direct condensation • Flooding • Frost • Premature oxidation or deterioration of enclosures or components, especially due to acid rain (caused by the atmospheric pollutants). Coatings selected, whenever practical, shall be those with a proven service record in the Los Angeles basin. • Climate Change Considerations: Design shall consider an adaptive design approach assuming progressively increasing rainfall intensity and durations. Increasing ambient temperatures and extreme drought conditions shall also be considered. Designer will reference and adhere to the latest guidance by the National Weather Service and the American Society of Civil Engineers.													
		2.2.2.D	Thunderstorm Conditions													

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29	Performance Criteria		The designer shall consider the following thunderstorm conditions in the design: 1. Lightning protection of buildings or structures is not required since the project lies within a five-thunderstorm-days-per-year isokeraunic zone. 2. Open power supply lines and high voltage underground cables and communication lines shall be provided with properly coordinated lightning arrester	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.2.2.E	Wind Velocity													
30	Performance Criteria		The designer shall consider wind velocity conditions in the design and refer to Metro Rail Design Criteria (MRDC) Section 5 for wind load	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.2.3	Elevation													
31	Prescriptive Spec		Equipment must be capable of operating without compromising performance at elevations in the range of sea level (datum) to 3,300 feet.													
		2.2.4	Floodplain													
32	Definition		The area within which Metro plans to build the Metro Rail System has the potential for flooding by the Los Angeles River Basin, including the Sepulveda Basin, the Tujunga Wash, Santa Clara River and its associated creeks (Amargosa, Gavin Canyon, Towsley, Pico Canyon, DeWitt Canyon, Newhall, and Placerita Creeks) Ballona Creek, San Gabriel River, Rio Hondo and Arroyo Seco. Several of these drainage systems have been channelized by flood control projects. The potential Metro Rail alignments cross the Los Angeles River and several areas identified as flood hazard zones on the Flood Insurance Rate Maps of the Federal Emergency Management Agency's National Flood Insurance Program.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.2.5	Geology													
33	Definition		All pertinent soil data shall be as specified in the Geotechnical Baseline Report for the specific Metro Rail Project. Designer shall refer to site specific geotechnical investigation for more comprehensive information.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.2.6	Air Quality													
34	Performance Criteria		All facilities, equipment and components shall be capable of operating without detriment under ambient conditions with maximum recorded levels of pollutants. Designer shall consider and make clear that air pollutants produced by construction and operation of the system are subject to regulatory requirements by the Environmental Protection Agency (EPA), the California Air Resources Board (ARB), and the South Coast Air Quality Management District (SCAQMD). Criteria pollutants (i.e. carbon monoxide, ozone, particulate matter, volatile organic compounds), and hazardous air pollutants (i.e. benzene, formaldehyde, black carbon), and greenhouse gas emissions are subject to Federal, State and local regulations. Potential air emissions from a project shall be analyzed per California Environmental Quality Act (CEQA) / National Environmental Policy Act (NEPA), as required per project environmental clearance	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.3	TRAFFIC AND TRANSPORTATION													
35	Performance Criteria		The designer shall follow all environmental mitigation criteria pertaining to traffic and transportation, as appropriate. For additional traffic criteria, see Metro Rail Design Criteria (MRDC) Section 3, Civil Criteria. Traffic and transportation planning and design environmental features will have been included in planning requirements for the project and the designer shall implement any specific requirements in the design package	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.4	LAND USE AND DEVELOPMENT													
36	Performance Criteria		The designer will incorporate these land use and development aspects into the design for the project. Development that occurs in conjunction with Metro Rail Projects may produce changes in land uses adjacent to stations, particularly residential neighborhoods. The primary measure of impact is the compatibility of development expected to occur in conjunction with the Metro Rail Project with the type and intensity of development permitted by local plans, and existing conditions. For areas adjacent to rail stations, land use studies will have been completed during the planning phase by Metro. In these studies, the station's area of effect shall be determined (i.e. one-half mile rail) along with the condition and types of use. The studies shall reference and incorporate Sustainability and Urban Design Standards produced by APTA, including the most current Social and Economic Sustainability for Transit Agencies recommended practices (APTA, 2018). Designer will conform with CEQA, Los Angeles Department of Transportation (LADOT), and local agency guidelines regarding LADOT Transportation Assessment Guidelines, VMT Calculator, TDM Strategy, and Travel Demand Forecast. The designer will incorporate any associated land use studies into the design for the project.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
37	Performance Criteria		Designer will consider and implement Strategic Plan Goals of the Metro Equity Focus Communities. This includes helping Metro to target infrastructure and service investment towards those with the greatest needs and enhancing communities and lives through mobility and access.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
38	Performance Criteria		Potential redevelopment areas and parcels, which could be consolidated, shall be identified. The studies would provide a summary of percentage of land uses existing in the station area, such as mixed use, office, or commercial, densities, and amount of land which could be redeveloped. Recommendations would be made regarding the area's development during the planning phase by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.4.1	Project Goals													
39	Performance Criteria		The basic goal of the Metro project is to provide Metro rail users with the benefits of improved public transportation in a cost-effective, environmentally sensitive, attractive and socially responsible manner. The designer will always adhere to these project goals in the design and conduct of their contract obligations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.4.2	Urban Design Guidelines													
40	Performance Criteria	2.4.2.A	Build safe, sustainable communities by integrating transit service into existing or new neighborhoods and corridors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
41	Performance Criteria	2.4.2.B	Increase transit ridership by more effectively linking transit service with development.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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42	Performance Criteria	2.4.2.C	Improve transit efficiency by integrating transit service and investments with infrastructure improvements and land development consistent with Metro's Transit Oriented Communities (TOC) principles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
43	Performance Criteria	2.4.2.D	Improve transit access for pedestrians and bicyclists by providing high quality transfer areas and infrastructure in collaboration with neighborhoods and local jurisdictions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
44	Performance Criteria	2.4.2.E	Conserve natural resources by developing patterns and communities that require less land for development and reduce demand for fossil fuels to meet energy needs.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
45	Performance Criteria	2.4.2.F	The Metro system shall be designed, where possible and desirable, to stimulate urban development and redevelopment while avoiding drastic changes that disrupt the public commerce or social interaction. Positive changes such as street improvements shall be incorporated where there is opportunity to do so and where cost-sharing agreements can be made with the local jurisdiction. Property acquisitions shall be evaluated and adjusted as necessary to ensure the development potential of remainder properties (for both Metro and adjacent property owners. Subterranean and surface-level infrastructure shall be located and designed so as to preserve or enhance the development potential of surrounding property, including Metro-owned property for joint development.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
46	Performance Criteria	2.4.2.G	Displacement of buildings and public activity areas shall be minimized. Retail establishments shall be protected and mitigated from construction activities. Creation of physical barriers to land use functions and reduction in traffic circulation capacity shall be avoided to the extent it is practicable to do so.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
47	Performance Criteria	2.4.2.H	The project shall be implemented in such a way as to maintain consistency with local community, the City and regional land use plans, insofar as possible. Exceptions shall be coordinated with the appropriate authority having jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
48	Performance Criteria	2.4.2.I	The design shall consider the viewpoint of the user, the adjacent residential or business community, and the nearby pedestrian, motorist, or bicyclist. In this regard, the items of concern include: potential noise impacts and mitigation measures, historic preservation, visual intrusion, visual barriers, station access, continuity and transition of structures, separation of alignment, common system elements, and maintenance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
49	Performance Criteria	2.4.2.J	Historic properties whose physical and/or visual environments may be altered by the project are identified in the environmental compliance document, for example, the Final Environmental Impact Statement (FEIS/FEIR) as described in the Record of Decision. During construction, standard practices shall be employed to minimize the impact on these properties. As much as possible, trucks and other equipment will be routed away from historic properties. With regards to operational impact, standard methods of physical protection and photographic record keeping may be necessary. Photographic record keeping, if required, will document the properties' environments before startup of rail operations. The California State Historic Preservation Office (OHP), Federal Transit Administration (FTA), and Advisory Council on Historic Preservation (ACHP), as applicable shall be consulted regarding the mitigation measures to be employed at each affected site.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
50	Performance Criteria	2.4.2.K	The design shall minimize visual intrusion on public and private spaces. In addition, the design shall comply with the requirements presented in the environmental compliance document (e.g. FEIS/FEIR) on environmental related issues	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
51	Performance Criteria	2.4.2.L	Design of the Metro system shall be sensitive to the specific requirements pertinent to affected communities but consistent with the environmental compliance document FEIS/FEIR mitigations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
52	Performance Criteria	2.4.2.M	Metro's stations and visible infrastructure shall follow Metro's Systemwide Station Design Architectural Standards and Urban Design Best Practices, to ensure compatibility with surrounding urban context, but consistent with the environmental compliance document (e.g., FEIS/FEIR) mitigations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.4.3	Transit Parkway Definitions													
53	Performance Criteria		**Guideway:** Where the elements below are part of the advanced conceptual design for the project, the designer shall incorporate into the design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
54	Definition	2.4.3.A	**Bridges:** Aerial guideway structures that include the Light Rail Transit (LRT) or Heavy Rail Transit (HRT) trackways, walkways and systems facilities. Bridges may include center or side platform stations where aerial stations occur, stairs, elevators and escalators. A single or dual LRT or HRT trackway may be provided on the bridge structure. The trackway itself may include direct fixation, ballasted or embedded sections. Bridges include structures with columns, abutments, retaining walls or Mechanically Stabilized Earth (MSE) walls supporting the bridge structure. MSE walls used for the approach ramp to bridges may be landscaped or have other Transit Parkway Improvements. Bridges may also include long span bridge structures with abutments and no column or MSE wall support	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
55	Definition	2.4.3.B	**Street Restoration:** Street Restoration includes all existing street conditions along the alignment of the Project to be restored or improved due to the construction of the LRT or HRT Transit Parkway. This element includes restoration and improvements to adjacent streets outside the Right-of-Way (ROW) and also includes restoration and improvement work within the ROW at crossings and other locations. Street Restoration may accompany the implementation of the following: roadway alignment and reconstruction, at-grade LRT or HRT guideway alignment, bikeway and bicycle facilities implementation, utility relocation, bridge construction and other grade separation construction, location of grade crossings and pedestrian crossing features, street connections to parking facilities, landscaping, and other transit parkway improvements. The landscape element must not interfere with the safe and efficient operation of any Metro Rail Line (including maintenance issues, such as proximity to Overhead Catenary System [OCS] for Light Rail). Station area definitions may be used to group and describe the scope of Street Restoration work	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
56	Definition	2.4.3.C	**Sound Barriers:** Sound barriers are structures built as part of the Route alignment and Guideway of the Project to mitigate excessive noise	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
56	Definition	2.4.3.D	**Station Types:**	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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57	Definition	2.4.3.D.1	• **At-Grade Center Platform Station:** This station type allows trains to arrive, load and unload passengers at the same platform simultaneously from two directions. This station is designed to expedite transfers between trains, if needed, and also facilitates redirecting passengers to single track operating trains from the same platform. These stations would require a larger station site area to accommodate the platform, trackway, and other station features in an existing location, compared to an at-grade side and split platforms station	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
58	Definition	2.4.3.D.2	• **At-Grade Side Platform Station:** This station type allows trains to arrive, load and unload passengers only from one side of the platform. A minimum of two platforms are required at a station location to accommodate train service in opposite directions using a double track alignment. There are two types of side platform stations: At-grade side opposing and at-grade side and split platform. At-grade side opposing stations would allow trains to arrive, load and unload from opposite directions simultaneously, directly opposite each other. At-grade side and split platform stations allow for trains to arrive at platforms located typically on either side of a crossing. Side and split platforms would allow for vehicles to make a left turn at a crossing. An at-grade side opposing platform station may require a wider ROW to accommodate two platforms without changing the trackway alignment to accommodate the station. An at-grade side and split platform station requires the least ROW width to accommodate two platforms; however, it will require a longer station site area to accommodate a duplicate of all station features on both platforms	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
59	Definition	2.4.3.D.3	• **Aerial Center Platform Station:** This station type has platform features similar to an at-grade center platform station; however, this station type is located on a bridge or aerial structure	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
58	Definition	2.4.3.E	**First/Last Mile (FLM):** Infrastructure, systems, and modes of travel used by transit riders to start or end their transit trips. This includes, but is not limited to, infrastructure for walking, biking, and rolling (e.g., bike lanes, bike parking, sidewalks, and crosswalks), shared use services (e.g., bike share and car share), facilities for making modal connections (e.g., kiss and ride and bus/rail interface), signage and wayfinding, and information and technology that eases travel (e.g. information kiosks and mobile apps). Current Metro policy calls for FLMfirst/last mile components to be included as part of the scope of all transit projects. Improvements will be planned and designed consistent with the Metro FLMFirst/Last Mile Strategic Plan and Planning Guidelines adopted in April 2014, Metro FLM Guidelines adopted in May 2021, and other applicable guidelines.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
59	Definition	2.4.3.F	**Project Boundary**: The physical boundary of the rail transit project. All elements inside the project boundary are considered part of the transit project and delivery of these elements are Metro's responsibility. All improvements outside of the project boundary are considered projects for delivery by local agencies.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
60	Definition	2.4.3.G	**Seamless:** Refers to continuous, uninterrupted, and consistent active transportation or FLM streetscape elements on either side of the project boundary. Examples of seamless streetscape elements include, but are not limited to, sidewalks, street lighting, and street trees that do not start, stop or abruptly change their form or function at the project boundary	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
61	Definition	2.4.3.H	**Transit and Car Sharing Facilities:** If provided, shall be consistent with existing industry accepted best practices for such infrastructures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
62	Definition	2.4.3.I.1	**Transit Center:** Transit Centers are bus transit facilities located at LRT or HRT stations. Transit Center facilities allow for the transfer of passengers from bus transit to another mode, facilitating circulation flow for bus vehicles and organize passenger movements in a comfortable, and convenient manner. Transit Centers also provide information on transfers to LRT or HRT and to other buses using the Transit Center and the destination adjacent or surrounding the station area, where the Transit Center is located. There are two types of Transit Centers: On-street or Off-street Transit Centers. • On-Street Transit Center: Serves a high level of bus activity including Metro Rapid, Metro Local, City, or Other Service Provider and community-based operations • On-street customer service is primarily on-street bus service layover facilities. • Accessed by bus transfer, drop-off, walking and bicycle • May include shared park-and-ride opportunities in some locations, and maybe taxi waiting areas. • May be located adjacent to transit-oriented retail and or mixed-use development. • Customer services and amenities may include: service identity, signage, service maps timetables, lighting, seating, and phones, public art, neighborhood area maps/information, Ticket vending machines, real-time service information, "Next Bus" display Variable Message Sign (VMS), bicycle racks (part of Gateway and Neighborhood Station), sidewalk intersection paving improvements for pedestrian and American Disabilities Act (ADA) access and safety.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
63	Definition	2.4.3.I.2	**Off-Street Transit Center:** Serves Metro Rail and/or the interface of two Metro Rapid lines along with Metro, Local, Municipal Operator, Other Service Providers and community-based services; along with limited and express services where appropriate:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
64	Definition		May include a combination of on-and-off-street customer service and bus service/layover.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
65	Definition		May include some operational support facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
66	Definition		Accessed by full range of modes, rail, bus transfer, auto, drop-off, walking and bicycle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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67	Definition		May include shared or transit-only park-and-ride facilities, taxi waiting zones, located adjacent to transit-oriented retail and or mixed-use development, may be integrated with on-site development.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
68	Performance Criteria	2.4.3.I.3	**Customer service and amenities:** will include (See applicable MRDC Sections for details on the following)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
69	Performance Criteria		Service identity, signage, canopy, service maps/timetables, and a neighborhood area map/information	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
70	Performance Criteria		Ticket vending machines, lighting, seating, phones and bicycle racks and lockers	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
71	Performance Criteria		Sidewalk/intersection paving improvements, access and pedestrian safety features	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
72	Performance Criteria		Communication system, VMS to provide real-time travel, or delay information, Closed-Circuit Television (CCTV) cameras, security speaker telephones in case of an emergency, signage and graphics	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
73	Performance Criteria	2.4.3.J	**Stations:** Designs shall align with Metro's Systemwide Station Design Standards as contained in Section 6 of the MRDC and the Architectural Standard / Directive Drawings. Provisions shall be made for Electric Vehicle Supply Equipment (EVSE) when parking facilities are included in design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
74	Definition	2.4.3.K	**Bicycle Linkages:** Bicycle use can provide the short distance connection between origins and destinations. Bicycle linkages integrate on-street bicycle infrastructure with the transit. Improvements should include station design and bicycle parking. Examples of bicycle linkages are wide curb lanes, bicycle lanes or bicycle paths, directional signage, lighting, security, signal and crosswalk treatments. Bicycle Linkages will be planned as part of the transit project, consistent with FLMFirst/Last Mile policy, and other applicable guidelines. Maintaining consistency with First-Last Mile (FLM) and FTA policies y (FTA, 2011), as applicable, three-mile bike sheds shall define thresholds of the planning pathway in any given station area.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
75	Definition	2.4.3.L	**Pedestrian Linkages:** Pedestrian Linkages integrate the landscaping, public art, and other transit parkway improvements together with station program guidelines to connect develop linkages from the station to the surrounding area. within two station area zones: the station site area and station vicinity. Pedestrian linkages include streetscape improvements to station site areas across from the station platforms. These linkages may typically include and not be limited to street trees, information way-finding, kiosks, benches, lighting, sidewalk treatments and enhanced crosswalks. Typically include improvements to the sidewalk and street across and adjacent to the ROW. Pedestrian linkages may include additional ROW and opportunities for future enhancements at surrounding parcels or in the station influence area. Pedestrian linkages Bicycle Linkages will be planned as part of the transit project, consistent with the FLMFirst/Last Mile policy, and other applicable guidelines. Maintaining consistency with First-Last Mile (FLM) and FTA (FTA, 2011) policies, as applicable, one-half mile walksheds shall define thresholds of the planning pathway in any given station area.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.4.3.M	**Station Area Definitions:**													
76	Definition		**The Station Site:** Is the land area centered on the station, extending approximately 200 to 300 feet from each station, and lying within the Metro owned ROW or on-street within a local jurisdiction. The Station Site may include additional ROW, to include parking or to reach a major cross-street, or it may include adjacent property which Metro is considering acquiring. The Station Site area willwould contain the best level of streetscape and station amenities. Station entrances willwould occur within this zone. Station entrances willwould be located away from direct visual access to residential areas. Station entrances willwould open onto arterial or local streets, using pedestrian medians and sidewalks as pedestrian linkages and buffers from the station entrance to the Station Site area. Station entrances for aerial stations located on bridges would be located away from direct visual access to residential areas. Drop-off areas would be located within this zone. It willwould be located near station entrances away from adjacent residential areas. The driveways to all parking facilities located within this zone will not face residential areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
77	Definition		**Station Vicinity:** Is defined as adjacent land area which has a direct physical relationship with the station site. Typically, this adjacent area will extend perpendicular from the station site roughly one block, approximately 300 to 600 feet. The area of extension may reach out further at major cross-streets, and less where a wall or other barrier limits adjacent physical relationships. The key physical relationships are: 1) land use of adjacent buildings and property, 2) visual relationships with respect to massing, building height, shading, and sight lines both for existing buildings and the station structure itself, and 3) circulation relationships with respect to paths for pedestrians, transit users, intermodal, bicyclists, and motorists. The Station Vicinity area would contain a less intensive level of streetscape amenities than the Station Site area. The designer shall seek approval for the reduced level from Metro. Station entrances would be located away from direct visual access to residential areas. Drop-off areas would be located near station entrances away from adjacent residential areas. Driveways to all Parking Facilities located within this zone may not face residential areas. Parking Facilities located within this zone will provide proper screening from adjacent uses. Provisions shall be made for Electric Vehicle Supply Equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
78	Definition		**Station Influence Area:** Is defined as the land area within approximately a one-halfmile radius from the station whose street pattern, land use, demographics, topography, transit service, and other factors may directly or indirectly influence the design of the station area.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.5	LAND ACQUISITION AND RELOCATION													

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79	Performance Criteria		The designer shall consider environmental conditions of any land acquired by Metro, which may include contamination, unexpected ground conditions, easements, or other property considerations. When a project requires the acquisition of land, Metro acquires the required property interest and, in the event the land is occupied, will assure the relocation of all tenants and/or businesses under the requirements of the Uniform Relocation Act.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
80	Definition		The ROW is the composite of total requirements of all interests and uses or real property needed to construct, maintain, protect, and operate the transit system, including tunnels and land on either side of the tracks for street-level or aerial sections. Metro will either acquire the necessary property rights for the project which include full takes, part-takes, subsurface easements, permanent easements or temporary easements. Property rights required for a project are identified in the Environmental Impact Report (EIR) and Environmental Impact Statement (/EIS), or any required Supplemental EIR/EIS document, and those are the property rights that will be acquired.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
81	Performance Criteria		A Phase 1 and, if required, a Phase 2 environmental site assessment is conducted on all properties identified for acquisition. It is preferred that the property to be acquired not include any with contaminated structures, soil or groundwater, but at times that cannot be avoided. The designer shall consider the extent of contamination identified in relevant investigations in the site information for the project. The designer will seek guidance from ESD on potential properties requiring further investigation and make recommendations to reduce the potential for unforeseen conditions during construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
82	Performance Criteria		Full and partial acquisition of parcels would be necessary for ROW requirements of the project. Easements, which are interests in land owned by another that entitles its holder to a specific limited use, may be necessary for both construction and the underground alignment. Temporary construction easements may be necessary for construction sites and permanent underground easements would be required for the alignment to pass under private property. When the construction of the Metro Rail Projects would directly displace residents, homes, businesses, social services and public facilities, they would be entitled to receive financial assistance as prescribed under the Uniform Relocation Act	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.6	**AESTHETICS/URBAN DESIGN**													
83	Performance Criteria		The designer shall follow the criteria below to properly consider aesthetics/urban design considerations in Metro projects.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.6.1	Guideways													
84	Performance Criteria		Aerial guideway sections should be designed to be slim, not bulky, and visually attractive. As part of final design activities, guideway materials and surface textures shall be selected in accordance with generally accepted architectural principles in collaboration with project stakeholders, to achieve an effective integration between the guideway and its surrounding environment. Landscaping shall also be used, as appropriate, to achieve this integration.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.6.2	Visual Clutter													
85	Performance Criteria		When alignments are aerial or at-grade, the existing and proposed overhead power lines could result in visual clutter, in the context of the surrounding environment. To minimize this, such overhead lines shall be consolidated where feasible. Design should consider least interference from these elements consistent with safe and efficient Rail System Operations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
86	Performance Criteria		With specific regard to the visual treatment of aboveground traction power substations (TPSS), the following criteria shall apply. Landscaping shall be used to screen the TPSS from sensitive adjacent land uses, such as residential areas and, if possible, from the guideway. Lighting and security equipment shall be located so as not to be visible from adjacent sensitive land uses. The substations shall be designed to be architecturally compatible with their surroundings and blend into the urban or natural environment. A wall shall be constructed around the TPSS in sensitive areas, when necessary. Local ordinances for screening shall be followed. Where possible, every effort should be made to integrate a TPSS into a larger structure in the central business districts	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.6.3	Art and Design													
87	Performance Criteria		Art and design shall be integral to all Metro Rail projects. Projects shall be designed to have well lit, uncluttered public areas with integrated signage and artwork, making them safe, accessible, spacious and responsive to their transit sites. Intuitive wayfinding, and signage consistent with Metro Signage Standards and Design Directive Drawings, will aid riders in recognizing and navigating the overall Metro system. Project specific Art Programs shall be developed by, and executed through, Metro Art and Design, after thorough evaluation of stations, guideway and track elements, and support facilities (yards, shops, administration buildings, parking areas and other Project elements) for high-impact, art and design excellence approaches that knit the Project into the surrounding area and promote a sense of place. Additionally, artworks and signage may be utilized on construction fences, barriers, and other temporary applications to mitigate visual impacts and aid rider navigation during construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.6.4	Light and Glare													

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88	Performance Criteria		Lights are necessary for safety, security, and access; however, Llights used for construction and for operational lighting can illuminate adjacent properties in undesirable ways. Designs will follow the principle of keeping direct and reflected illumination or glare from the project from striking adjacent properties, where feasible and follow building codes related to light pollution. Design should consider least interference from these elements consistent with safe and efficient Rail System Operations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
89	Performance Criteria		Station plazas, parking lots, yard area and guideway lighting fixtures and standards shall incorporate directional shielding where needed, to avoid the intrusion of unwanted light and glare into adjacent sensitive land uses, such as residential.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.6.5	Trees and Vegetation													
90	Performance Criteria		For trees and vegetation, use Metro approved palette for the project ROWs including transit stops, parking lots, yards, and other open spaces to provide shading, improve air quality, water quality, carbon storage, and community health. Consider characteristics such as diurnal sun position, existing shading, reflected heat from concrete surfaces, and other important characteristics when placing landscape and hardscape as a shading device. Design shall adhere to the Metro Tree Policy.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.6.6	Shade Structures and Canopies													
91	Performance Criteria		Aerial structures and other above ground facilities can block views generated by existing vantage points and cast shade or shadows on adjacent land uses. Designs should consider adjusting building masses and placing them on parcel so that shade and shadow are minimized on adjacent parcels and viewscapes are not blocked. Design should consider least interference from these elements consistent with safe and efficient Rail System Operations. Use shade structures and canopies to provide shade and protection from severe weather days of extreme heat and heavy precipitation. Consider characteristics such as diurnal sun position, existing shading, reflected heat from concrete surfaces, and other important characteristics when placing shade structures and canopies. The designer's plan to reduce the impact of heat and glare on riders and operators will be submitted to ESD for review and approval	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7	**NOISE AND VIBRATION (OPERATION ONLY)**													
		2.7.1	General Information													
92	Performance Criteria		This section is intended to provide performance requirements for all noise and vibration control problems relating to the operation of the LRTight and HRTeavy Rail Transit system. Noise control during construction is covered in the Division 1 Construction Specifications. The designer shall incorporate performance requirements into its design. The basic goals of this performance specification are to:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
93	Performance Criteria	2.7.1.A	Provide transit system patrons with an acoustically comfortable environment by maintaining noise and vibration levels in vehicles along the way and in stations within acceptable limits.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
94	Performance Criteria	2.7.1.B	Minimize the adverse impact of system operation and construction on the community by controlling transmission of noise and vibration to adjacent properties.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
95	Performance Criteria	2.7.1.C	Provide reasonable and feasible noise and vibration control consistent with economic constraints	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
96	Performance Criteria	2.7.1.D	Design a rail transit system that controls airborne noise from transit train operations, transit ancillary areas and facilities such as yard operations, vent and fan shafts of the ventilation system, electrical substations, and emergency service buildings. The design should also provide for any required control of ground-borne noise and vibration from the transit vehicle operations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
97	Performance Criteria	2.7.1.E	Provide a satisfactory and comfortable acoustical environment for patrons in station areas using sound-absorbing materials on under-platform areas, platform level walls and ceilings, and the ceilings and walls of concourse areas for control of noise and reverberation in the station. Overall control of station noise also requires inclusion of maximum noise limits in equipment specifications.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
98	Performance Criteria	2.7.1.F	Ensure acoustic environment of a station contributes to the intelligibility of public address announcements and the overall passenger comfort. Station public address (PA) systems are essential to ensuring a safe and informed passenger experience for Metro customers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
99	Performance Criteria	2.7.1.G	In all cases, the designer shall seek approval from Metro on its noise mitigation measures and require the constructor to seek approval of its noise mitigation plan before implementation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7.2	Criteria for Wayside Noise													
100	Standard Criteria		The objective of the noise analysis is to determine a wayside community noise impact criterion to provide a basis to determine whether noise mitigation measures will be required to avoid significant impact to the project community. The designer shall consider the noise impact of all Metro projects in the context of the noise criteria outlined in this section. The wayside noise criteria are related to the type of activities normally taking place within a building or the community as a whole. The noise criteria are also related to the existing levels of ambient noise in the community as measured at 50 feet from the noise source (i.e. rail facilities), per FTA criteria. For example, rail vehicle noise would be more objectionable in a quiet residential area at night than in a busy commercial area during the day. Existing ambient noise levels should be established using the FTA methodology with Metro approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
101	Performance Criteria		The FTA Guidelines define three levels of noise assessment: Screening, General and Detailed. A Detailed Analysis is required for the engineering phase of a transit project. The Mitigation Monitoring and Reporting Plan (MMRP) will provide the required noise mitigation measures applicable to the project. These are derived from the General Noise Assessment completed during the Environmental Impact Report (EIR) and Environmental Impact Statement (EIS). Typically, one of the mitigation measures would require a detailed noise impact assessment be performed prior to the beginning of construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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102	Performance Criteria		A Detailed Analysis requires specific information of the Project's operational parameters and the transit vehicle noise emission characteristics. Specific information of the existing wayside, ambient noise environment, and the sensitivity of all buildings and land uses along the alignment which would be adversely affected are required. Once this information is available, a Detailed Analysis of the noise impacts can be performed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
103	Standard Criteria		For operational noise impacts, a Detailed Analysis determines the projected change in ambient noise due to the operation of the transit system along a new alignment following the methodology specified in the FTA Guidelines. The projected changes in ambient noise due to transit operations are compared with the criteria contained in the FTA Guidelines for fixed guideways.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7.3	Airborne Noise from Rail Operations													
104	Standard Criteria		The FTA "noise impact criteria are defined by two curves which allow increasing project noise levels as existing noise increases up to a point, beyond which impact is determined based on project noise alone." The two curves define three degrees of impact: No Impact, Impact, and Severe Impact. The three degrees of noise impact can also be presented in terms of the noise level increase as specified in the FTA Guidelines	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
105	Definition		The existing ambient noise environment and the Project noise are characterized by noise metrics which are based on noise exposure over a specific period of time. For residences and other buildings where people normally sleep, the noise metric is the day-night level or Ldn. The Ldn is a 24-hour noise level average with nighttime noise levels penalized by adding 10 decibels to the ambient noise level between the hours of 10 p.m. and 7 a.m. For other land uses, the hourly average noise level Leq(h) is the noise metric to be used. The Leq(h) to be used is for the noisiest hour of transit-related activity during hours of noise sensitivity	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
106	Standard Criteria		The FTA Guidelines specify which noise metric to use for different land use categories. This is specified in the FTA Guidelines (ibid.), and replicated in Table 2-1 herein (ibid., Table 3-2, page 3-5).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
107	Performance Criteria		All noise impact assessment is to be performed with respect to outdoor areas where there are noise sensitive land uses.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
108	Standard Criteria		The noise impact criteria for transit operations are summarized in a Table in the FTA Guidelines for the different land use categories. The first column shows the existing noise exposure, and the remaining columns show how much additional noise exposure from the transit project is necessary to cause either a moderate or severe impact.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
109	Standard Criteria		The future noise exposure would be the combination of the existing noise exposure and the additional noise exposure caused by the transit project. As the existing noise exposure increases, the amount of allowable increase in the noise exposure created by the project decreases.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
110	Performance Criteria		Future project noise levels that exceed the "severe impact" criteria will require noise mitigation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
111	Standard Criteria		At those land uses or noise sensitive sites, not considered during the environmental review process, where existing ambient noise levels have not been measured, performance requirements for a single train passby may be used. The FTA Guidelines provide performance requirements for single passby maximum noise levels for airborne noise from transit trains for typical community areas for specific types of buildings. These criteria are generally applicable at the nearside of the nearest dwelling or occupied building under consideration or at 50 ft. from the track centerline, whichever is closer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
112	Standard Criteria		For some types of buildings or occupancies, maximum noise level limits should be applied regardless of the community area. The design should reflect careful consideration of noise control when the transit line is near auditoriums, TV/movie/music recording studios, schools, day care centers, theaters, amphitheaters, and churches. Table 2-2 lists performance requirements for maximum airborne noise from "train" operations near specific types of buildings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7.4	Noise Mitigation Measures													
113	Performance Criteria		Metro requires that feasible and practical noise reduction measures be considered to mitigate a severe noise impact at a sensitive area or land use. The designer shall consider the noise mitigation measures outlined in this section. Feasible noise reduction measures that may be considered to mitigate an above-groundLRT or HRT noise impact are the installation of noise barriers within or outside the transit ROWright-of-way, as well as use of materials in the station to help reduce and control or maintain the noise ratio to a specified level.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
114	Standard Criteria		To determine the level of noise to be mitigated for all stations, an acoustical site survey shall be conducted. This survey will help the Employer of Record (EOR) and Agent of Record (AOR) to determine what materials and methods to use to achieve a comfortable noise level for all passengers and the surrounding neighborhoods.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
115	Prescriptive Spec		Metro requires that outdoor living areas be mitigated a minimum of 5 dBA or more for the noise barriers to be considered to be acoustically effective. Noise barriers providing less than 5 dBA reduction will not be considered a reasonable mitigation measure. The results of the survey shall be incorporated into the design by the designer.													
116	Performance Criteria		Additional guidelines to be considered in evaluating the feasibility of a noise barrier as a mitigating measure are: • The number of dwelling units benefited should be large enough such that the barrier cost per receptor makes the barrier reasonable; • The structural design of the barrier should be feasible; • The acceptance of a noise barrier and its aesthetic impacts will consider the input of impacted residents and neighboring groups, as well as customers of the transit station environment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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117	Performance Criteria		At locations where the use of noise barriers is not considered feasible or cost effective, sound insulation of indoor living areas will be considered for payment by Metro. Sound insulation measures will consist of improving the sound attenuation of the exterior wall construction of sleeping and living spaces to achieve an interior noise level criteria of Ldn = 45 dBA through any or all of the following measures: replacement windows, adding storm windows to existing windows, adding insulation to the exterior walls, and caulking and gasketing existing doors and windows. These measures are effective if the sleeping and living spaces have an air-conditioning or forced-air ventilation system, which incorporates an outside air intake, which allows occupants to keep doors and windows closed. If such a sys-temdoes not exist, then the sound insulation measures provided would include such a system for the sleeping and living spaces affected.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
118	Performance Criteria		The following noise mitigation measures will also be considered: • Wheel design measures, such as the use of resilient wheels and damped wheels to reduce rolling and squeal noises will be considered. • Operational restrictions, including speed reduction, reduction of nighttime operations, and minimization of warning horns and signals. Operational noises and wheel squeal noises during railcar testing and startup at the maintenance facilities shall be considered by the designer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7.5	Ground-Borne Noise Vibration Criteria													
119	Performance Criteria		The designer shall consider ground-borne noise and vibration from train operations, as well as track vibration isolation. Ground-borne noise and vibration are exactly the same phenomena, up to the point of perception at the dwelling. Ground-borne vibration describes waves in the ground, which can be measured using vibration pickups mounted on side-walks, foundations, basement walls, or stakes in the ground and which can be perceived as mechanical motion. Ground-borne noise describes sound generated when the same waves in the ground reach room surfaces in the buildings, causing them to vibrate and radiate sound waves into the room. Track isolation methods to reduce the noise and vibration of incoming trains shall be applied depending on the site requirements. An acoustic site survey shall be conducted per project, which will used by the EOR and AOR to determine the track isolation method to be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7.5.A	Ground-Borne Noise from Train Operations													
120	Standard Criteria		Table 2-3 presents the criteria for maximum ground-borne noise due to transit train operations for different category of land uses. As with airborne noise, there are some types of buildings for which specific performance requirement should be applied, regardless of area category. Table 2-4 presents performance requirements for generally acceptable levels of transient ground-borne noise levels in occupied spaces of various types of buildings and rooms. This table is intended to be a general guide.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7.5.B	Ground-Borne Vibration from Train Operations													
121	Standard Criteria		Table 2-3 presents the criteria for maximum ground vibration for different category of land uses. The criteria apply to measurements of vertical vibration of floor surfaces within the buildings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7.5.C	Track Vibration Isolation													
122	Performance Criteria		Above grade track systems or locations with critical isolation adjacencies shall incorporate resilient decoupling to attenuate vibrations transmitted to stations and surrounding structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
123	Standard Criteria		As with ground-borne noise, there are some types of buildings for which specific performance requirement for ground-borne vibration should be applied, regardless of area category. Table 2-4 presents performance requirements for ground-borne vibration levels in occupied spaces of various types of buildings and rooms. This table is intended to be a general guide. Any other structures would be evaluated on a site-specific basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
124	Standard Criteria		Ground-borne vibration meeting the performance requirements listed in Tables 2-3 and 2-4 will not be imperceptible in all cases; however, the level will be sufficiently low such that no significant intrusion or annoyance should occur. In most cases, there will be vibration from street traffic, other occupants of a building, or other sources that will create intrusion that is equal to or greater in level than the vibration from the transit trains.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7.6	Noise and Reverberation Time Control in Stations													
125	Performance Criteria		The purpose of this section is to define criteria which will result in a desirable acoustical environment in and around stations throughout the Metro Rail System. The designer shall consider the noise and reverberation requirements and objectives defined herein. The following objectives apply to transit stations: • Control and reduction of noise from transit vehicle operations; • Maximize the speech intelligibility from Public Address (PA) system announcements; • Control of noise generated by patrons and/or exterior sources; • Control of noise from station air handling equipment, vertical circulation equipment and any other station mechanical equipment; • Control noise levels to permit emergency communications	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
126	Standard Criteria		Table 2-5 summarizes the criteria for reverberation time and acoustic treatment of the various enclosed or partially enclosed areas of stations and the maximum mechanical noise levels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
127	Standard Criteria		Table 2-6 summarizes the speech intelligibility requirements of the public address (PA) system for the station maximum noise levels in Table 2-5 9: • 55 dBA Lmax for ancillary equipment background noise • 68 dBA Lmax for trains idling in the station • 80 dBA Lmax for trains entering and leaving the station on ballast and tie track • 85 dBA Lmax for trains entering and leaving the station on concrete trackbed	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
128	Prescriptive Spec		For underground or fully enclosed stations the goal is to achieve a maximum noise level of 55 dBA Lmax at any of the public areas from exterior noise sources.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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129	Performance Criteria		The noise levels inside stations are dependent on the design of the transit cars and station mechanical equipment and on the acoustic treatment in stations. The criteria and designs for the acoustic treatment consider the general architectural characteristics expected and the noise to be radiated by the transit cars and other noise sources.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
130	Standard Criteria		Table 2-9 defines the noise limits for trains entering and leaving the station and air handling equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
131	Prescriptive Spec		For at-grade or aerial stations, the goal is to achieve a noise level of Leq= 75 dBA or lower at the station platform from any exterior noise sources. The existing ambient noise levels at individual station locations should be measured during the noisiest traffic periods as part of the EIR/EIS process to determine if the one-hour peak noise level is higher than an Leq= 75 dBA. Noise levels higher than 75 dBA from nearby freeways or street traffic are of concern because of the potential interference with speech intelligibility of public address announcements, speech communication between riders, and phone communications. Achieving the goal of 75 dBA at the station platform through feasible and reasonable mitigation measures will depend on the existing noise level and the extent to which it exceeds 75 dBA.													
132	Prescriptive Spec		At those locations that exceed the 75 dBA goal, one or more of the following mitigation measures shall be provided: (1) noise barriers between the platform and roadway; (2) pedestrian shelters for outdoor waiting areas; (3) sound absorptive treatment of the underside of station canopies or bridge structures spanning the station platform; and (4) relocation of station platform or entrance locations.													
133	Prescriptive Spec		At those locations that exceed the 75 dBA goal, one or more of the following mitigation measures shall be provided: (1) noise barriers between the platform and roadway; (2) pedestrian shelters for outdoor waiting areas; (3) sound absorptive treatment of the underside of station canopies or bridge structures spanning the station platform; and (4) relocation of station platform or entrance locations.													
134	Performance Criteria		An analysis should be prepared to determine which measure or measures are most feasible. Noise barriers shall be the preferred solution, if determined feasible and effective.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
135	Performance Criteria		If applicable, sound wall barriers shall extend beyond the length of station platforms at freeway-adjacent stations to ensure noise stays below maximum allowable sound levels at the platform. Specific barrier dimensions are to be determined based on an acoustical study of each station and shall ensure clear visibility of security cameras and train operators. Alternating steel-clad panels with perforated sections of sound absorbing materials and transparent barrier walls are required when sound wall barriers are needed within the station public areas. The EOR shall conduct an acoustical site survey at the beginning phases of the project, to determine the height, width, thickness, and structural support needed for the barriers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
136	Prescriptive Spec		If achieving the goal of 75 dBA or lower at the station platform is not achieved after the implementation of mitigation measures, then alternate safety measures will be required to ensure that, under emergency conditions, public address announcements are communicated to and understood by all riders and emergency phone communication is possible from the station platform area. These measures would include the use of communication equipment designed for operation in a high noise level environment such as variable message sign (VMS) boards, emergency flashers and warning signals, and special phone equipment with amplified handsets or acoustical enclosures.													
		2.7.7	Noise Control in Stations													
137	Performance Criteria		The designer shall consider noise control measures in stations with specific areas and decibel ranges in mind.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7.7.A	Ancillary Areas													
138	Performance Criteria		Spaces for noisy ancillary equipment shall be located away from public spaces.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1	Prescriptive Spec		Noisy ancillary spaces opening directly to public spaces shall have sound-rated or double-entrance doors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
139	Performance Criteria		Acoustical treatment for each area listed below depends on location, type of noise, and occupancy. The areas to be considered are as follows: • Fan rooms • Pump rooms • Mechanical equipment rooms • Maintenance Building	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
139	Prescriptive Spec		Fan rooms, Pump rooms, and Mechanical equipment rooms, and maintenance buildings housing fans, pumps, and other equipment which generate sound levels of 85 dBA Lmax or higher at operator stations or 90 dBA Lmax or higher at any point 3 feet from the equipment shall have a ceiling sound absorption treatment with a minimum NRC of 0.70	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
140	Performance Criteria		Additional sound attenuation measures shall be required for noise-producing station ancillary areas that are adjacent to any public areas of the station or busy commercial areas/residences. These measures shall be analyzed, designed, and utilized per the decision of the EOR and AOR. If it is determined that extra measures will need to be taken for the adjacent ancillary areas, then the AOR and EOR shall conceal the sound attenuation from the public's view.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7.7.B	Platform Areas													
141	Prescriptive Spec		Sound absorbing materials shall be integrated into the overall design of the station and be concealed by acoustically transparent materials. Acoustic concrete and modular duct liner treatments shall be used to achieve high levels of acoustic absorption and support greater speech intelligibility from PA systems and help reduce noise buildup in stations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.7.7.C	Vertical Circulation Equipment													

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142	Prescriptive Spec		For all normal operating conditions for escalators and elevators located in public areas, the source noise level at 3 feet from the equipment shall not exceed 55 dBA Lmax for steady-state noise, and transient noise shall not exceed 60 dBA Lmax as measured using the fast meter response.													
143	Prescriptive Spec		Escalators. Noise produced by escalators operating individually in either direction under no load and maximum load in the station environment shall not exceed 55 dBA Lmax 5 feet above the tread at the entrance combs at both ends of the escalator.													
		2.8	AIR QUALITY													
144	Performance Criteria			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2.9	ENERGY													
		2.10	SURFACE AND SUBSURFACE CONDITIONS AND HAZARDOUS MATERIALS													
		2.11	HYDROLOGY, WATER QUALITY, AND WATER EFFICIENCY													
		2.12	BIOLOGICAL													
		2.13	CULTURAL RESOURCES													
		2.14	CLIMATE CHANGE AND ADAPTATION													
		3	CIVIL													
		3.3	UTILITIES													
		3.3.1	GENERAL													
145	Performance Criteria	3.3.1.A	These criteria govern the maintenance, support, restoration, and construction of utilities encountered by, or affected by, the construction. In the performance of work, due consideration shall be given to the needs of the transit system, the requirements and obligations of the utility organizations, traffic requirements, and the cooperative agreements between the Agencies or Companies and Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
146	Definition	3.3.1.A.1	Utilities comprise facilities belonging to governmental agencies other than Metro, Public Utility Corporations, and private parties, and include service lines to adjoining properties.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
147	Definition	3.3.1.A.2	Utilities encountered or close enough to be affected by transit construction may be:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
148	Performance Criteria	3.3.1.A.2.a	Supported and maintained complete in place during construction and continued in service following completion of the transit facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
149	Performance Criteria	3.3.1.A.2.b	Temporarily relocated and maintained; then, upon completion of transit facilities, replaced by new utilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
150	Performance Criteria	3.3.1.A.2.c	Permanently relocated beyond the immediate limits of transit construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
147	Performance Criteria	3.3.1.B	Utility service to abutting properties shall not be interrupted and, if temporarily relocated, shall be permanently restored to its prior location upon completion of work.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
148	Performance Criteria	3.3.1.C	Replacements for any existing utilities, including government facilities, and pavements shall be designed to provide service or capacity equal to that offered by the existing installations. Designer shall comply with local codes and standards of the agencies having jurisdiction. Unless specifically noted otherwise herein, the latest edition of the code, regulation, standard and standard plan that is applicable at the time the design is initiated, not when the bid is submitted nor the contract sign date shall be used. If a new edition or amendment to a code, regulation, standard or standard plan is issued before the design is completed, the Designer shall determine the impact of the change and seek Metro direction on how to proceed. Designer shall request Metro direction on current minimum standards to be used for design of replacement facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
149	Performance Criteria	3.3.1.D	Improvements to utilities shall not be included unless specifically directed by Metro	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
150	Performance Criteria	3.3.1.E	All designs involving maintenance, support, and relocation or other utility work shall conform to the applicable specifications, criteria, and standard drawings of the concerned corporations or agencies.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
151	Performance Criteria	3.3.1.F	Record elevations of all utilities shall be adjusted to project datum. Pertinent utility elevations and locations shall be checked by field survey, and, where critical to design, by digging test holes at locations approved by Metro. Designer shall request Metro direction on current minimum standards to be used for design of replacement facilities, and have direction and concurrence of the utility or agency affected.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
152	Performance Criteria	3.3.1.G	The Designer shall consider plans developed, or being developed, by others in adjoining sections to ensure that the overall utilities systems will be consistent with those existing before the start of construction, and that the systems will be compatible with those of the transit system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
153	Performance Criteria	3.3.1.H	Design of utility rearrangements shall ensure that construction of the transit facilities may proceed without undue hindrance and without endangering the continuity of utility service. The design shall consider space requirements for equipment and materials and clearances for installation of temporary traffic decking. The Designer shall request direction from Metro on allowable profiles and clearances for temporary deck structures. Design practice for a normal width underground station is to provide minimum clearance of 54 inches between top of temporary decking and the top of the relocated utility profile. These clearances may vary with the length of span required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
154	Performance Criteria	3.3.1.I	Take into account the needs of each utility for maintenance and accessibility when assigning vertical alignments.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
155	Performance Criteria	3.3.1.J	Where utilities cross under or run parallel to rail alignments consider live loads imposed by transit facilities in design of utility and utility casings (See Figure 3.22). Protection of both the utility and the transit facility must be considered	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:

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156	Performance Criteria	3.3.1.K	Utilities which penetrate through or cross over transit structures shall be designed to prevent shear failure and shall be encased if necessary to prevent damage. All utilities encasement shall be designed to comply with local governing agencies' standards and requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		City of LA: Artesia:
		3.3.2	SANITARY SEWERS AND STORM DRAINS													
		A	Codes and Standards													
157	Performance Criteria	3.3.2.A.1	The Designer shall determine the ownership of all impacted Sewer and Drainage Facilities prior to initiating detailed design of facility rearrangements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
158	Performance Criteria	3.3.2.A.2	Design and construction of Sanitary Sewer laterals to abutting properties shall conform to City and County of Los Angeles requirements or other applicable local codes. All sanitary sewer and storm drain discharges for both operation and construction of the Metro Rail Transit (MRT) shall be properly permitted and compliant with appropriate jurisdictional authority.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Sanitary Sewers													
159	Performance Criteria	3.3.2.B.1	The Designer shall specify to the Contractor to provide closed circuit television video (CCTV), both prior to and post-construction for all sanitary sewers, sanitary sewer maintenance holes and appurtenances that are affected by the project either crossing the right-of-way (rail tracks, wall, structure, etc.) or parallel to the right-of-way,that all sanitary sewer lines shall be videotaped prior to construction. If connecting to an existing manhole, videotape the manhole and the connection. If the rail tracks are on top of the sanitary sewer or storm drain, videotape the affected line from manhole to manhole.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
160	Performance Criteria	3.3.2.B.2	Sanitary sewer mains and service laterals to adjoining properties shall be maintained/protected by supporting in place, by providing alternative temporary facilities or by diverting to other points, as approved by the governing agency.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
161	Prescriptive Spec	3.3.2.B.3	Temporary sanitary sewer piping systems shall be of adequate size and slope to handle the flows of those sewers taken out of service. Minimum of a 3ft/sec self cleansing velocity shall be maintained. No sanitary sewage shall be discharged onto the project construction sites or at any other location.													
162	Performance Criteria	3.3.2.B.4	Temporary sanitary sewer facilities provided by contractor during construction shall be removed after project completion and after permanent facilities are in operation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
163	Performance Criteria	3.3.2.B.5	Capacity and service of replacement sanitary sewer system shall be equivalent to existing system and shall meet or exceed current design standards, based on the published design requirements of the agency having jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
164	Performance Criteria	3.3.2.B.6	Conduits shall be designed to maintain minimum velocities and flow depths per controlling agency's standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
165	Standard Criteria	3.3.2.B.7	Separation between sanitary sewers and water lines shall be per the applicable jurisdictional agency's design requirements. In general, maintain 10 feet minimum horizontal and 1 foot minimum vertical separation, or follow as required by the applicable jurisdictional agency's design requirements. The most stringent requirements shall apply.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
166	Performance Criteria	3.3.2.B.8	Review site specific condition, including flow capacity of existing sanitary sewers affected by the MRT, and incorporate such modifications into the relocation or realignment plan to protect both utility and MRT facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Storm Drains													
167	Performance Criteria	3.3.2.C.1	The Designer shall specify to the Contractor to provide closed circuit television (CCTV) video, both prior to and post-construction for all storm drain, storm drain maintenance holes and appurtenances that are affected by the project either crossing the right-of-way (rail tracks, wall, structure, etc.) or parallel to the right-of-way. If the conveyance system is water tight, provide alternative temporary or permanent facilities or divert flows to other points	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
168	Performance Criteria	3.3.2.C.2	All temporary storm drainage facilities used during construction shall be removed and restored with new permanent facilities at project completion. Restored facilities shall have capacities equivalent to those of existing facilities and shall meet or exceed current design standards of the agency having jurisdiction. Hydrology and Hydraulic calculations shall be provided to Metro and local agency to verify that the added volume within the restored facility is within capacity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
169	Performance Criteria	3.3.2.C.3	Review FEMA maps as well as area drainage conditions for local flooding and incorporate into design of storm drain facilities to provide for protection of transit facilities. See Section 3.8.8.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
170	Prescriptive Spec	3.3.2.C.4	New pipe shall have rubber gasket joints where it crosses the transit facilities.													
171	Performance Criteria	3.3.2.C.5	No surface drains from adjoining areas shall be connected to the transit drainage system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
172	Performance Criteria	3.3.2.C.6	All storm drain discharge locations, catch basins and general storm water runoff management shall comply with the Standard Urban Stormwater Mitigation Plan (SUSMP) required by the Los Angeles Regional Water Quality Control Board and other regulatory agencies. All storm drain discharge locations, catch basins and general storm water runoff management shall comply with Low Impact Development (LID) ordinance required by the local jurisdiction within which the Metro project is constructed on Metro property. Storm water runoff from future adjacent new development shall not run-on onto Metro's property. The project Operations and Maintenance plan at turnover shall only include infrastructure built within LA Metro property.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
173	Performance Criteria	3.3.2.C.7	New drainage facilities and connections to existing facilities shall be designed using the criteria in Section 3.8.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
174	Prescriptive Spec	3.3.2.C.8	All corrugated metal pipes, PVC pipes and ductile iron pipes crossing Metro Rail Tracks or within the Metro Right-of-Way shall be replaced by RCP and shall be designed to support rail vehicle traffic loading													
175	Prescriptive Spec	3.3.2.C.9	All new pipes designed to cross under any CMU sound wall or retaining wall shall be encased in concrete for a distance of 5-feet from both sides of the wall.													
176	Prescriptive Spec	3.3.2.C.10	All existing pipes that run under new walls shall be encased in concrete and designed to support loading from the wall.													
		3.3.3	WATER													

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		A	Codes and Standards													
177	Standard Criteria	3.3.3.A.1	All maintenance, relocation, restoration and construction of water mains and appurtenances shall conform to current design standards and criteria, specifications and practicies of the agencies having juristiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
178	Standard Criteria	3.3.3.A.2	Construction of water services to abutting properties shall conform to applicable local codes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	General													
179	Performance Criteria	3.3.3.B.1	Replacement of existing water mains and appurtenances shall provide capacities and services equivalent to those of existing facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
180	Performance Criteria	3.3.3.B.2	Services to adjoining properties shall be maintained by supporting in place, by providing alternative temporary facilities, or by diverting from other points.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
181	Performance Criteria	3.3.3.B.3	Upon approval from owners water lines through cut-and-cover construction shall be supported in place and braced to resist internal and external forces. New lines shall be aligned such that further relocation for placement of temporary decking or station construction will not be required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
182	Standard Criteria	3.3.3.B.4	Where major water distribution facilities cross the project alignment install emergency isolation valves outside the construction site if suitable isolation valves do not presently exist. Location and type of valve shall comply with criteria and requirements of the agency having jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
183	Standard Criteria	3.3.3.B.5	Cathodic Protection shall be provided for all ferrous metal pipelines in accordance with standards and criteria of the agency having jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
184	Standard Criteria	3.3.3.B.6	New water lines shall be welded steel pipe or ductile iron pipes as required by the utility agency.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.3.4	GAS													
		A	Codes and Standards													
185	Prescriptive Spec	3.3.4.A	All work on, or adjacent to, gas lines shall conform to regulations and standards of The Gas Company.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	General													
186	Performance Criteria	3.3.4.B.1	After consultation with Metro, the Designer shall inform The Gas Company if and where the transit system will affect the company's plant.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
187	Standard Criteria	3.3.4.B.2	Removal, installation, and connection of temporary or permanent gas mains shall be performed in accordance with the Gas Company Standards and Practices.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
188	Prescriptive Spec	3.3.4.B.3	Where possible new gas lines shall be placed within the street parkway or in the curbside lane one foot from the lip of the gutter.													
189	Standard Criteria	3.3.4.B.4	Maintain at least two feet of clearance from other utilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
190	Standard Criteria	3.3.4.B.5	Major gas line distribution facilities crossing the project alignment will have emergency isolation valves installed in accordance with The Gas Company standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.3.5	ELECTRIC POWER													
		A	Codes and Standards													
191	Prescriptive Spec	3.3.5.A	All maintenance, relocation and restoration of electrical lines throughout the transit system shall conform to the current practices of the electric company involved, the requirements of the Electrical code of the concerned jurisdictions and agencies, and the National Electrical Safety Code.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	General													
191	Standard Criteria	3.3.4.B.1	The preparation of designs shall be coordinated with and conform to design requirements of the electric utility company in whose jurisdiction the work occurs, and coordinated with any other concerned governmental agencies.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
192	Performance Criteria	3.3.4.B.2	Work to be done by the Local Electric Utility Company shall be indicated in the design drawings. The Electric Utility Company will install and energize all cables, make conduit connections to existing vaults, connect and energize all services and de-energize and remove cables from all facilities to be abandoned.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
193	Performance Criteria	3.3.4.B.3	Design shall show all existing overhead power lines and indicate those required to be abandoned or relocated. The Electric Utility Company will relocate or remove overhead power lines	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
194	Performance Criteria	3.3.4.B.4	Existing conduits and vaults within the work area shall be supported in place where possible. When facilities must be relocated, the plan and profile shall indicate alignment the depths such that future relocations to facilitate construction will not be necessary.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
195	Performance Criteria	3.3.4.B.5	Identify all ducts and vaults to be abandoned and removed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
196	Standard Criteria	3.3.4.B.6	Encase all new or relocated conduits in concrete as required by the Electric Utility Company.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
197	Standard Criteria	3.3.4.B.7	Vertical and lateral clearances from transit facilities to overhead lines shall comply with P.U.C. requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Duct-Bank, Vaults, and Maintenance Holes Design Criteria													
198	Standard Criteria	3.3.4.C.1	The design criteria for this sub-section shall be in compliance with the State of California rules for construction of underground electric supply and communication systems prescribe by the Public Utilities Commission of the State of California General Order No. 128. See Metro Rail Design Criteria Section 7 and Section 9 for underground duct bank requirement and cabling.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
199	Standard Criteria	3.3.4.C.2	Install duct-bank with minimum slope of 4 inches per 100 feet to ensure positive drainage and to avoid water accumulation in the conduits. In addition all open ends of conduits in the vault shall be sealed with water tight sealant and to prevent dirt clogging. All vault extension rings and construction joints shall be properly watertight sealed to prevent water seppage to vault.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
200	Standard Criteria	3.3.4.C.3	Any conduit or duct-bank shall be encased in concrete (450-C-2000 or equal). Concrete used for conduit encasement shall meet the requirements of Mix Design 450-C-2000. Duct-bank crossing under or running adjacent to railroad tracks, under roadways, and subjected to surcharge loading due to adjacent structure shall be designed and reinforced to withstand the surcharge loading. Duct-bank alignment and clearance from tracks shall in complaince with the requirements as stipulated in the Metro Design Criteria Section 4 for Guideway and Trackwork.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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201	Standard Criteria	3.3.4.C.4	All walls and the roof section of poured-in-place vaults and maintenance holes must be constructed with one continuous monolithic pour and must be waterproof. Poured-in-place vaults and maintenance holes shall rest on 6 inch of compacted crushed 1 inch rock, Type A, meeting the requirements of SSPWC, Subsection 200-1.2 and 200-1.4 and shall have the sump sealed at location where high water table is encountered. At location where soil permeability is optimum, the vault sump knockout shall be removed to facilitate the percolation of nuisance water back to ground.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
202	Standard Criteria	3.3.4.C.5	All vaults, maintenance holes and hand-holes shall be placed in areas where substructures are not subjected to surcharges other than backfill around the substructure. Adjacent retaining walls, foundations, or footig must be designed such that their loading does not affect the structural integrity of the substructures. For all vaults and maintenance holes within the railroad load and influence zone shall be designed to withstand the surcharge loading.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
203	Standard Criteria	3.3.4.C.6	Manhole openings shall be minimum 3' from the outside edge of rail, and manhole covers at ballasted area shall be raised above grade and cannot be covered over. All manhole covers shall be traffic-rated and bolted down with one or two securty bolts. Manhole covers installed at grade with the roadway pavement shall have rubber gasket ring for water proofing against storm runoff into the vaults. For Metro Rail Transit Operations and Safety Requirement, all Third Party utilities' manholes shall be located a minimum of 7 feet away from the nearest rail.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
204	Standard Criteria	3.3.4.C.7	Chipping or core drilling of any pre-cast concrete substructure, except at designated knockout locations, shall not be allowed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
205	Standard Criteria	3.3.4.C.8	All substructures shall be designed and fabricated to provide a dry and watertight installation. Any through-holes used for lifting shall be filled with non-shrink grout capable of reaching a minimum strength of 4500 psi in 28 days, except that lifting holes in the removable cover shall be plugged with an appropriate diameter neoprene plug. Mastic tape is not required on transformer pad and hand-hole installations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
206	Standard Criteria	3.3.4.C.9	Manhole and in-ground concrete pullbox steel plate cover shall be labeled/identified with special embossed, non-skid pattern. Manhole covers shall be traffic rated for H20 loading.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
207	Standard Criteria	3.3.4.C.10	When pre-cast concrete structures are located in high water table areas, two layers of mastic tape shall be placed at all joints and gaps between the pre-cast substructure panels or sections. Pre-cast concrete substructure, if required, shall be water proofed with 'zebron No. 386" coating or equivalent.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
208	Standard Criteria	3.3.4.C.11	Substructures shall not be set in an area where excess surface or landscaping water accumulates. Use of electric sump pumps to drain the excess water is not allowed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
209	Standard Criteria	3.3.4.C.12	The grading around the substructures shall be configured in such a way that all surface water will be drained away from the substructures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
210	Standard Criteria	3.3.4.C.13	All substructures shall be accessible to the maintenance trucks by means of a clear and unobstructed path from the street to the structure with a minimum width of 12 feet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
211	Standard Criteria	3.3.4.C.14	All substructure frames and covers located in parking areas shall be adjusted to match required grade. The grade shall be set such that the surrounding surface, immediately adjacent to the structure and for a distance of three feet minimum, can be sloped away at a rate of 1/2 inch per 10 feet of run.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
212	Standard Criteria	3.3.4.C.15	All substructure frames and covers located in planter areas (not accessible to pedestrian traffic) shall be adjusted such that their top surface is 2 inches above final grade of the surrounding ground. All sprinkers shall be located 6' away from the manhole covers. Provide concrete apron around manhole cover for ease of maintenance access.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
213	Standard Criteria	3.3.4.C.16	All gaps exceeding 1/8 inch between ends of conduits, which have been glued into place, and the abutment step in plastic terminators cast into substructure end and sidewalls, shall be filled with body putty (Bondo) or equivalent. Construction grout is not an acceptable substitute for Bondo.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
214	Standard Criteria	3.3.4.C.17	Plantings such as trees, plants and shrubs near the conduit(s) in direct buried or encased buried shall be at a minimum clearance of 5 feet. Trees and plants shall be planted so that their growth does not apply unintended pressure causing possible damage to the conduit(s).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.3.6	TELEPHONE													
		A	Codes and Standards													
215	Standard Criteria	3.3.6.A	All maintenance, relocation and restoration of telephone lines throughout the transit system shall conform to current practices of the appropriate telephone company.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	General													
216	Performance Criteria	3.3.6.B.1	Where possible existing cable ducts and vaults will be supported in place or moved in such manner to avoid cutting the cables.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
217	Performance Criteria	3.3.6.B.2	Design shall indicate which telephone lines are to be mainted complete in place; which ducts are to be removed, cables supported temporarily during work and, upon completion of work, replaced by a new system of ducts and cables; and any rerouting or new construction. Abandoned lines, and those to be abandoned, shall also be indicated.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
218	Performance Criteria	3.3.6.B.3	Design shall indicate what work, primarily pulling and cutting-over new cables, will be performed by the affected telephone company.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
219	Performance Criteria	3.3.6.B.4	Design shall provide that any telephone lines maintained or installed within limits of transit system excavation shall be supported permanently on compacted backfill.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
220	Standard Criteria	3.3.6.B.5	Preparation of design shall be coordinated with the involved telephone company and any governmental agencies.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
221	Prescriptive Spec	3.3.6.B.6	The design for lowering of cables will be coordinated with other utility work to eliminate the need to cut and splice telephones cables.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
222	Standard Criteria	3.3.6.B.7	Minimum depth of conduits shall be in accordance with the requirements of the municipal agency having jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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223	Standard Criteria	3.3.6.B.8	Installation of temporary and permanent manholes, split case ducts and duct encasement shall conform with local standards and practices.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
224	Standard Criteria	3.3.6.B.9	Vertical and lateral clearances from transit facilities to overhead telephone and other communication lines as listed herein shall comply with P.U.C. requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.3.7	TELEGRAPH TELECOMMUNICATIONS													
		A	Codes and Standards													
225	Standard Criteria	3.3.7.A	All restoration of telegraph telecommunication lines shall conform to existing codes, plans, and standards of the local jurisdictional agency.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	General													
226	Prescriptive Spec	3.3.7.B.1	Design shall include manholes equal in size to existing manholes. Concrete may be used instead of brick.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
227	Prescriptive Spec	3.3.7.B.2	Pipes and conduits shall be supported temporarily during work, and upon completion of work, placed on compacted backfill.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.3.8	OTHER COMMUNICATION CABLE SYSTEMS													
228	Standard Criteria	3.3.8	In the event of design involving maintenance, relocation, or restoration of communication cables other than Telephone and Telegraph, such as cables belonging to coaxial TV companies, National Defense Cables, and private alarm systems, Designer shall verify ownership, and after consultation with the owners, shall perform the necessary design work in accordance with the approved codes and standards of the companies and agencies affected.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.3.9	FIRE AND POLICE ALARM SYSTEMS													
229	Standard Criteria	3.3.9	Except for required support and protection of cables and restoration of ducts by the Contractor, all work along the corridor will be performed by the respective owners of such systems or their designed representatives.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.3.10	PARK FACILITIES													
		A	Codes and Standards													
230	Prescriptive Spec	3.3.10.A	All relocation and restoration of underground utility lines, water mains, sewers, drains, catch basins, sprinkler systems, lights, pavements, and other improvements within parks shall conform to requirements of the local authority's park and recreation departments invovled.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	General													
231	Standard Criteria	3.3.10.B	Design for the various facilities shall be submitted for approval to the Park and Recreation Department of the concerned local authority.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.3.11	STREET LIGHTS													
		3.3.11.A	These criteria refer to removal and restoration of existing street lighting facilities													
		B	Codes and Standards													
232	Standard Criteria	3.3.11.B	All relocations, temporary or permanent, and restoration of existing street light facilities shall be in accordance with the practices and requirements of the local agency having jurisdiction, Local Electrical Codes and the National Electrical Safety Codes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	General													
233	Standard Criteria	3.3.11.C.1	Street light design shall conform to the standards, requirements and Electrical Code of the agency having jurisdiction and the National Electrical Safety Code and shall be done by Agency having jurisdictional responsibility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
234	Performance Criteria	3.3.11.C.2	The Designer shall coordinate the work with the affected City or County Department of Public Works and Department of Transportation to assure jurisdictional compliance and shall coordinate station entrance plaza lighting and side walk illumination with street lighting design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
235	Performance Criteria	3.3.11.C.3	Materials, spacing, height and conduit depth shall be in accordance with requirements of Agency having jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.3.12	TRAFFIC SIGNALS													
236	Definition	3.3.12.A	These criteria refer only to relocation and restoration of existing traffic signals and construction of temporary traffic signals within public right-of-way.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
237	Standard Criteria	3.3.12.B	All relocation, temporary or permanent, and restoration of these facilities shall be in accordance with the practices and requirements of the local jurisdiction. In addition, the Manual on Uniform Traffic Control Devices shall be followed. Local ordinances include the municipal codes and standard plans of all jurisdictions and the following reference: City of Los Angeles Special Provisions and Standard Drawings for Installation and Modificaiton of Traffic Signals. In Los Angeles, all Materials used in the installation and/or modification of traffic signal systems shall conform to the latest material specifications, Department of Transportation, City of Los Angeles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	General	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
238	Standard Criteria	3.3.12.C.1	Relocation, restoration, and other work involving traffic signals shall meet the standards of the affected City or County and the California Department of Transportation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
239	Performance Criteria	3.3.12.C.2	The Designer shall coordinate the work with the California Department of Transportation and the affected City or County Department of Public Works to assure Jurisdiction compliance	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
240	Definition	3.3.12.D	For new traffic signalization and signalization at all at-grade crossings refer to paragraph 3.7.7 "Traffic Control Devices"	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.3.13	OIL PIPE LINES AND STEAM LINES													
		A	General													
241	Performance Criteria	3.3.13.A.1	All oil transmission lines and steam lines belonging to private companies shall be relocated clear of the project site. All work shall be performed by the owner of said installation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
242	Performance Criteria	3.3.13.A.2	After consultation with metro, the Designer shall inform the pipeline company where the transit system will affect the company's facilities and shall coordinate the transit system design with the pipeline company to assure safety and compatibility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.3.14	ABANDONED UTILITIES													

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243	Prescriptive Spec	3.3.14.A	Abandoned utilities within the limits of excavation shall be cut and removed. Cut ends shall be plugged or capped. Abandoned lines larger than 15 inches in diameter remaining within the right-of-way shall be backfilled with sand, one sack cement slurry or controlled low strength material (CLSM).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
244	Prescriptive Spec	3.3.14.B	Service connections to demolished buildings will be abandoned and cut at service source or main, unless otherwise directed by the local jurisdiction agency.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.4	RIGHT-OF-WAY													
		3.4.1	GENERAL													
245	Performance Criteria	3.4.1.A	Right-of-way is the composite total requirement of all interests and uses of real property needed to construct, maintain, protect, and operate the transit system. Some right-of-way requirements are temporary and reversionary in nature, while other requirements are permanent as dictated by operating needs. The philosophy of Metro is to acquire and maintain the minimum right-of-way required consistent with the requirements of the system and good right-of-way practices. Because right-of-way plans approved by Metro are used as a basis for acquisition of property, all interests and uses required shall be shown on the right-of-wayplans together with the detailed property dispositions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
246	Performance Criteria	3.4.1.B	The taking envelope is influenced by the topography, drainage, ditches, retaining walls, service roads, utilities, and the nature of the structure and side slopes selected.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
247	Performance Criteria	3.4.1.C	The limits of permanent right-of-way shall be shown on the right-of-way plans as an unbroken line utilizing simple curves and tangents. Spiral curves will not be used in right-of-way descriptions. Chords may be used in lieu of curves under special conditions approved by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.4.2	TYPES OF RIGHT-OF-WAY													
		A	Fee Simple													
248	Performance Criteria	3.4.2.A.1	Full ownership of property. It should provide sufficient space for the construction, operation, protection, and maintenance of the transit system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
249	Performance Criteria	3.4.2.A.2	Fee simple should always be the first type of right-of-way to be considered for any surface or aerial construction. If this is not practical, another type of right-of-way should be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Permanent Surface Easement													
250	Performance Criteria	3.4.2.B.1	An easement that provides space for the transit structures, and for the future maintenance of structures, which support aerial facilities located on private property. This easement also is applicable where structures, such as railroad bridges, pass over transit facilities. The easement shall have definite upper and lateral limits which shall be described by the Designer. Where required, lower limits will be described	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
251	Performance Criteria	3.4.2.B.2	The recommended easement width must include basic track width, drainage, supporting slopes, and utilities, and must consider the overall effect on the affected property.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Permanent Underground Easement													
252	Performance Criteria	3.4.2.C	An easement that encompasses the total transit facility located beneath the surface of the ground. It shall have definite upper and lateral limits which shall be described by the Designer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Permanent Aerial Easement													
253	Performance Criteria	3.4.2.D	An easement that completely envelopes the aerial portion of the transit facility. Its upper, lower, and side limits shall be described by the Designer	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Temporary Construction Easement													
254	Performance Criteria	3.4.2.E	An easement, temporary in nature, that provides sufficient space to allow for the use of the property by the Contractor during construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Utility Easements													
255	Performance Criteria		Where a utility within an existing easement is relocated, then a new easement shall be provided for the utility rearrangement and granted to the appropriate utility owner. This replacement easement shall be equivalent to the preceded easement.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
256	Performance Criteria		Utility easements which are required shall be treated as right-of-way. Bearings and distances along the sideline shall be shown as well as the lengths and widths of the easements and ties to the limits of right-of-way or property lines. All easements shall be in accordance with local and utility regulations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.4.3	RIGHT-OF-WAY CRITERIA AND LIMITS													
257	Performance Criteria		The following criteria are provided for establishing the limits of the right-of-way.The dimensions are given for minimum conditions and must be modified where engineering requirements dictate additional needs. All right-of-way limits shall be vertical or horizontal planes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A	Below Grade													
		1	Rock Tunnel													
		a	Upper Limit													
258	Performance Criteria		The limit of the right-of-way is described by elevations of horizontal planes, stepped as required, co-locating the steps with existing property lines or prominent suitable topographical features.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
259	Prescriptive Spec		Ten feet above the high point of the structure is the minimum required vertical distance to the horizontal plane of the envelope. Allowances shall be made for rock bolting which may be required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
260	Performance Criteria		Allowances shall be made for rock bolting which may be required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		b	Lateral Limit													
261	Prescriptive Spec		Vertical planes 10 feet outside the inside finish surface of the tunnel	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
262	Performance Criteria		Where necessary, allowances shall be made for rock bolting or other required special construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
263	Prescriptive Spec		With formal approval of Metro, the right-of-way lateral limit may be set at the existing property line if the normal lateral limit of the right-of-way encroaches upon the existing property by no more than 3 feet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
264	Performance Criteria	c	Lower Limit: Where used, the lower limit shall be configured in a manner similar to that for the upper limit. Lower limits normally are not defined for rock tunnels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		2	Earth Tunnel													
265	Prescriptive Spec	a	Upper Limit: The limit of the right-of-way is described by elevations of horizontal planes, stepped as required, co-locating the steps with existing property lines or prominent suitable topographical features. Ten feet above the high point of the structure is the minimum required vertical distance to the horizontal plane of the envelope. Allowances shall be made for rock bolting which may be required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
266	Prescriptive Spec	b	Lateral Limit: Vertical planes 5 feet beyond the outside face of each tunnel structure. Allowances shall be made for grouting which may be required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
267	Prescriptive Spec	c	Lower Limit: Where required by local conditions, a lower limit shall be configured in a manner similar to that of the upper limit, using a minimum vertical distance of 10 feet below the low point of the structure, where possible. Allowances shall be made for grouting which may be required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Cut-and-Cover Construction													
268	Prescriptive Spec	a	Upper Limit: 10 feet above the high point of the structure. The limit shall be delineated by elevations of horizontal planes, stepped as required, co-locating the steps with existing property lines or prominent suitable topographical features	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
269	Prescriptive Spec	b	Lateral Limit: Vertical planes 5 feet beyond the outside faces of the structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
270	Prescriptive Spec	c	Lower Limit: Where required by local conditions, the lower limit shall be configured in a manner similar to that of the upper limit using a minimum vertical distance of 10 feet below the low point of the structure, where possible	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4	Stations													
271	Performance Criteria	a	Right-of-way required for stations shall include space needed for platforms, ticketing, waiting rooms, access to station ancillary rooms and accommodations, and for the structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
272	Prescriptive Spec	b	In addition to the structural, mechanical, and electrical requirements for space, the requirements for pedestrian circulation space must be observed. A 15-foot-wide longitudinal walk strip on one side of the finished escalator portal is required. A 20-foot distance from the newels of the escalators must also be preserved for pedestrian circulation. Minimum head room is 8 feet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5	Vent and Fan Shafts													
273	Performance Criteria		The first choice for location of fresh air intakes, vents, emergency stairway exits and fan shafts shall be located on Metro property. The second choice is to locate the appurtenances within the public right-of-way, immediately behind the back of the curb and shall be flushed with existing surface. The metal portions of the appurtenances shall not occupy more than 50 percent of the sidewalk area, and shall provide for a clear space of 48" of level concrete behind the metal portions. The third choice is to locate the appurtenances on private property. When located on private property, the limit of right-of-way is 3 feet from the outside face of the structure. Access to the shaft is required. Vent shafts should be secured and elevated to prevent debris accumulation or hazard infiltration.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	At-Grade Construction													
		1	Exclusive Right-of-way													
274	Performance Criteria	a	Upper Limit: Normally, an upper limit is not required. When an upper limit is required, the limit shall be described by the elevations of horizontal planes, stepped as required, and colocating the steps with existing property lines or prominent suitable topographical features. The minimum required vertical distance from top-of-rail to the horizontal plane is 16'-6".	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
275		b	Lateral Limit: On exclusive right-of-way, the minimum allowable distance from the centerline to the nearest track to the right-of-way limit varies according to the following situation:													
276	Standard Criteria	b1	When the walkway is on the outside of the track, use California Public Utilities Commision minimum clearance criteria plus the dynamic envelop of the LRT vehicle, plus the horizontal track construction tolerance on both tangent and curved alignments.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
277	Performance Criteria	b2	When the walkway is between the tracks, and/or is on the outside of the tracks opposite from the track in question, then the minimum distance is the dynamic envelope of the LRT vehicle plus the horizontal track construction tolerance, plus the running clearance of the LRT vehicle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
278	Performance Criteria	c	Additional distances, such as for service roads, drainage ditches and catenary poles, shall be added to the above.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
279	Performance Criteria	d	In retained cuts or on retained fills, the minimum right-of-way required is measured laterally to the outside edge of the retaining wall footings. Allowances shall be made for pile encroachments. In side cuts, unretained open cuts, or fills, the slopes shall be included in the right-of-way.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
280	Prescriptive Spec	e	Lower Limit: When required, the lower limit shall be defined in a manner similar to that for the upper limit, using a minimum vertical of 10 feet below top-of-rail, where possible.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Shared Right-of-way													
281	Performance Criteria		On restrictive or shared right-of-ways, such as in highway and railroad corridors, the minimum rights-of-way shall be as approved by Metro and by the agencies, jurisdiction, or the owner involved.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Stations													
282	Performance Criteria	A	Right-of-way required for stations shall include space needed for platforms, ticketing, waiting rooms, access to station ancillary rooms and accommodations, and for the structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
283	Prescriptive Spec	B	In addition to the structural, mechanical, and electrical requirements for space, the right-of-way shall include area for pedestrian circulation walkways 15 ft, longitudinally, on one side of the finished escalator portals, and 20 ft of clear space from the newels of the escalators. Minimum vertical headroom clearance shall be 8 ft.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4	Substations and Tie Breaker Stations													
284	Prescriptive Spec		Substations and tie breaker stations at-grade require a minimum 15 ft access strip. The requirement for land varies. The land should be contiguous to the right-of-way for the transit system, where possible, with 5 ft provided between the limit of the right-of-way and the face of the structure for maintenance purposes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5	Storm Drainage													

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285	Prescriptive Spec	A	Open Ditches: The minimum width for surface drainage easements shall be governed by local agency involved. As a guideline, the minimum easement width is 10 ft with 2 ft minimum clearance from outside edge of structure to right-of-way line.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
286	Prescriptive Spec	B	Underground Drainage: Easement widths for underground drainage systems shall be approved by the local agency involved. As a guideline, the minimum easement width is 10 ft with 2 ft minimum clearance from outside edge of structure to right-of-way line.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Aerial Construction													
287	Prescriptive Spec	1	Upper Limit: Where required by local conditions, the upper limit is delineated by elevations of horizontal planes, stepped as required, co-locating the steps with existing property lines or prominent suitable topographical features. The minimum required vertical distance from top-of-rail to the horizontal plane is 16'-6".	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
288	Prescriptive Spec	2	Lateral Limit: 25 ft outside the centerline of each track. Easements shall be required for maintenance of and repairs to structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
289	Performance Criteria	3	Lower Limit: Where required by local conditions and specifically directed by Metro, the lower limit will be the ground level with specified use restrictions, except where crossing other rights-of-ways.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Multilevel Easements													
290	Performance Criteria		Multilevel easements, such as the ones at station entrances located in buildings, may be required by Metro. In such instances, the Designer shall prepare a separate detailed drawing showing all interests on each floor level proposed for use by Metro. The following requirements shall be met:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
291	Performance Criteria	1	Each floor level affected by the transit facility shall be so noted and separately illustrated. A separate entry in the property disposition table for each level.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
292	Performance Criteria	2	Each type of easement on a floor level shall be dimensioned and symbolized properly. All column locations shall be shown.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
293	Performance Criteria	3	The elevations of each floor easement shall be given and shall be referenced to the project datum. Elevations normally shall be from the underside of the floor structure to the underside of the next higher floor structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.4.4	RIGHT-OF-WAY INFORMATION REQUIREMENTS													
		A	Curve Data													
294	Performance Criteria		The Designer shall reduce all spirals ato ciruclar curves at the limits of the right-of-way. Circular curves are the only types of curves acceptable for recording purposes. Curve data shall be shown on the right-of-way plan sheet in a table of curve data. Tangent sections are to be used in lieu of curves to show the limits of the right-of-way when curves are extremely flat.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Continuous Right-of-Way													
295	Performance Criteria		Although Metro may not require acquisition of public space, all plans shall show the right-of-way envelope as being continuous, crossing public as well as private space. Such private space shall be identified.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Isolated Right-of-Way													
296	Performance Criteria		The boundary for the easement areas supporting all new construction, such as fan and vent shafts, substations, escalators, and chiller plants, shall be defined geometrically with ties shown wherever the location is not contiguous to the right-of-way.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Vaults													
297	Performance Criteria	1	Vaults affected by transit construction shalll be shown and their disposition shall be noted. The vaults shall be labeled as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
298	Performance Criteria	a	Category "A" - vaults which must be removed during construction	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
299	Performance Criteria	b	Category "B" - vaults which lie within the influence line of construction, but may not require removal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
300		2	The influence line generally may be considered to project outward on a 1:1 slope from the lowest point of excavation nearest the property line. Vaults not in Category "A", but within the influence line, could experience cracking, and utility lines may be subject to rupture. The owner may be required to abandon the use of such vaults during construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Explanatory Notes													
301	Performance Criteria		The Designer shall use explanatory notes, where applicable, to aid in clarifying the right-of-way takings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Projections in Public Space													
302	Performance Criteria		The Designer's right-of-way plans shall show all vaults, fire escapes, signs, display windows, footings, foundations, and other projections in public space which must be removed to accommodate the construction of the transit system. The projections into public space affected by the construction will be identified in terms of location and type of projection and reported separately to Metro as soon as possible. In areas where projections are numerous, a chart shall be provided on the plans for clarification.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		G	Underpinning													
303	Performance Criteria		The Designer shall provide detailed plans of the right-of-way necessary for any underpinning required in this scope of work. Separate drawings showing the easements required for the Contractor shall be prepared and referenced. The underpinning details shall show the dimensions of the easements and tie the easements to the transit system right-of-way. The property line and all supporting columns of hte structure shall be shown. Proposed access and location of dust walls shall be shown.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		H	Street Closings													

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304	Performance Criteria		The Designer shall provide separate drawings showing the areas of public property to be closed and utilized for the transit system. These drawings shall be prepared in accordance with local jurisdictional requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.4.5	SURVEYS AND MONUMENTATION													
305	Performance Criteria	A	Any Land Surveyor, or Civil Engineer registered in California before 1982, may conduct surveys and prepare drawings for recording in California. Civil Engineers registered in 1982 and thereafter may conduct surveys only if they have passed the Land Surveyor's examination and are duly registered as Land Surveyors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
306	Performance Criteria	B	Using field surveys, record information, and computations, the Designer shall prepare individual plats of survey in accordance with requirements. The final plats shall comply with the recording requirements of the County of Los Angeles. The Transit system's right-of-way envelope shall be described as metes and bounds, U.S. lands, parcels and other areas which are affected by the envelope are similarly described. Coordinates and elevations further describing the right-of-way and existing property corners shall be shown on the plans. Coordinates shall be provided for all angle and curve points along the limits of the right-of-way.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
307	Performance Criteria	C	Monuments, as shown in Figure 3.3, will be used wherever monumentation is required and where it can be utilized in the form shown. Monuments shall be placed at each PC and PT of right-of-way line curves, and, as necessary, to satisfy involved jurisdictions. Where monument locations are such that use of the above-described monument is not practical, other suitable monuments may be used, subject to approval of Metro and the jurisdictions involved.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.5	**CONTROL OF ACCESS**													
		3.5.1	GENERAL													
308	Performance Criteria		The rapid transit right-of-way shall be protected in such a manner as to prohibit public vehicular or pedestrian traffic from the right-of-way except at points of passenger entrance and egress, such as at stations and parking areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.5.2	CROSSINGS - DELETED													
		3.5.3	RIGHT-OF-WAY BARRIERS													
309	Prescriptive Spec	A	Throughout the system, fencing or other suitable barriers shall be provided to prevent the public from gaining access to the tracks. See Figures 3.4, 3.5 and 3.6 for acceptable barriers.													
310	Performance Criteria	B	The design of the transit system shall take into consideration the protection of the system against local flooding resulting from stream overflows aand surface flooding. Based on field investigations, consultations with local authorities, studies of any recorded data, and analyses of existing and proposed drainage systems, the Designer shall submit findings and recommendations to Metro for approval while in the preliminary stages of work. Final design shall not be undertaken prior to receipt of such approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		1	Pedestrian Barriers													
311	Performance Criteria		Acceptable forms of pedestrian barriers include fences, walls, and elevation differences of appropriate magnitude. A deterrent in the form of barbed wire or equal physical obstruction, approved by Metro, shall be mounted on fences or walls.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Vehicular Barriers													
312	Performance Criteria		When transit rail tracks are located adjacent to freeway or highway traffic, a separation barrier shall be installed between the transit rail tracks and freeway lanes to prevent vehicular traffic intrusions into the Metro right-of-way. This barrier must be the tallest Caltrans approved standard barrier having the highest Caltrans approved crash design impact load rating. If there are existing barriers that separate the freeway from the Metro right-of-way but do not meet these criteria, these existing barriers must be removed and replaced with barriers that do meet this criteria, whenever a new rail line is introduced in this location. The barriers shall also be designed to meet Caltrans highway safety sight distance and Metro Rail Operations safety requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Safety Railings													
313	Performance Criteria		Where elevation differences alone constitute a sufficient pedestrian or vehicular barrier, safety railings must be provided for the protection of both the public and the rapid transit personnel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4	Temporary Barriers													
314	Performance Criteria		All construction sites and Contractor's areas shall have temporary fencing and suitable barricades, where required, to protect pedestrians and vehicles. It shall be noted on the plans that the Contractor is required to fence only the area he will need to conduct his operations. Dimensions of fencing may be scaled.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.6	**SERVICE ROADS**													
315	Performance Criteria		Service roads shall be provided for transit system construction at-grade on exclusive right-of-way wherever land permits and wherever real estate and construction make their inclusion feasible. The decision to include or exclude a service road shall be made by Metro upon receipt of the Designer's evaluation of feasibility	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7	**STREETS**													
		3.7.1	GENERAL													
316	Performance Criteria		Unless otherwise stated, new facilities or alterations to existing facilities to be maintained by others shall be designed in conformance with published standards of the governmental agency having jurisdiction or with the criteria contained herein, where such criteria exceed local agency standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
317	Performance Criteria		Where the requirements stipulated in this document or any referenced source are in conflict, the stricter requirement shall govern.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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318	Performance Criteria		Unless specifically noted otherwise herein, the latest edition of the code, regulation and standard that is applicable at the time the design is initiated shall be used. If a new edition or amendment to a code, regulation or standard is issued before the design is completed, the design shall conform to the new requirement(s) to the extent practical.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.2	MAINTENANCE OF TRAFFIC													
		A	Codes and Standards													
319	Performance Criteria		Traffic maintenance shall be coordinated with, and subject to approval by, local authorities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Design shall include:													
320	Performance Criteria	1	Traffic staging and detours necessary to assure proper maintenance of traffic	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
321	Performance Criteria	2	Street and sidewalk areas of temporary decking for the duration of construction. The Designer shall seek Metro direction for the height and profile of temporary streets and sidewalks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.3	ROADWAY GEOMETRICS													
322	Performance Criteria		The restoration of existing streets impacted by Metro construction shall match the existing streets.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
323	Performance Criteria		However, if the local jurisdiction requests street width changes or further street improvements, they may be included as part of the Project improvements, within reasonable limits of the Project impacted area, subject to Metro concurrence.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
324	Performance Criteria		The roadway geometrics derived in the preliminary engineering design phase should be used as a guide for final design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
325	Performance Criteria		Roadway geometry must be evaluated utilizing appropriate truck- and bus-turning radii.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A	Geometric Design Considerations													
326	Performance Criteria		Geometric design considerations include: Traffic safety; Type of highway, interstate, freeway, major street, etc; Traffic volumes, existing and projected; Types of design vehicles; Necessary curves or curb, radii required or determined by turn overlay templates; Parking, legal or emergency; Stalled or broken-down vehicles; Grades with consideration of drainage requirements; Sight distances; Visibility, nighttime lighting, inclement weather, topography, etc; Mode of traffic signalization, hardware, software timing and phasing; Pedestrian traffic; Available or additional right-of-ways; Public transportation, railroad, light rail, buses, etc; Bicycle Traffic; Site characteristics - industry, schools, shopping centers, etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Traffic Lane Widths													
327	Standard Criteria		Lane widths are measured from the center of the striped line to the center of an adjacent striped line or curb face. The following criteria indicate the optimum traffic lane widths. In cases of significant constraint, a width reduction may be necessary.	EX	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		MPP 531: Application and Design for Striping, Channelization and Special Signing
328	Performance Criteria		Approval from Metro and local agency must be obtained prior to using minimum lane widths. Use of less than desirable widths will also require approval from the City, if used for City streets.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Number of Traffic Lanes													
329	Performance Criteria		The number and type of traffic lanes (i.e., through, right or left) shall be determined in consultation with the jurisdictions, generally based on a traffic analysis which considers projected traffic volumes, LRT vehicle intersection crossings, critical traffic movements and geometric configurations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
330	Prescriptive Spec		The lane configuration and signal timings shall, whenever possible, be designed to provide no worse than level of service D at signalized intersections in the P.M. peak hour during at least the year following completion of this project.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Parking Lanes													
331	Performance Criteria		Parking locations shall be determined in consultation with the jurisdictions based on traffic analysis, safety considerations and demand for on-street parking. Twenty-four hour parking prohibition shall be recommended at those locations (e.g. near intersections and at Metro stations) where roadway width is not adequate to provide the necessary number of through lanes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
332	Performance Criteria		Peak-hour parking prohibition shall be recommended at those locations where traffic analysis shows that the capacity of the traveled way without the parking lane will provide level of service D or worse.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Curb Return Radius													
			Roads:													
333	Prescriptive Spec		Curb Return Radius: City of Los Angeles - 25’	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
334	Prescriptive Spec		Curb Return Radius: Los Angeles Co. Master Plan Highway - 35'	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
335	Prescriptive Spec		Curb Return Radius: Other Los Angeles County - 25'	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
336	Prescriptive Spec		Curb Return Radius: Parking areas - 15'	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
		F	Cross Slopes													
337	Prescriptive Spec		Cross Slope: Concrete and asphalt concrete pavement roads: 2%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
338	Prescriptive Spec		Cross Slope: Aggregate surface pavement: 3%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
339	Prescriptive Spec		Cross Slope: Concrete and asphalt concrete pavement roads: 2%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		

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340	Prescriptive Spec		Close Slope Parking areas: 1% min. 6% Max.	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
		G	Sidewalks													
341	Prescriptive Spec		Sidewalk: Maximum cross slope shall be 2%, and match the elevation of existing building(s) finished floor elevation(s), flow away from the building(s)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
342	Prescriptive Spec		Sidewalk: Minimum slopes shall be 0.5%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
343	Standard Criteria		Federal and State accessibility requirements must be met for sidewalk areas behind and adjoining driveways, alley openings, and pedestrian ramps.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.4	PAVING													
		A	Codes and Standards													
344	Performance Criteria		All pavement restoration in public streets shall conform to the current specifications and practices of the several jurisdictions and agencies involved.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	General													
345	Performance Criteria		Restored pavements shall be of similar materials and shall conform to widths existing prior to transit construction, except that if an existing street is found to be based on obsolete paving materials, such as wood block or brick, replacement will not be in kind, and current specifications and practices will control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.5	CONCRETE BUS PADS													
346	Performance Criteria		Concrete bus pads shall be provided when requested by Metro operations at all bus stops which are constructed or reconstructed adjacent to Metro Rail Projects in conformance with the standards and specifications of the agency having jurisdiction. Continuous concrete pads may be required throughout an entire block in the vicinity of the station entrance when subject to heavy bus traffic or requested by the agency having jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.6	BUS TURNOUTS													
347	Performance Criteria		Single bus turnouts shall be a minimum of 10 feet wide with a minimum 50' curb parallel to through traffic lanes and 60' transition entry and 40' transition exit. For each additional pass-through bus berth add 50', and for each additional layover bus berth add 80'. (See bus bay dimensions on Figure 3- 19.) For 60' articulate bus and BRT Bus Turnouts, refer to BRT Design Criteria Figure 3-6.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.7	TRAFFIC CONTROL DEVICES													
348	Performance Criteria	A	Relocation, restoration, and other work involving and traffic signals shall meet the standards of the affected jurisdiction or California Department of Transportation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
349	Performance Criteria		The Designer shall coordinate the work with the California Department of Transportation and the affected jurisdiction to assure jurisdictional compliance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Codes, Regulations, and Standards													
350	Performance Criteria		All maintenance, relocations of traffic control devices, temporary or permanent, and restoration of these facilities shall be in accordance with the practices and requirements of the local jurisdiction and Metro. In the case where the local jurisdictions have no standards, the Manual on Uniform Traffic Control Devices shall be followed. Local ordinances include the municipal codes and standard plans of all jurisdictions, and the following reference: City of Los Angeles Special Provisions and Standard Drawings for Installation and Modification of Traffic Signals. When within the jurisdiction of the City of Los Angeles the City will prepare their own documents and drawings for the traffic control devices to be relocated by the Contractor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
351	Performance Criteria		In Los Angeles, all materials used in the installation and/or modification of traffic signal systems shall conform to the latest material specifications, Department of Transportation, City of Los Angeles. Where the requirements stipulated in this document or any referenced source are in conflict, the more strict requirement shall govern.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Traffic Operations													
352	Prescriptive Spec		Traffic control devices shall be installed at all at-grade crossings of the LRT tracks in conformance with latest effective version of General Order No. 143 of the Public Utilities Commission of the State of California. See Subsection 12.2.7 of Section 12 (Signaling) regarding protection at grade crossings in the corridor, where gates are to be installed. For operation in the street median, along a side alignment, or in mixed flow with vehicular traffic, Rail Vehicles shall travel at a speed not to exceed the speed permitted by the local vehicle code, but in no case greater than 35 mph. Left turns across the tracks from the parallel roadway shall be prohibited at unsignalized intersections. Although it is not desirable from a safety point of view to allow unprotected left turns across the tracks from a parallel roadway, an exception to this rule may be permitted at locations such as driveways where there is no alternative means of providing access to fronting properties along streets traversed by the Rail Vehicles. At any such locations, where an exception is desired, appropriate design features and/or operational procedures shall be incorporated to minimize conflicts with left-turning vehicles and rail vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
353	Performance Criteria		At each signalized intersection, LRT traffic signals shall be provided in addition to the traffic signals controlling motorists at the intersection. These LRT traffic signals shall be standard traffic signal equipment using nonstandard aspects and shall be operated by the same controller as the intersection traffic signals. This shall require special phases and LRT priority capabilities in the traffic signal control equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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354	Performance Criteria		Controllers shall have the ability to be operated in either an isolated mode (free), or in a coordinated mode. All traffic signals shall be capable of being coordinated with adjacent traffic signals on both the corridor and on cross streets at least 200 feet either side of the rail line. The primary method of coordination shall be fixed cycle length coordination via time- based coordinators, but the provision of master coordination capabilities as part of the monitoring and programming system is considered a definite advantage. Traffic signal preemption capabilities shall be provided at each intersection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
355	Performance Criteria		Where rail vehicles pass through or adjacent to signalized intersections without gates, capability for both full and partial rail vehicles priority shall be provided in the traffic signal controller(s). Where crossings are gated, adjacent traffic signals shall be equipped with the capability for normal railroad preemption. At those locations where the "window" concept is to be employed in addition to normal railroad preemption capability, a facility to restrict preemption to prespecified portions of the traffic signal cycle (the window) shall also be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Design Guidelines													
356	Prescriptive Spec		Type 170 controllers shall be utilized throughout the system unless otherwise required by local jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
357	Performance Criteria		Where there are existing cable interconnects between traffic signals, they shall be utilized. Otherwise, traffic signals shall be coordinated using time-based coordination.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
358	Performance Criteria		The traffic signal design and details shall conform to the requirements of the agency having jurisdiction, as shown on that agency's Standard Plan.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
359	Performance Criteria		Plans shall show location of all new and existing traffic signal equipment and conduits	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
360	Performance Criteria		Designs shall be coordinated with the agency controlling the intersection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
361	Performance Criteria		Consideration shall be given to incorporating a raised median island on the approach to at-grade street crossings where roadway geometry permits, to reduce the opportunity for vehicles to bypass crossing gates in their down position.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
362	Performance Criteria		Particular attention shall be given to the integration of at grade station platforms into the intersection design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
363	Performance Criteria		Pedestrian capacity and control at station access and egress points must be considered. Where pedestrian-actuated traffic signals are provided, they shall be designed to regulate pedestrian crossings of the LRT and/or railroad tracks, as well as of the adjacent roadways. Pedestrian push buttons shall be provided to actuate the pedestrian signals. All pedestrian signals shall display international symbols. An appropriate pedestrian refuge area shall be provided at either end of the crosswalk, including the area between LRT tracks in at-grade station areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
364	Performance Criteria		Bicycle travel on streets approaching rail crossings must be considered. Provide warning devices, including signage and/or markings, that caution people riding bicycles to cross railroad tracks at a 90 degree angle to minimize a wheel slipping or being caught	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
365	Performance Criteria		Traffic signal indications shall be provided for each approach to an intersection at a minimum of two locations (on two poles).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
366	Performance Criteria		Where left turns or right turns across the LRT tracks are to be controlled by a traffic signal, a protected turn phase shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
367	Performance Criteria		Pedestrian traffic signals shall be provided at all signalized intersections.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
368	Prescriptive Spec		Specially designed signal equipment (such as special poles and standards) shall be replaced in kind if they are removed or modified as a result of this project. (At the discretion of the agency having jurisdiction).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.8	STREET SIGNING AND STRIPING													
		A	GENERAL													
369	Performance Criteria		After consultation with Metro, the Designer shall coordinate with concerned authorities to assure compatibility of street signing with transit construction staging.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
370	Performance Criteria		Street striping and restriping plans may be done by the local jurisdiction. Otherwise the Designer will prepare the plans, subject to the approval of the local jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Codes and Standards													
371	Performance Criteria		All work involving relocation, restoration, and temporary installation of street signing shall conform to current standards of local jurisdiction and of the California Department of Transportation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.9	PARKING METERS													
		A	General													
372	Performance Criteria		Within their jurisdictions the affected agencies will remove and restore meter heads; the Contractor shall remove, store, and reinstall posts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Codes and Standards													
373	Performance Criteria		Does not apply, since work will involve only removal and restoration of existing facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.10	RAMPS AND CURB CUTS													
374	Performance Criteria		Wheelchair ramps shall be provided in accordance with the following: 1) Restore or replace any existing ramps. 2) Provide ramps at intersections where any of the curb returns are modified as part of the LRT Projects and provide direct access to stations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
375	Standard Criteria		The design of curb cuts and ramps shall be in accordance with the applicable provisions of the Americans with Disabilities Act (ADA) and Title 24, California Code of Regulations Part 2, "Regulations for the Accommodation of the Disabled in Public Accommodations."	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
376	Performance Criteria		Location of ramps and curb cuts in public space shall be obtained from the local governing jurisdiction and shall be in accordance with the ADA and Title 24.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.11	SIDEWALKS													

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377	Performance Criteria		Sidewalks shall be in accordance with the standards of the agency having jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.12	VENTILATION GRATING OPENING													
378	Performance Criteria		Ventilation grating openings shall be located to minimize any adverse effect on existing features of landscaping, improvements, and environment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
379	Prescriptive Spec		Such gratings may be located either in raised median strips, Metro property adjacent to public R.O.W. or in an approved location immediately behind the street curbs, provided the width of grating does not exceed 50 percent of the sidewalk width or 5 feet, whichever is greater, but must maintain a minimum clear level concrete distance of 48 inches behind the metal portions of the grate.													
380	Performance Criteria		Such gratings may be located either in raised median strips, Metro property adjacent to public R.O.W. or in an approved location immediately behind the street curbs, provided the width of grating does not exceed 50 percent of the sidewalk width or 5 feet, whichever is greater, but must maintain a minimum clear level concrete distance of 48 inches behind the metal portions of the grate. Where possible, gratings will be located outside of the far tangent points at street intersections and will not be located in any crosswalk area. Covered openings, such as mechanical access openings, may be permitted in sidewalk.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
381	Standard Criteria		Sidewalk and street gratings for subway vent and fan shafts shall be steel grating with bar sizes and spaces to be designed considering the type of traffic to be imposed. Grate bar spacing shall comply with ADA with a maximum gap not to exceed ½”.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.13	VAULTS													
		A	General													
382	Performance Criteria	1	The Designer shall determine which vaults will be affected by transit construction. Details shall show the portion of each vault to be excavated; new walls required to permit continued use of vaults outside construction limits; new walls to accomplish complete abandonment of vaults, where required; the work required to restore vaults, including delivery chutes and freight elevators and the area available for permanent occupancy by the original owner upon completion of transit facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
383	Performance Criteria	2	The Designer shall determine what goods or facilities must be removed from the vault; how deliveries will be made to properties when existing vault entrances must be abandoned; and the time required to take each of the above enumerated steps. This information shall be forwarded to Metro at the earliest practical date to avoid possible construction delay, and Metro will arrange for permission to occupy the vault and make the necessary alterations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
384	Performance Criteria	3	All vaults shall be designed to be “watertight”, with no water intrusion.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Codes and Standards													
385	Performance Criteria		All remodeling, abandonment, or other work involving private vaults extending from adjoining buildings into public space shall conform to the rules, regulations and practices of the jurisdictions involved.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.14	DRIVEWAYS													
386	Performance Criteria		Driveway minimum and maximum widths and numbers shall be in accordance with the standards of the agency having jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.15	LANDSCAPE AREAS AND STREET TREES													
		A	General													
387	Performance Criteria	1	Street trees and landscaped areas shall be preserved wherever practicable. The Designer shall indicate the trees to be removed and replaced, and those that are to be protected. Street tree replacement shall meet the local governing agency requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
388	Prescriptive Spec	1	Subject to local jurisdiction approval, street trees may be replaced on and one-for-one basis with 36" box standard. The tree species shall be designated by the local jurisdiction. Tree location shall be coordinated with the location of other sidewalk features, such as streetlights, fire hydrants, station appurtenances, and underground utilities and basements.	EX												Los Angeles: BSS
389	Performance Criteria		When required, shade trees shall be planted to comply with CALGreen requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.7.16	EXIT HATCHES													
390	Performance Criteria	A	Hatches in driveways and parking areas: Hatches shall not be located in driveways. Hatches shall not be located in parking areas unless protected by bollards and provided with adequate protected egress lanes to a public way.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
391	Prescriptive Spec		Hatches shall be installed at a minimum six inches higher elevation than the surrounding grade level. Elevation of the egress lanes, to a public way, to match elevation of Exit Hatch and public way.													
392	Performance Criteria	B	Hatches Installed in Sidewalks: Hatches to be designed so that the hatch doors are installed in one plane generally conforming to sidewalk cross slopes. Edges around the exit hatch shall not cause tripping hazard to the pedestrians. Adjust sidewalk finished grade to ensure runoff draining away from exit hatches.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
393	Prescriptive Spec		Locate edge of Exit Hatches minimum of 1'-6" from face of curb.													
		3.8	**DRAINAGE**													
		3.8.1	GENERAL													
394	Performance Criteria		Storm drainage system design shall be in conformance with the requirements of the agency having jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
395	Performance Criteria		When applicable, designer is to coordinate LID projects with the local Regional Water Quality Control Board, which may issue a permit or otherwise require LID.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.8.2	HYDROLOGY													
		A	Surface and Aerial Construction													

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396	Performance Criteria		Hydrology shall be based upon standards and methods of computation used by the Los Angeles County Department of Public Works, the City of Los Angeles Bureau of Engineering, Engineering Design Standards, or the local jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Underground Sections in Earth													
397			Drainage for underground sections in earth shall be designed to exclude groundwater and shall be based on the formula:													
		C	Underground Sections in Rock													
398			Drainage for underground sections in rock shall be designed to collect groundwater in order to relieve hydrostatic pressure, and shall be based on the formula													
		3.8.3	DESIGN STORM DRAINAGE AREA													
			10-year Storm Frequency													
399	Prescriptive Spec		Track Roadbed (to top of subballast)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
400	Prescriptive Spec		Main storm drains	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
401	Prescriptive Spec		Parking lots	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
402	Prescriptive Spec		All longitudinal drains or subdrains that could flood the roadbed	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
			50-year Storm Frequency													
403	Prescriptive Spec		All culverts and drainage crossing the rail system where flooding could damage system	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
404	Prescriptive Spec		All sump condition areas (defined as a low area which prevents the free passage of water with consequent flooding of streets of Private property).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
405	Prescriptive Spec		All other areas	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
		3.8.4	RAINFALL INTENSITY													
406	Performance Criteria		Rainfall intensity I, for calculation of design flows, shall be determined using procedures designed in the Los Angeles County Department of Public Works Hydrology Manual	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.8.5	SURFACE DRAINAGE													
407	Prescriptive Spec	A	Plaza area drainage shall be designed to minimize surface water level and velocity to maintain a safe walking surface. Minimum grade shall be 0.3 percent and maximum grade shall be 2.0 percent in open plaza areas. Special drains shall be installed as necessary. Maximum water surface over drains shall be 1/2 inch. Maximum water velocity in plaza areas shall be 2 feet per second.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
408	Prescriptive Spec	B	Parking lots shall be designed so that storm water is overland flow to a gutter or curb and gutter, then to an inlet where the water will enter a closed drainage system or other drainage facilities to be approved by the local agency having jurisdiction of the overall system and Metro, such as retention or irrigation systems. Overland flow shall be a minimum of 0.3 percent grade, and shall not run for more than 75 feet before being intercepted by a drainage structure such as a gutter or a drain. The maximum flow (flood width) in the gutter in a parking area shall not exceed 12 feet before being collected in a drainage system. Best Management Practices (BMP) shall be incorporated to satisfy SUSMP requirements for parking lots of 5,000 square feet or more, having 25 or more parking spaces and exposed to storm water runoff													
409	Prescriptive Spec	C	Street drainage shall be designed so water surface remains below top of curb and does not flow more than 1/2 inch deep in the traveled way. The traveled way being the lane that begins 8 feet away from the face of curb. Water surface elevation shall be controlled by adding catch basins as necessary and comply with local LID requirements.													
410	Performance Criteria	D	A storm drainage system shall be provided along all trackways and at all yards. The system normally consists of a combination of graded subgrade areas and perforated self-cleaning subdrains connected to the necessary laterals, collectors, and outfall structures. A system of ditches, catch basins, and storm drain pipes shall be designed to directed surface runoff away from all track areas and also to handle flow from the subdrain and any roof drain systems. In no case shall a storm drain flow into a subdrain.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
411	Prescriptive Spec	1	Yard trackwork areas shall be underlain by a 6" minimum layer of semi-impervious subballast properly compacted and graded at a minimum slope of 24:1 to the subdrains. Open surface track and material storage areas also shall be covered with an 8" layer of semi-impervious compactable material and shall be graded to area drains at a minimum slope of 24:1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	The drainage system shall contain the following minimum slopes													
412	Prescriptive Spec		Subdrains: -0.5%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
413	Prescriptive Spec		Laterals: -0.5%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
414	Prescriptive Spec		Main Collectors: -0.5%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
415	Prescriptive Spec		Ditches: -0.5%	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
416	Prescriptive Spec	3	Cleanouts shall be provided at the terminus of each subdrain. Manholes shall be provided at maximum intervals of 300' on the laterals and main collectors, or a junction, on angle points greater than 10 degrees in order to facilitate the maintenance of the drainage system. The individual subdrain runs shall not be longer than 300'.													
		3.8.6	DRAINAGE STRUCTURES													

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417	Performance Criteria	A	Drainage Structures, except for parking lots, shall be designed special structures which satisfy the conditions. Use of a local agency's standards is permissible, but shall meet local jurisdictional requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
418	Performance Criteria	B	Drainage structures for parking lots shall be selected from the standard storm drain details of the jurisdiction in which the parking lot is to be constructed. Inlet structures should not be located adjacent to bus pads, on-site bus stops, or where patrons would normally be picked up or dropped off by vehicles other than Metro buses.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
419	Prescriptive Spec	C	A sufficient number of inlets shall be provided to intercept the surface drainage. Inlets on grade shall be designed to intercept 85 percent or more of the design flow. Inlets in sump areas shall be designed to intercept 100 percent of the design flow or as required by local jurisdiction, whichever is more stringent. The amount of flow intercepted by an individual inlet shall be determined by the procedures outlined in the Federal Highways Administration's Hydraulic Engineering Circular No. 22 (HEC-22), entitled "Urban Drainage Design Manual" dated September 2009. Where local agencies have jurisdiction, inlets shall be designed in accordance with the practices of the local agency having jurisdiction.													
		3.8.7	STORM DRAINS													
		A	Closed Conduit													
420	Prescriptive Spec	1	Hydraulic Design: Pipe sizes shall be selected based on the criteria for Hydraulic design: Closed Conduits, in the Los Angeles County Flood Control District Hydraulic Design Manual. Main line minimum size shall be 24 inches and catch basin connector pipe minimum size shall be 18 inches. For storm drains run greater than 100 feet : the minimum size of reinforced concrete pipe (RCP) used shall be 24". When Metro construction requires the connection of a new storm drainage system to an existing system, the Designer shall check the hydraulics of the existing system, including the new flows, to determine adequacy and grades of the new drainage system. The minimum flow velocity shall comply with local governing agency design standard requirement. The Designer shall also check to see that the entrances and vent shafts and emergency stair exits are not subject to inundation by the Q50 frequency flood													
421	Prescriptive Spec	2	Materials: All underground storm drains shall be reinforced concrete pipe (RCP). RCP located in track R.O.W. shall be provided with cathodic protection as necessary. High Density Polyethylene Pipe (HDPE) and Polyvinyl Chloride Pipe (PVC) may be used where its use is approved by the governing agency. Drain connections in structural walls and floors shall be Ductile Iron Pipe (DIP). Steel pipe shall not be used in the permanent underground drainage system.	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX		
422	Definition	3	Friction Coefficient: Material Manning "n" Ductile Iron Pipe (DIP) 0.014 Polyvinyl Chloride Pipe (PVC) 0.012 Reinforced Concrete Pipe (RCP) 0.013 High Density Polyethylene Pipe (HDPE) 0.011	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
423	Performance Criteria	4	Structural Considerations: Class of pipe and bedding shall be determined from foundation conditions, depth of cover, and loading conditions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Open Channel													
424	Performance Criteria	1	Open channel design shall be based on the Criteria for Hydraulic Design: Open Channels, of the Los Angeles County Flood Control District Hydraulic Design Manual.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
425	Definition	2	Materials and Friction Factors: Below is a list of the treatments acceptable for open channel storm drainage. Accompanying each treatment is the roughness coefficient to be used in the solution of the Manning Formula and the maximum allowable velocity. The Designer shall submit for approval by Metro other channel alternatives. Material Manning "n" Max. Allowable Velocity ft/sec ▯ Concrete 0.013 20 ▯ Earthen Channel (clay) 0.020 4 ▯ Earthen Channel (rough,) 0.030 4 For other conditions refer to an appropriate hydraulic reference (e.g. King's Handbook of Hydraulics, etc.).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.8.8	FLOOD CONTROL													
426	Performance Criteria		The design of the transit system shall include an analysis of the potential flooding based on FEMA Special Flood Hazardous Area (SFHA) and local governing flood control requirements in the vicinity of transit facilities. Under any circumstances there shall be no flooding at the track guideway and station area, and to ensure that there is no impact to Metro track revenue services. The flood analysis shall consider such flood sources as storm surge flooding of rivers, flood control channels, storm drainage systems, and surface flows. The Designer shall perform the analysis the early design stage and submit the hydrology and hydraulic analyses report, together with recommendations for protecting the transit facilities from flooding and related impact to adjacent properties to Metro for review and approval. The proposed protection shall address all openings into the facilities, including tunnel portal entrance area, station entrances, vent shafts, emergency exits, access hatches and utility connections.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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427	Performance Criteria		The design of any drainage facility for flood control shall incorporate all applicable requirements to reduce erosion and control sedimentation caused by drainage facilities or construction activities. For all cases, the culvert opening shall be sized so that the energy grade line for subgrade event will not rise above the adjacent subgrade elevation (defined as 2.52 feet below top of rail elevation for timber ties and 2.81 feet below top of rail elevation for concrete ties).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.9	SITE WORK AND PARKING FACILITIES													
		3.9.1	GENERAL													
428	Performance Criteria	A	This chapter establishes criteria and standards for the design of streets, parking lots, parking structures, pedestrian facilities, and driveways, including signage, marking and striping, all of which are to be maintained by Metro. Roadway design in public right-of-way and for railroad crossings at-grade shall be in conformance with the specification and design guidelines of the affected local jurisdiction. (See 3.7, STREETS)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
429	Performance Criteria	B1	To provide for the safety of Transit Patrons while arriving, waiting at or departing from the station site.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
430	Performance Criteria	B2	To establish convenient traffic circulation patterns for vehicular and pedestrian movement.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
431	Performance Criteria	B3	To provide parking facilities that are safe, convenient, attractive, and easily maintained.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
432	Performance Criteria	B4	To provide for the reconstruction of local roads and streets	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.9.2	TRAFFIC MODES													
433	Performance Criteria	A	Patrons will arrive at, and depart from stations in as many as seven basic modes, as follows: Rail Pedestrian Bicycle Bus-and-Ride Drop Off/Pick Up Motorcycle Park-and-Ride	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
434	Performance Criteria	B	Facilities to park bicycles, motorcycles, and cars as well as off-street Bus-and-Ride and Kiss-and-Ride facilities will be incorporated at selected stations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
435	Performance Criteria	C	The maximum possible separation between modes of transportation shall be provided	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.9.3	METRO SYSTEM STREETS DESIGN ELEMENTS													
436	Performance Criteria	A1	Vehicular Entrances to Station Sites Vehicular entrances to station sites shall be in accordance with the following: 1. Vehicular entrances from public streets shall be from minor streets where possible, with provisions for sufficient stacking space provided at intersections with major streets.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
437	Performance Criteria	A2	Entrances, where feasible, should be so located that a vehicle approaching the station from any direction, missing one entrance, will find a second available without circuitous routing	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
438	Performance Criteria	A3	The number of vehicular entrances along any one street shall be minimized.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
439	Prescriptive Spec	A3	Entrances shall be at least 150 feet apart.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
440	Prescriptive Spec	A3	Sufficient number of entrances shall be provided so that the volume per lane entering station sites does not exceed 300 vehicles per hour	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
441	Performance Criteria	A4	Wherever the volume of traffic entering or exiting a public street increases the street traffic volume beyond the street capacity, the addition of auxiliary lane(s) shall be considered.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
442	Prescriptive Spec	B	Traffic Lanes All roadways other than those used mainly for service or maintenance purposes shall have at least one traffic lane for each direction of travel. The number of traffic lanes provided on these roadways shall be sufficient so that the vehicular volume per lane does not exceed 300 vehicles per hour. Where these roadways are one-way and have only a single traffic lane, the traveled-way width shall be 20 feet with either a gutter or shoulder on each side giving a clear distance of at least 24 feet between constraints. Lane width for roadways of more than one lane, exclusive of gutter or shoulder width, should be 12 feet but shall be not less than 11 feet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
443	Performance Criteria	C1	Parking Lanes and Curb Loading Zones 1. Placement of loading zones on access roadways shall reflect the following order of preference with respect to proximity of the loading zone to the station concourse: Buses Passenger cars (Drop Off/Pick Up) Taxi reservoirs	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
444	Performance Criteria	C2	Parking on Transit System roadways preferably shall be parallel to the curb. Lane width prescribed herein for parking and loading zones includes the gutter width.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
445	Performance Criteria	D1	Loading Zones for Buses and Taxis 1. The required bus (or taxi) design capacity for a station shall be determined by the Designer based on the individual requirements for each station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
446	Performance Criteria	D2	Loading zones for buses and taxis shall be located to provide the most direct and safest intermodal transfer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
447	Performance Criteria	D3a	The following designs show standard layout for various types of bus loading zones. a. Recessed Bus Bays: Where the volume of passenger cars or buses warrants on roads used jointly by cars and buses, the bus loading zone shall be recessed from the through traffic lane.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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448	Performance Criteria	D3a1	Recessed bus bays shall be designed parallel to and close enough to the curb so that passengers may enter and leave any door by an easy step to the curb. Upon leaving, the merging lane will enable the bus an easy re-entry into the through traffic lane.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
449	Prescriptive Spec	D3a2	The loading zone shall have a 10-foot wide lane, and the total length for a two-bus loading area should be 120 feet long with a 40-foot tapered section at each end. For each additional bus required, an additional 80-feet length shall be added at curbside.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
450	Standard Criteria	D3b	Parallel-to-Curb Bus Bays: Parallel to curb base shall have 10-foot-widelanes and a length of 80 feet.	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	•LA - Bus pad length 120', B4807 •All other cities = greenbook, Length = 85'	LA city std plans greenbook
451	Performance Criteria	D3c	Sawtooth Bus Bays: Sawtooth bus bays will reduce the length of loading zone, but will increase the width of roadway. The critical movement in this layout is the operation of moving a bus out and around a parked bus at the loading zone.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
452	Standard Criteria	D3c1	The minimum roadway width is determined as follows: 23 ft - 8 in. Clearance path of bus 2 ft - 0 in. Additional clearance 3 ft - 4 in. High point 29 ft - 0 in. Nominal roadway width	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
453	Performance Criteria	D3c2	The nominal roadway width is the average of the high and low points of the sawtooth and allows a direct comparison with the parallel-to-curb bus bays.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
454	Performance Criteria	D3d	60' articulated recessed bus bays and parallel-to-curb bus bays shall refer to BRT Design Criteria Figure 3-6. In addition, sawtooth bus bays for 60' articulated buses shall refer to BRT Design Criteria Figure 3-5	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
455	Prescriptive Spec	D3e	Passenger Car Drop Off/Pick Up shall have a minimum lane width of 8 feet. Parking spaces for Drop Off/Pick Up shall be 25 feet long and shall be no closer than 20 feet to a crosswalk	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
456	Standard Criteria	D3f1	Passenger Drop-off and Loading Zones for Disabled Shall be a minimum of 20 feet in length of vehicle pull-up space	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	LA DBS meets same length	
457	Standard Criteria	D3f2	Minimum 20' x 5' access aisle adjacent and parallel to the vehicle pull-up space	NE	NE	EX	EX	NE	EX	NE	NE	EX	NE	NE	Bell, Cerritos, Southgate = Greenbook length = 18' Cudahy = UBC Article 8, ch3, Aisle = 12'	
458	Performance Criteria	D3f3	Access aisle shall connect directly to an accessible route	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
459	Standard Criteria	D3f4	Minimum 114" vertical clearance at accessible drop-off and loading zones and along at least one vehicle access route to the zone	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		LA DBS
460	Standard Criteria	D3f5	The zone must be signed "PASSENGER LOADING ZONE ONLY" and include the International Symbol of Accessibility in white on a dark blue background (CA Title 24 1131B.1)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.9.4	SITE WORK CRITERIA													
461	Performance Criteria	A1	All areas of proposed construction shall be cleared, grubbed, and stripped. Areas disturbed by construction shall be protected by an erosion control system. Methods of erosion control to be considered include jute matting or burlap, application of chemical materials to stabilize surface areas, and application of gravel or coarse rock. Storm water pollution and prevention program (SWPPP) shall conform to the rules, regulations and practices of the agencies having jurisdiction. Seeding and sodding as a form of erosion control, shall be used on a case by case basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
462	Performance Criteria	A2	Construction of fills in areas that receive loading shall be a controlled fill. The method and device of construction and rework of existing soil shall be as recommended by the geotechnical consultant	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
463	Performance Criteria	A3	Site work shall comply with CALGreen for construction waste reduction disposal and recycling and for handling of excavated soil and land clearing debris.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
464	Performance Criteria	A4	Storm water pollution prevention design shall comply with CALGreen Section 5.106 Site Development. Grading and paving design plans shall show SWPPP and Best Management Practices (BMPs) during construction in accordance with CALGreen.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
465	Performance Criteria	A5	Heat island effect shall be considered in design in accordance with CALGreen	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
466	Standard Criteria	B1a	Parking lots a. Driveway Slopes and Ramps • 20% maximum slope on driveway or ramp. • 10% maximum cross slope of a driveway or ramp. • Transition slopes are required when the slope of the driveway or ramps exceeds 12%	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
467	Standard Criteria	B1b	General • 5% maximum slope in any direction in a parking stall. • 6% maximum slope in any direction in a traveled area. • 2% desirable slope in any direction. • 0.3% minimum slope in any direction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
468	Standard Criteria	B1c	Comply with Title 24 ADA Standards regarding slopes at parking spaces and access aisles designated for accessible parking. Accessible parking spaces shall be located at an optimum location and via the shortest and most accessible route within the parking. Routes should be delineated per current MUTCD Standards. Sidewalks, ramps, and curbs must meet the current ADA Standards. • Maximum 6%	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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469	Standard Criteria	B2	Metro Property Streets ? Maximum 6% ? Desirable 5% ? Minimum 0.5% ? Desirable 1% ? Cross-slope 2% ? Crown cross section except on curves where 2% continuous cross-slope toward center of curve may be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
470	Standard Criteria	B3	Maximum Grade Differential for Metro Property Streets ? Crest Vertical Curve 9% ? Sag Vertical Curve 6.5%. NOTE: Crest and Sag Curves at top and bottom of ramps without parking may exceed these differentials, but must use a vertical curve 20 feet in length or more.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
471	Performance Criteria	B4	All Other Streets ? Refer to Applicable Jurisdiction	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
472	Standard Criteria	C	Design Speeds 1. In parking facilities - not applicable 2. On Metro Property streets - 30 mph. 3. All other streets - Refer to applicable Jurisdiction	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
473	Standard Criteria	D1	Clearances 1. Metro Property Streets ? Vertical, 14 feet 6 inches ? Horizontal, 2 feet 6 inches from face of curb to fences, light standards, and pedestrian barriers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
474	Standard Criteria	D2	Parking Lots ? Vertical, 7 feet 0 inches (with height restrictions noted) ? Horizontal, 2 feet 6 inches. ? Minimum 114	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
475	Standard Criteria	E	Vertical Curves on Metro Property Streets 1. Crest Curves - Lmin = 28 A 2. Sag Curves - Lmin = 35 A. Where: Lmin = minimum vertical curve length A = Algebraic difference in grades No vertical curves shall be less than 20 feet	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
476	Standard Criteria	F	Curb Returns Parking Lots and Areas 1. For cabs, 20 feet (Inside Radius) 2. For buses, 30 feet minimum (inside radius), 50 foot minimum (outside radius clear). 3. For passenger cars 15.3 feet minimum (inside radius), 25.8' minimum (outside radius clear).	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	LA City Complete streets Guide Bus/Transit = 25' LA County Std 1130-1 = 17' min	
477	Standard Criteria	G	Sight Distance at Intersections To comply with "A Policy on Geometric Design of Rural Highways," current edition, published by the American Association of State Highways and Transportation Officials (AASHTO)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
478	Prescriptive Spec	H	Curbs and Gutters All Transit Property streets and parking lots shall have curbs and gutters. Curbs shall be 6-inch-high, barrier-type, with sloping face of 1 inch horizontal to 6 inches vertical. Gutters shall be 24 inches, sloped to roadway or parking lot cross-slope and grade. Curbs and gutters shall be cast-in-place Class A concrete, and shall be in compliance with City or Public Work Construction standard plans.	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	EX	LA City, S-410-2, curb face batter 1-1/2 : 12 Greenbook 2021, 120-3, curb face batter 3:12	
479	Prescriptive Spec	I	Side Slopes Cut-and/or-fill-slopes shall be as flat as possible, and shall not exceed a slope of 2:1 (horizontal to vertical) or as recommended by the geotechnical consultant. Tops of cut slopes shall be rounded.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
480	Performance Criteria	J	Drainage Drainage runoff shall be calculated in accordance with: 1. Surfaces shall be sloped to drain away from areas where pedestrians walk. 2. Catch basins are not to be located in pedestrian walkway	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.9.5	TRAFFIC CONTROL DEVICES													
481	Performance Criteria	A	General Criteria The paragraphs that follow prescribe the criteria to be used for signs and for pavement and curb markings in streets, parking lots, and parking structures. See Section 3.3.12 for traffic signal requirements. Curb markings, signs and striping used on Metro-owned streets and parking lots shall be standard facilities as required by the latest edition manual on Uniform Traffic Control Devices. The application of any traffic control device shall: 1. Fulfill an important need 2. Be located in such a manner as to command attention and provide adequate time for response 3. Command respect and gain compliance 4. Convey a clear, simple, and appropriate message 5. Complement a good design	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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482	Performance Criteria	B	Signs 1. Signs shall be displayed only for the specific purpose and under the specific conditions prescribed in these criteria. 2. Signs shall not be used to confirm well known or universally recognized rules of the road. They shall be used where special regulations apply at specific places or at specific times only, or where hazards are not self-evident. Care shall be taken not toinstall too many signs, especially those of the regulatory or warning types, which, if used too excessively, tend to lose effectiveness. On the other hand, a frequent display of directional signs will not lessen their value. 3. Signage per latest edition of Uniform Traffic Control Devices, and California MUTCD 2003 Rev. 1, as amended for use in California.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
483	Performance Criteria	C	Striping Codes and Standards Paint materials, striping details, including standard pavement marking, striping with markers, striping transitions and crosswalk detail are to be obtained from standard plans and drawings of each jurisdiction where appropriate and shall comply with current federal and state accessibility regulations. Where local standards are not available, the latest edition of Manual on Uniform Traffic Control Devices and Caltrans Traffic Manual shall be used as guides to pavement marking.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.9.6	PARKING GENERAL (SEE FIGURES 3.8 THRU 3.21)													
484	Performance Criteria		For parking lot design within the station area, the designer shall consider providing adequate designated parking stalls per project requirements for Metro security personnel and those engaged in revenue pickup from TVMs. The identified location for security parking shall be safe and close to the station entrance. Other required designated parking stalls per the California Green Building Code shall be incorporated into the parking lot design, such as parking for clean air vehicles and bicycles and providing Electric Vehicle (EV) charging.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
485	Standard Criteria	A1	Parking Stall Dimensions 1. Stall Angle (Parallel) 45o 60o 90o Stall Dimension Normal Car - width 9.0 ft 9.0 ft 9.0 ft 9.0 ft - length 22.0 ft 18.0 ft 18.0 ft 18.0 ft Disabled spaces - width 14.0 ft 14.0 ft 14.0 ft - length 18.0 ft 18.0 ft 18.0 ft Disabled Van Space 45o 60o 90o - Width 17.0 ft 17.0 ft 17.0 ft - length 18.0 ft 18.0 ft 18.0 ft Small Car - width 8.0 ft 8.0 ft 8.0 ft - length 15.0 ft 15.0 ft 15.0 ft Clear Aisle - width (Roadway) 13.0 ft 19.0 ft 27.0 ft (one way) (one way) (two way)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
486	Prescriptive Spec	A2	The criteria relating to small-car stalls shall be based on the specifications and design guidelines of the local agency responsible for locale parking lot layout.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
487	Prescriptive Spec	A3	Disabled parking spaces shall be provided in accordance with Title 24, Section 2-7102, California Code of Regulations (CCR) (refer to Caltrans Standard Plan Accessible Parking Off-Street). Disabled parking spaces shall be located as near as practical to a primary entrance to a facility (building, station entrance, or boarding platform). The space shall be located so that a disabled person does not have to wheel or walk behindparked cars other than his/her own. Pedestrian ways shall be provided so as to ensure an accessible pathway from each such parking space to the facility; walks and sidewalks shall conform to Title 24 Sec. 2-3323. When parking is provided for patrons, employees, or visitors, the minimum number of disabled spaces required is as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
488	Prescriptive Spec	A3	Total No. Parking Spaces No. disabled Parking Space Required 1 to 25 1 26 to 50 2 51 to 75 3 76 to 100 4 101 to 150 5 151 to 200 6 201 to 300 7 301 to 400 8 401 to 500 9 501 to 1000 2% of total 1001 and over 20 plus 1 for each 100 over 1000 One (1) Van Parking Space for every 6 disabled spaces The requirement in Title 24, shall also be met for other factors such as signage, minimum dimensions of accessible spaces, slope of parking surfaces, and entrances/vertical clearances for parking structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
489	Performance Criteria	B1	Multilevel Parking Structures 1. Ground levels shall contain entrances and exits, reservoir areas and internal ramps, and locations for Pay Parking Machines, as well as parking areas. Drop Off/Pick Up areas shall be located outside the parking structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
490	Performance Criteria	B2	2. Traffic circulation within parking structures shall be designed to minimize vehicular travel distances and number of turns. A left hand traffic pattern is preferred.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
491	Performance Criteria	B3	3. Columns will be located to provide uniform spans for the structure as much as is possible. Columns must not encroach on the clear dimensions noted for cars, unless a small-car stall can be created. Columns shall be located not closer than every third stall.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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492	Performance Criteria	B4	4. Where site conditions permit, adjoining street grades shall be used to minimize the need for ramps between parking levels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
493	Performance Criteria	B5	5. Internal ramps shall be placed as far as practicable from entrances and exits. The ramps shall be so placed that they do not constitute a direct and natural path for pedestrian travel to the station concourse. Internal ramps shall be designed for two-way travel. Parking stalls shall not be located on curved internal ramps.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
494	Performance Criteria	B6	6. External ramps may be used where appropriate. The ramps shall be designed for two-way travel and shall merge directly into, or diverge directly from streets. Whenever practicable, a grade separation of pedestrians and vehicles shall be provided where external ramps cross pedestrian walkways. Parking stalls shall not be located on external ramps.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
495	Performance Criteria	B7	The design capacity of ramps shall be 200 vehicles per lane per hour.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
496	Prescriptive Spec	B8	Ramp grades shall be kept as low as practicable, and excluding areas of transition, shall not exceed 6 percent on ramps with parking or 12 percent on ramps without parking.													
497	Prescriptive Spec	B9	Traveled ways, other than parking aisles and ramps, shall be 24 feet wide for two-way travel and 16 feet wide for one-way travel. The minimum vehicular inside turning radius shall be 16 feet, and the minimum outside turning radius shall be 26 feet.													
498	Performance Criteria	B10	Secure enclosed bike parking for long term rental shall be provided at ground level close to station entrance but not located immediately next to queuing areas. The size and number shall meet Metro's Bike program that is a function of ridership.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
499	Performance Criteria	B11	Electrical conduits for Electric Vehicle (EV) chargers shall be installed per the requirements of local jurisdictions. Number of EV parking stalls will be determined by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.9.7	Drop Off/Pick Up Facilities													
500	Performance Criteria	A	Capacity The required design capacity for a station shall be determined by the Designer and will be based on the individual requirements of each station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
501	Performance Criteria	B1	Location Location of Drop Off/Pick Up facilities shall be in accordance with the following: 1. Drop Off/Pick Up facilities located off-street, in a parking lot, shall be as near to the station concourse entrances as practicable and shall be physically separated so as not to appear as an integral part of long-term parking areas within the parking lot or parking structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
502	Performance Criteria	B2	Drop Off/Pick Up facilities shall be located off-street, as near to the main station entrance as practical, and shall be physically separate from long-term parking areas and Bus-and-Ride facilities. Loading is preferred on the right-hand side of the car. The location should, if possible, be such that a driver can view the station entrance to see an exiting passenger for whom he is waiting.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
503	Performance Criteria	B3	An accessible parking area for persons waiting to pick up persons with disabilities shall be provided as required by installing appropriate pavement markings and signs per MUTCD Standards requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
504	Performance Criteria	B4	All Drop Off/Pick Up parking spaces shall be delineated by signs or curb markings as being limited to short-term use.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
505	Performance Criteria	B5	Drop Off/Pick Up parking stalls shall be 9 feet wide and 18 feet long.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
506	Performance Criteria	B6	All loading and unloading areas need to be properly marked with signage and curb markings indicating short-term parking for Drop Off/Pick Up only.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.10	**CORROSION CONTROL**													
		3.10.1	INTRODUCTION													
		A	Scope													
		B	Codes, Standards and Regulations													
507	Performance Criteria		Corrosion control systems shall conform to the requirements of the codes (including ordinances), regulations (including general rules and safety orders), and standards and recommended practices in publications by the organizations listed:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
508	Performance Criteria	B1	NACE International (National Association of Corrosion Engineers)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
509	Performance Criteria	B2	Steel Structures Painting Council (SSPC)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
510	Performance Criteria	B3	National Fire Protection Association (NFPA)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
511	Performance Criteria	B4	American National Standard Institute (ANSI)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
512	Performance Criteria	B5	National Electrical Manufacturers Association (NEMA)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
513	Performance Criteria	B6	American Society of Testing and Materials (ASTM)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
514	Performance Criteria	B7	State of California, Department of Transportation (CALTRANS) Standard Specifications	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
515	Performance Criteria	B8	Standard Specifications for Public Works Construction (SSPWC)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
516	Performance Criteria	B9	American Institute of Steel Construction (AISC), Code of Standard Practice for Steel, Buildings and Bridges	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
517	Performance Criteria	B10	California Building Code (CBC)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
518	Performance Criteria	B11	California Underground Storage Tank Regulations, Title 23	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
519	Performance Criteria	B12	Environmental Protection Agency (EPA)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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520	Performance Criteria	B13	American Association of State Highway and Transportation Officials (AASHTO)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
521	Performance Criteria	B14	U.S. Department of Transportation, Regulations for the Transportation of Natural (or other) Gas by Pipeline, Parts 191 and 192, Title 49	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
522	Performance Criteria	B15	U.S. Department of Transportation, Regulations for the Transportation of Liquids by Pipeline, Part 195, Title 49	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
523	Performance Criteria	B16	California Code - Chapter 5.5: The Elder Pipeline Safety Act of 1981 [51010-51019.1]	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
524	Performance Criteria	B17	Applicable local and munipal codes	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.10.2	GENERAL													
		A	Requirements													
		1	Soil Corrosion Control													
525	Performance Criteria		Designs shall be based on corrosive characteristics of the soils as documented in pre-design evaluation reports, and from actual on-site measurement as necessary.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Stray Current Corrosion Control													
526	Performance Criteria		Criteria in this category apply to measures installed with the traction power system and trackwork to ensure that stray earth currents do not exceed maximum acceptable levels. Designs shall be based on conditions documented in pre-design evaluation reports.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Atmospheric Corrosion Control													
527	Performance Criteria		Criteria in this categoy apply to systems or measures installed to mitigate corrosion caused by local climatological conditions and air pollutants.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4	Microbiologically Influenced Corrosion (MIC)													
528	Performance Criteria		Criteria in this category apply to systems or measures installed to mitigate corrosion caused by microorganisms found in water distribution systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	System Interferences													
529	Performance Criteria		Corrosion control engineering shall be interfaced and coordinated with other disciplines, including mechanical, utiltiy, electrical, signaling, and communications design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.10.3	SOIL CORROSION CONTROL													
		A	General													
		1	Materials of Construction													
530	Performance Criteria		All buried pressure and nonpressure piping and conduit shall be non-metallic, unless metallic materials are required for specific engineering purposes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
531	Performance Criteria	1a	Direct buried non-pressure piping (metallic) shall include provisions for corrosion control through the use of protective coatings or encasements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
532	Performance Criteria	1b	Direct buried pressured piping (metallic) shall include provisions for corrosion control through the use of protective coatings and cathodic protection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Location for Below-Grade Conduits and Piping													
533	Performance Criteria		Horizontal runs of metallic piping and conduits for below grade structures shall be routed through the inside of the structure in lieu of direct burial. Vertical runs of metallic piping and conduits for below grade structures shall be routed through vent shafts, utility chases, or other vertical passages within the structure to keep buried pipe depths at normal utility depths, not exceeding 10 ft.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Safety and Continuity of Operations													
534	Performance Criteria		Corrosion control provisions shall be required for those facilities, where failure of such facilities caused by corrosion may affect the safety or interrupt the continuity of operations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4	Accessibility of Installations													
535	Performance Criteria		Corrosion control provisions shall be accessible after installation, allowing for periodic maintenance and monitoring.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5	Special Considerations													
536	Performance Criteria	5a	Individual transit-owned facilities shall be reviewed to determine the need for, and extent of, additional requirements not established herein.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
537	Performance Criteria	5b	Corrosion control for facilities owned by others shall be determined by the owners, except where contractual agreements make it a transit design responsibility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
538	Performance Criteria	5c	Installation of corrosion control measures for facilities owned by others, but designed as part of Metro Rail Projects, shall be coordinated through Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Materials and Methods													
		1	Coatings													
539	Performance Criteria	1a	Minimum volume resistivity of 10^10 ohm-centimeter	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
540	Prescriptive Spec	1b	Minimum thickness as recommended for the specific system, but not less than 0.015 inch.													
541	Performance Criteria	1c	A chemical or mechanical bond to the metal or concrete surface or a tape system depending on the service of piping system on which the coating is to be applied.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
542	Performance Criteria	1d	Minimum five-year performance record for the intended service.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
543	Performance Criteria	1e	Mill application wherever possible, with field application of a compatible mastic or tape system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
544	Performance Criteria	1f	Mechanical characteristics capable of withstanding reasonable abuse during handling and earth pressure after installation, for the design life of the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
545	Standard Criteria	1g	Coatings shall conform to current South Coast Air Quality Manangement District Rules and Regulations governing paints and solvents.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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546	Standard Criteria	1h	Coatings for linings on potable water lines or tanks shall be accepted by the Environmental Protection Agency (EPA), National Sanitation Foundation (NSF International - standard NSF/ANSI Std. 61), and/or the American Water Works Association (AWWA) for such use.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
547	Performance Criteria	1i	Coatings specified for corrosion control of buried metallic or concrete facilities shall satisfy the following criteria. Designers shall specify surface preparation, application procedure, primer, number of coats, dry film thickness, and testing and repair procedures for the coating system specified. Generic coating systems for buried structures shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
548	Performance Criteria	1i1	Extruded polyethylene/butyl-based systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
549	Performance Criteria	1i2	Coal-tar enamal (hot applied)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
550	Performance Criteria	1i3	Coal-tar epoxies (two component systems)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
551	Performance Criteria	1i4	Fusion bonded epoxies	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
552	Performance Criteria	1i5	Polyethylene-backed butyl mastic tapes (cold-applied)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
553	Performance Criteria	1i6	Bituminous mastics (airless spray)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
554	Standard Criteria	1j	Polyethylene encasement specified for ductile iron and cast iron piping systems shall comply with AWWA Standard C105.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Electrical Insulation of Piping													
555	Performance Criteria		Devices used for in-line electrical isolators for corrosion control of piping shall include nonmetallic inserts, isolating flanges, isolating couplings and isolating unions. Devices shall meet the following criteria:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
556	Prescriptive Spec	2a	A minimum resistance of 10 megohms prior to installation and mechanical and temperature ratings appropriate to the structure in which they are installed.													
557	Prescriptive Spec	2b	Sufficient electrical resistance after insertion itno the operating piping system such that no more than 2 percent of a test current applied across the device flows through the insulator, including flow through conductive fluids if present.													
558	Prescriptive Spec	2c	Where conductive fluids with a resistivity of less than 1000 ohm-centimeters are present, internal coating requirements shall be based on separate evaluation.													
559	Performance Criteria	2d	Isolating devices (except nonmetallic units) buried in soils shall be encased in a protective coating.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
560	Performance Criteria	2e	Isolating devices installed in chambers or otherwise exposed to partial immersion or high humidity shall have a protective coating applied over all components.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
561	Performance Criteria	2f	Isolating devices shall conform to current NACE International recommended practices. The designer shall specify the need for and the location and type of in-line isolating devices with consideration of the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
562	Performance Criteria	2f1	Inaccessible in-line isolating devices such as buried or elevated insulators shall be equipped with permanent test facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
563	Performance Criteria	2f2	In-line devices for cathodically protected pipelines that are located inside underground stations or tunnels shall be equipped with permanent test facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
564	Prescriptive Spec	2g	A minimum clearance of 6 inches shall be provided between new and existing metallic structures. When conditions do not allow a 6 inch clearance, the design shall include special provisions to prevent electrical contact with existing structures.													
565	Performance Criteria	2h	Casing insulators used electrically isolate metallic carrier pipes from metallic pipe casings shall be concentric support spacers fabricated from high-density injected polyethylene. Support spacers shall be sized to maintain a minimum 2 inch clearance between the carrier pipe or protruding joints of carrier pipe and the inside surface of the pipe casing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
566	Performance Criteria	2i	Casing end seals used for sealing the annular space between a metallic pipe casing and metallic carrier pipe shall be fabricated from non-conductive material that will provide electrical isolation between the casing and carrier pipe. End seals shall be external pull-on or internal mechanical type seals that meet the following criteria:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
567	Performance Criteria	2i1	External pull-on type seals shall be fabricated from synthetic rubber and banded to the carrier pipe and casing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
568	Performance Criteria	2i2	Internal mechanical type seals shall consist of interlocking synthetic rubber link shaped to fill the annular space between the carrier pipe and casing and expanded with non-conductive pressure plates.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
569	Performance Criteria	2i3	Seals shall be sized for the particular combination of carrier pipe and casing involved to obtain a watertight seal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
570	Performance Criteria	2j	Insulating wall sleeve assemblies for carrier pipes at floor, roof and wall penetrations of structures shall consist of a metallic pipe sleeve and interal mechanical seals that provide a watertight seal with complete electrical isolation between the carrier pipe and pipe sleeve or structural elements of the penetration.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
571	Performance Criteria	2j1	The design of assemblies for floor and wall penetrations of above-grade structures and vaults or at-grade structures without an exterior hydrocarbon-resistant membrane shall employ internal mechnical-type seals consisting of interlocking synthetic rubber links shaped to fill the annular space between the carrier pipe and pipe sleeve when expanded with non-conductive pressure plates.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
572	Performance Criteria	2j2	Sealing clamps for exterior hydrocarbon-resistant membrane shall be designed to provide electrical isolation between the carrier pipe and clamp.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
573	Performance Criteria	2j3	Mastic and lead sealants or other types of chaulking shall not be acceptable for seals on insulating wall sleeve assemblies.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Electrical Continuity of Piping													

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574	Performance Criteria		Electrical continuity shall be specified for all nonwelded pipe joints in buried cast iron, ductile iron and steel pressure piping and shall meet these requirements:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
575	Performance Criteria	3a	Direct burial insulated, stranded copper wire shall be used of a minimum length necessary to span the joint being bonded.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
576	Performance Criteria	3b	Wire size shall be based on the electrical characteristics of the structure and resulting electrical network to minimize attenuation and allow for cathodic protection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
577	Prescriptive Spec	3c	A minimum of two bond wires per joint shall be used for redundancy.													
578	Performance Criteria	3d	The need to specify electrical continuity on non-pressurized piping shall be considered on an individual basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4	Cathodic Protection													
579	Performance Criteria		Cathodic protection shall be accomplished by sacrificial galvanic anodes to minimize corrosion interaction with other underground utilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
580	Performance Criteria	4a	Cathodic protection system design shall be based on theoretical calculations that include the following parameters:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
581	Prescriptive Spec	4a1	Cathodic current density (min. 1.0 mA/sq. ft. of bare area)													
582	Performance Criteria	4a2	Estimated current output per anode	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
583	Prescriptive Spec	4a3	Estimated percentage of bare surface area (minimum 1%)													
584	Performance Criteria	4a4	Estimated total number of anodes, size and spacing	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
585	Prescriptive Spec	4a5	Minimum anode life of 25 years (50% efficiency)													
586	Performance Criteria	4a6	Estimated anode bed resistance to earth	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
587	Performance Criteria	4a7	Estimated pipeline resistance to earth	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
588	Performance Criteria	4b	Rectifiers shall be rated at a minimum o f50% above calculated operating levels to overcome a higher-than-anticipated ground bed resistance, lower-than-anticipated coating resistance, or presence of interence bonds.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
589	Performance Criteria	4c	Test facilities consisting of a minimum of 2 structure connections	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Structures and Facilities													
		1	Ferrous Pressure Piping													
590	Performance Criteria		All new buried cast iron, ductile iron and steel pressure piping shall be cathodically protected. Designs shall satisfy the following minimum criteria:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
591	Performance Criteria	1a	Application of a protective coating to the external surface of the pipe (See paragraph 3.10.3.B.1, Coatings)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
592	Performance Criteria	1b	Installation of in-line electrical isolating devices for electrical isolation of pipe from interconnecting pipe and other structures, and segregation into discrete electrically-isolated sections depending upon the total length of piping.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
593	Performance Criteria	1b1	Isolating union or flange shall be located a maximum of 5 ft from the wall, roof or floor penetration.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
594	Performance Criteria	1b2	Direct metallic contacts to the electrically-isolated section of pipe between the isolating union or flange and wall, roof or floor penetration, such as pipe hangers and supports, shall not be allowed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
595	Performance Criteria	1c	Electrical continuity through the installation of insulated copper wires across all mechanical joints other than intended insulators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
596	Performance Criteria	1d	Additional facilities shall be installed at intermediate locations, either at intervals not greater than 200 ft, or at greater intervals as determiend on an individual structure basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
597	Performance Criteria	1e	Permanent test/access facilities at buried casings to allow for verification of electrical isolation between the casing and carrier pipe and evaluation of protection levels of cathodic protection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
598	Performance Criteria	1f	Number of anodes and direct current output requirements for rectifiers shall be determined on an individual structure basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Copper Piping													
599	Performance Criteria	2a	Buried copper pipe shall be electrically isolated from nonburied piping, such as that contained in a station structure, through use of an accessible insulating union or flange installed inside the structure where the piping enters a wall or floor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
600	Performance Criteria	2b	Copper pipe shall be electrically isolated at connections to dissimilar pipe such as steel and ductile iron pipe through the use of insulating fittings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
601	Performance Criteria	2c	The need for cathodic protection on buried copper pipe shall be considered on an individual basis taking into account local soil characteristics and past performance in similar environments.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Prestressed and Reinforced Concrete Cylinder Pipe (Pressure)													
602	Prescriptive Spec	3a	Prestressed concrete cylinder pipe shall not be used in the area of yard or shop facilities or at locations where an analysis of soil borings indicate the pipe will be exposed to chloride concentrations in excess of 200 ppm. Design and fabrication of prestressed concrete cylinder pipe shall be in accordance with AWWA standard C301 with the following provisions:													
603	Prescriptive Spec	3a1	A minimum mortar coating thickness of 1 inch.													
604	Prescriptive Spec	3a2	The use of 6-gauge or larger prestressing wire. The use of Class IV wire shall not be allowed.													

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605	Prescriptive Spec	3a3	Use of Type II cement, or a sulfate-resistant fly ash modified Type II cement or Type V cement when analysis of soil borings indicate structures will be exposed to soil sulfate concentrations in excess of 2000 ppm or ground water sulfate concentrations in excess of 1500 ppm.													
606	Performance Criteria	3a4	Electrical continuity between steel cylinder and prestressing wires at each end of a fabricated pipe section.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
607	Prescriptive Spec	3a5	Provide a minimum of two longitudinal shorting straps for prestressing wire. Number and size of straps shall be determined on an individual basis.													
608	Prescriptive Spec	3a6	Provide a minimum of two copper bonding wires between each section of steel cylinder at each joint.													
		4	Gravity Flow Piping (non-pressured)													
609	Performance Criteria	4a	Corrogated steel piping used outside the Metro right-of-way shall include the following minimum provisions:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
610	Performance Criteria	4a1	An Internal mortar lining with a bituminous coating on ductile iron only (not required for cast iron soil pipe)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
611	Performance Criteria	4a2	Application of hot-applied asphaltic protective coating, with a minimum resistivity of 10^10 ohm-centimeter on both the internal and external surfaces. Coating to have an established performance record for the intended service.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
612	Performance Criteria	4b	Cast and ductile iron non-pressure piping shall be designed and fabricated to include the following provisions:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
613	Performance Criteria	4b1	An Internal mortar lining with a bituminous coating on ductile iron only (not required for cast iron soil pipe)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
614	Standard Criteria	4b2	A polyethylene encasement on the external surfaces in contact with soils, per AWWA Standard C105.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
615	Performance Criteria	4b3	A bituminous mastic coating on the external surfaces of pipe six inches on each side of a concrete/soil interface. Pipe and fittings at concete thrust blocks shall be mastic coated and covered with a loosely-applied felt wrap secured with tape.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
616	Standard Criteria	4c	Reinforced concrete, nonpressure piping shall be designed and fabricated in accordance with AWWA Standard C302 and include:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
617	Performance Criteria	4c1	Water/cement ratios shall be the minimum required to meet the strength requirements of AWWA C302.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
618	Prescriptive Spec	4c2	Maximum 250 ppm chloride concentration in the total concentration mix (mixing water, cement, admixture, and aggregates)													
619	Prescriptive Spec	4c3	Use of Type II cement, or a sulfate-resistant fly ash modified Type II cement or Type V cement when analysis of soil borings indicate structures will be exposed to soil sulfate concentrations in excess of 2000 ppm or ground water sulfate concentrations in excess of 1500 ppm.													
		5	Electrical Conduit													
620	Performance Criteria	5a	Buried metallic conduits shall be hot-dip galvanized rigid steel with PVC or other coating acceptable for direct burial, including couplings and fittings. The PVC coating is not required when conduits are installed in concrete.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
621	Performance Criteria	5a1	Joint threads cut in conduit after galvanizing by manufacturer shall be protected with a flame sprayed zinc coating.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
622	Performance Criteria	5a2	Couplings and fittings shall be hot-dip galvanized after fabrication and cutting of threads.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
623	Performance Criteria	5a3	Threads for field cuts in conduit shall be protected with a zinc-rich coating.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Corrosion Control Testing													
624	Performance Criteria		Corrosion control designs for buried structures and hydraulic elevator cylinders shall include provisions for the following minimum testing to insure compliance with design specifications:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
625	Performance Criteria	1	Electrical continuity of piping systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
626	Performance Criteria	2	Electrical continuity of test facilities	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
627	Performance Criteria	3	Electrical effectiveness of insulating fittings	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
628	Performance Criteria	4	Electrical testing (holiday testing) of coating	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
629	Performance Criteria	5	Performance/baseline testing for cathodic protection systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6	Hydraulic Elevator Systems													
630	Performance Criteria	6a	Hydaulic Elevator Cyliners	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
631	Standard Criteria		Design of hydraulic elevator cylinders shall comply with California Underground Tank Regulation (CUTR), Title 23, when required by local City and County agencies or by the California Code of Regulations for Elevators when local codes do not prevail.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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632	Performance Criteria	6a1	Application of an external protective coal-tar epoxy coating resistant to deterioration by petroleum products (hydraulic fluid).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
633	Performance Criteria	6a2	Installation of hydraulic casing within a sealed PVC enclosure inside an outer concentric fiberglass-reinforced plastic (FRP) casing, or inside a high density polyethylene (HDPE) casing locations where an exterior hydrocarbon-resistant membrane is required for elevator pit. Casing thickness, joints, and diameter shall be designed to prevent moisture intrusion to maximize eletrical insulation between the cylinder and earth, and to provide secondary containment when considered necessary or required in the design of the hydraulic elevator system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
634	Performance Criteria	6a3	A removable moisture-proof sealing lid installed on the top of the casing prior to installation of the cylinder. The top of the casing shall be permanently sealed against moisture intrusion after installation of the cylinder.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
635	Performance Criteria	6b	Hydraulic Fluid Lines	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
636	Standard Criteria		Design of hydraulic fluid lines shall comply with CUTR, Title 23, when required by local City and County agencies and Codes or California Code of Regulations for elevators. Hydraulic fluid lines shall be installed within the station or structure and shall not be buried in soil unless absolutely mandatory for specifc engineering purposes. If burial is required, the design of the hydraulic fluid lines shall include the following corrosion control provisions:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
637	Performance Criteria	6b1	Application of an external corrosion-protective coal-tar epoxy coating or equivalent coating resistant to deterioration by petroleum products (hydraulic fluid)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
638	Performance Criteria	6b2	Installation inside a non-metallic casing for corrosion control. Design shall include provisions to preevent moisture and soil intrusion into the casing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
639	Performance Criteria	6b3	Non-metallic casing shall be fiberglass-reinforced plastic (FRP) or high-density polyethylene (HDPE) at locations where an exterior hydrocarbon-resistant membrane is required for an elevator pit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
640	Performance Criteria	6b4	If compliance with CUTY, Title 23, is required or considered necessary in the design of the hydraulic elevator system, the buried hydraulic fluid line shall be provided secondary containment through the use of the non-metallic casing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7	Underground storage tanks and associated product lines shall be installed in accordance with CUTR, Title 23.													
641	Performance Criteria	7a	Tanks and product lines shall be constructed of fiberglass-reinforced plastic unless other materials of construction, such as steel, are absolutely mandatory for specific engineering purposes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
642	Performance Criteria	7b	Where possible, double-wall fiberglass-reinforced plastic tanks shall be used for containment purposes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
643	Performance Criteria	7c	Cathodic protection and corrosion control requirements shall comply with Title 23.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
644	Performance Criteria	7d	If metallic product lines are required, they shall be provided secondary containment through the use of a non-metallic casing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8	Buried Concrete/Reinforced Concrete Structures (Excluding Tunnels)													
645	Performance Criteria		The design of concrete structures shall be based on:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
646	Performance Criteria	8a	Use of Type II cement, or a sulfate-resistant fly ash modified Type II cement or Type V cement when analysis of soil borings indicate structures will be exposed to soil sulfate concentrations in excess of 2000 ppm or ground water sulfate concentrations in excess of 1500 ppm.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
647	Performance Criteria	8b	Use of dense, low-permeability and durable concrete by control of water/cement ratio and use of an air entrainment admixture. Use a maximum water cement ratio by weight in accordance with either ACI standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
648	Prescriptive Spec	8c	Maximum chloride concentration of 250 ppm in the cement, mixing water, aggregate and admixtures combined.													
649	Performance Criteria	8d	Concrete cover over reinforcing steel shall be in accordance with ACI Standards, but not less than the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
650	Prescriptive Spec	8d1	A minimum of two inches on soil side of reinforcement when pouring within a form.													
651	Prescriptive Spec	8d2	A minimum of three inches on the soil side when pouring directly against soils.													
652	Performance Criteria	8d3	A minimum of three inches of cover on the soil side under all situations when an analysis of soil borings indicate structures will be exposed to chloride concentration in excess of 200 ppm.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
653	Performance Criteria	8e	The need for additional corrosion control measures, as a result of localized special conditions, shall be determined on an individual basis by the corrosion engineer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9	Support Pilings													
654	Performance Criteria		Designs based on the use of permanently installed metallic supports exposed to the environment such as steel H-beams or soldier piles may require special corrosion control measures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
655	Performance Criteria		As part of the soil corrosivity study, soil chemical data such as pH, chlorides, sulfides, and sulfates shall be collected and used to calculate the corrosion rate for the support piling.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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656	Performance Criteria	9a	Reinforced concrete piling, including prestressed fabrications, shall be designed to meet the following minimum criteria:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
657	Performance Criteria	9a1	Use of a Type II Cement, or a sulfate-resistant fly ash modified Type II cement or Type V cement when analysis of soil borings indicates structures will be exposed to soil sulfate concentrations in excess of 2000 ppm or ground water sulfate concentrations in excess of 1500 ppm.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
658	Standard Criteria	9a2	Concrete cover over reinforcing steel shall be in accordance with ACI Standards, but not less than 3 inches over the outermost reinforcing steel including prestressing wire if present.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
659	Performance Criteria	9a3	Use water/cement ratio by weight in accordance with ACI Standard and maximum chloride concentrations of 250 ppm in the total mix.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
660	Performance Criteria	9a4	Additional corrosion control measures as required based on site-specific conditions as determined by the corrosion engineer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		10	Concrete Subway Structures (Cut-and-Cover Construction and Tunnels)													
661	Performance Criteria		All cut-and-cover concrete subway structures shall include the following provisions:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
662	Performance Criteria	10a	Use of a Type II Cement, or a sulfate-resistant fly ash modified Type II cement or Type V cement when analysis of soil borings indicates structures will be exposed to soil sulfate concentrations in excess of 2000 ppm or ground water sulfate concentrations in excess of 1500 ppm.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
663	Performance Criteria	10b	Use of dense, low-permeability and durable concrete by control of water/cement ratio and use of an air entrainment admixture. Use a maximum water cement ratio by weight in accordance with either ACI standards or a maximum water/cement ratio of 0.45 by weight, whichever is less.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
664	Performance Criteria	10c	Maximum chloride concentration of 250 ppm in the cement, mixing water, aggregate and admixtures combined.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
665	Standard Criteria	10d	Concrete cover over reinforcing steel shall be in accordance with ACI Standards, but not less than the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
666	Prescriptive Spec	10d1	A minimum 2 inches of cover on soil side of roof slab and exterior walls for box structure.													
667	Prescriptive Spec	10d2	A minimum 3 inches of cover on soil side of invert slabs for box structure.													
668	Prescriptive Spec	10d3	A minimum 3 inches of cover on soil side of tunnel structures when pouring directly against soils.													
669	Prescriptive Spec	10d4	A minimum 3 inches of cover on soil side of footings for retaining walls.													
670	Prescriptive Spec	10d5	A minimum 2 inches of cover on soil side of retaining walls.													
671	Prescriptive Spec	10d6	A minimum 2 inches of cover on soil side of structural members such as beams, girders, columns, and stairs.													
672	Prescriptive Spec	10d7	A minimum 3 inches of cover on soil side of base slabs for structural members.													
673	Prescriptive Spec	10d8	A minimum 3 inches of cover on soil side under all situations when an analysis of soil borings indicate structures will be exposed to chloride concentrations in excess of 200 ppm.													
		11	Steel Tunnel Liners													
674	Performance Criteria	11a	The assessment shall include a corrosion control report and corrosion control specifications, including provisions in the following as a minimum	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
675	Performance Criteria	11b	Exterior surfaces of steel liners shall be provided a corrosion protective coating. Protective coatings shall consist of one or more of the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
676	Performance Criteria	11b1	Dielectric coatings	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
677	Performance Criteria	11b2	Mortar Coatings	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
678	Performance Criteria	11b3	Concrete encasement	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
679	Performance Criteria	11c	The design of steel liners shall take into consideration the need, if any, to provide provisions for the future application of cathodic protection when cathodic protection is not installed as part of initial construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
680	Performance Criteria	11d	Stray current corrosion control measures for steel liners shall satisfy the requirements of Article 3.10.4, Stray Current Corrosion Control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
681	Performance Criteria	11e	Probability of Microbiologically Induced Corrosion (MIC) shall also be evaluated as a part of the corrosion control survey.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12	Prestressed Concrete Cylinder Pipe/Tunnel Liners													
682	Performance Criteria	12a	Subsection pertains to the use of prestressed concrete pipe with a steel cyliner for tunnel liners	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
683	Performance Criteria	12b	Design and Fabrication of prestressed concrete pipe with a steel cyliner shall be as defined for prestressed concrete pipe (pressure), with the exception that a minimum of four longitudinal shorting straps shall be required between each layer of prestressing wire. Stray current corrosion control measures for prestressed piped tunnel liners shall be as defined in Article 3.10.4, Stray Current Corrosion Control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		13	Earth Retained Retaining Walls													
684	Performance Criteria	13a	Mechanically Stabilized Earth (MSE) wall to be used within the City of Los Angeles shall require special approval from the City.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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685	Prescriptive Spec	13b	Structural backfill for retaining walls using steel reinforcing strips shall be a granular (well-drained) and non-corrosive select backfill material. Laboratory analysis shall demonstrate that the backfill meets the following minimum requirements:													
686	Prescriptive Spec	13b1	Chemical Constituents: Chlorides - 100 ppm (maximum) Sulfates - 200 ppm (maximum)													
687	Prescriptive Spec	13b2	Saturated Resistivity of Backfill: Not less than 3000 ohm-cm.													
688	Prescriptive Spec	13b3	pH acceptable range 6 to 10													
689	Performance Criteria	13c	Steel reinforcing strips shall be galvanized or coal-tar epoxy-coated, with the exception that galvanized coatings shall not be used under either of the following conditions:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
690	Prescriptive Spec	13c1	Saturated resistivity values of select backfill are less than 10,000 omh-cm.													
691	Prescriptive Spec	13c2	pH values of select backfill are out of the range of 6.5 to 8.													
692	Prescriptive Spec	13d	Coal-tar epoxy coating for steel reinforcing strips shall be in accordance with Paragraph 3.10.3.B.1, Coatings.													
693	Prescriptive Spec	13e	Galvanizing for steel reinforcing strips in accordance with ASTM A123 and a minimum thickness of 86 micrometers (two ounces per square foot)													
694	Performance Criteria	13f	Design of steel reinforcing strips shall include provisions for the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
695	Performance Criteria	13f1	Electrical separationg between the reinforcing strips and reinforcement located within reinforced concrete panels	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
696	Performance Criteria	13f2	A corrosion monitoring system that can be used to elevate corrosion rates on reinforcing strips located in select backfill materials.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.10.4	STRAY CURRENT CORROSION CONTROL													
		A	General													
697	Performance Criteria		Stray current control shall reduce or limit the level of stray currents at the source, under normal operating conditions, rather than trying to mitigate the corresponding effects (possibly detrimental) which may otherwise occur on transit facilities and other underground structures. The basic requirements for stray current control are as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
698	Performance Criteria		The mainline system shall be operated with no direct or indirect electrical connections between the positive and negative traction power distribution circuits and ground.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
699	Performance Criteria		The traction power system and trackwork construction shall be designed such that maximum stray earth currents, during normal revenue operations, do not exceed 0.20 amperes/1000 feet. Stray current levels are general values only based on typical utility configurations, transit structures, and soil characteristics. Values subject to change based on project specifics. This value is considered the uniformly distributed, maximum instantaneous level during normal operations. This criteria shall also apply to special trackwork and ancillary systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
700	Performance Criteria		Ancillary systems and equipment connected to either the positive or negative traction power distribution circuits shall contribute no more than 5 percent of the system earth conductance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Traction Power System													
		1	General													
701	Performance Criteria		Traction power supply systems shall be designed as dedicated systems, providing power to light rail lines. Joint use of traction power facilities, between rail lines, is not permitted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
702	Performance Criteria		Individual traction power supply systems for each light or heavy rail system shall be designed with three electrically isolated, independent subsystems: mainline, yard(s), and shop(s). DC traction power circuits for the mainline and yard(s) shall be electrically isolated from electrical grounds. DC traction power for shop(s) shall include provisions that the negative circuit (rails) be interconnected to electrical grounds.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
703	Performance Criteria		Traction power substation equipment (transformer/rectifier units) shall not be used to provide power to both light rail and heavy rail lines. Transformer/rectifier units and other equipment may be housed in the same room, with common AC power inputs, grounding facilities and other ancillary systems, provided the DC power circuits are electrically segregated.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Traction Power Substations (Mainline)													
704	Performance Criteria		Traction power substations shall be spaced at intervals such that maximum track-to-earth stray current discharge is less than 0.20 amperes/1000 feet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
705	Performance Criteria		Substations shall be provided with access to the negative bus for stray current monitoring and testing. Access shall be provided either inside, through the use of dedicated wall space, or outside through the use of a weathertight enclosure with an open conduit between the enclosure and the negative bus. Access shall be such that stray current testing can be performed by the utility operators under supervision by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Positive Distribution System													

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706	Performance Criteria	3a	Individual and separate positive distribution systems shall be provided for the mainline, yard(s), and shop(s). These individual positive distribution systems shall be designed for electrical isolation between the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
707	Performance Criteria		1) Mainline and Yard(s) 2) Mainline and Shop(s) 3) Yard(s) and Shop(s).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
708	Performance Criteria	3b	Each individual and separate positive distribution system shall be normally operated as an electrically continuous bus, with no electrical separation, except during emergency or fault conditions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
709	Performance Criteria	3c	Overhead Contact System (OCS), consisting primarily of support poles, the contact wire and, where applicable, the messenger wire, shall be designed to meet the following minimum requirements and include the following minimum provisions:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
710		3d	A maximum leakage current to ground of 5.0 milliamperes per mile of double track OCS with 2,500 Vdc applied between the OCS and ground.													
711	Performance Criteria	3e	Discrete grounding of individual at-grade support poles, in lieu of interconnecting poles to each other or to a common ground electrode system. Electrical continuity of foundation reinforcing steel is to be established and support poles are to be electrically connected to the foundation reinforcing steel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
712	Performance Criteria	3f	Common grounding of support poles on aerial structures through electrical connection to either bonded (welded) reinforcing steel in the deck or to each other and a common ground electrode system, when present.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
713	Performance Criteria	3g	Third-rail contact systems, consisting primarily of support pedestals/pads, contact rail insulators and contact rails, shall have a minimum in-service resistance to earth of 10 megohms per 1,000 feet of contact rail. Individual contact rail insulators shall have a minimum resistance of 1,000 megohms.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4	Mainline Negative Return System													
714	Performance Criteria	4a	Running Rails The mainline running rails, including special trackwork, embedded track, grade crossings and all ancillary system connections, shall be designed to have the minimum in-service resistances per 1,000 feet of track (two rails) cited in Table 3.1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
715	Performance Criteria		The criteria cited in Table 3.1 shall be met through the use of appropriately-designed insulating track fastening device such as insulated tie plates, insulated rail clips, direct fixation fasteners, rail boots, or other approved methods. Methods for constructing rails in embedded sections, at grade crossings and at high-rail vehicle access locations must provide for suitable isolation measures to comply with the stated minimum resistance criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
716	Prescriptive Spec		<u>Trackwork Construction Area</u> --> <u>(Ohms-1000ft. 2-rails)</u> Stations, Tunnels and Portals --> 500 At-Grade, Grade-Separated and Aerial --> 500 Embedded Segments (At-grade crossings/city streets) --> 300													
717	Prescriptive Spec	4b	Crossbonds Track Crossbonds shall be provided between mainline inbound and outbound tracks at the following locations for stray current control. Additional crossbonding shall be provided, as required, to meet criteria for traction power, signaling, and other considerations: 1) At each mainline traction power substation 2) Within 500 feet of passenger station platforms if not covered by the above criteria for crossbonds.													
718	Performance Criteria	4c	Switch machines, signaling devices, train communication systems and other devices or systems which may contact the mainline rails shall be electrically isolated such that the criteria given in Table 3.1 are satisfied.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
719	Performance Criteria	4d	Devices or systems which are electrically grounded that contact the rails (directly or indirectly) shall be electrically isolated from contacts with the rails. The criteria for the electrical isolation shall be met through the use of dielectric insulating materials that will electrically isolate the devices/systems from contacts with the rails. The grounding system for the devices/systems shall not be common with the rails.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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720	Performance Criteria	4e	Devices/systems which may contact the rails (directly or indirectly) that do not require an electrical ground shall be electrically isolated from contacts with earth. The criteria for electrical isolation shall be met through the use of dielectric insulating material that will electrically isolate the devices/ systems from contacts with earth.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
721	Performance Criteria	4f	Railroad Crossings and Non-Electrified Tracks Electrified transit tracks shall be electrically isolated from railroad tracks at all railroad crossings and from maintenance or other non-electrified tracks. Electrical isolation shall be achieved through the use of rail insulating joints with a minimum resistance of 10 megohms. Trackwork that is electrically connected to electrified transit trackwork must meet the resistance-to-earth criteria cited in Table 3.1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
722	Performance Criteria	4g	Electrical Continuity The running rails shall be constructed as an electrically continuous power distribution circuit through use of rail joint bonds, continuously welded rail or a combination of the two.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5	Storage and Maintenance Yards													
723	Performance Criteria		Yard traction power shall be provided by a separate dedicated DC power supply electrically segregated in both the positive and negative circuits from the shop and mainline. The yard/mainline traction power segregation points shall be located such that all track on the mainline side of each segregation point is electrically insulated from earth and satisfies the criteria in Table 3.1. The relative positions for the positive and negative yard/mainline insulators shall be such that they satisfy the design requirements for Vehicle Considerations, for minimizing stray current flow through vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
724	Performance Criteria		Operating procedures shall preclude the stopping or parking of trains across the positive and negative insulators. The insulators on the positive system shall be of the non-bridgeable type. The yard traction power substation shall be provided with access to the negative bus for stray current monitoring and possible stray current drainage. Access shall be provided either inside through use of dedicated wall space, or outside through use of a weather-tight enclosure with an open conduit between the enclosure and the negative bus. Access to the dedicated wall space or outside enclosure shall be provided through one or more conduits terminated at a manhole(s) located outside the perimeter of the substation near existing underground pipeline that may require stray current corrosion mitigation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
725	Performance Criteria		The yard traction power substation shall include provisions for emergency interconnection to the mainline traction power system. If the yard and mainline power originates in the same substation and a positive tie breaker is provided for emergency interconnection of the rectifiers, an interlocked isolating switch is to be provided in the connection between the rectifier negatives.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
726	Performance Criteria		Yard track including at-grade crossings shall generally not require insulating track fastening devices. Yard track shall be constructed with no direct or indirect electrical connections between the rail and electrically grounded systems. The design of yard track shall include the following minimum provisions:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
727	Performance Criteria	5a	Switch machines, signaling devices, automatic train controls and other devices or systems which are electrically grounded and may contact the rails (directly or indirectly) shall be electrically isolated from contact with the rails. The criteria for electrical isolation shall be met through the use of dielectric insulating materials that will electrically isolate the devices/systems from contacts with the rails. The grounding system for the devices/systems shall not be common with the rails.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
728	Performance Criteria	5b	Use of a hard rock, nonporous, well-drained high-resistivity ballast material.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
729	Prescriptive Spec	5c	A minimum of 1-inch clearance between the ballast material and all metallic surfaces of the rail and other metallic track components in electrical contact with the rail.													
730	Prescriptive Spec	5d	All dead-ended track shall have the negative power rail crossbonded to other negative power rails within 10 feet of the end of the track.													
731	Performance Criteria	5e	All dead-ended tracks shall have insulated joints installed to isolate bumping posts or similar devices that may be electrically grounded. Insulated joints shall be located so that a vehicle will not bridge the insulators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
732	Performance Criteria	5f	Crossbonding negative feeder cables shall utilize a main cable run (possibly several cables) with taps to negative power rail(s) as opposed to long runs of individual cables connected to single negative power rails.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
733	Performance Criteria	5g	Yard track shall be electrically insulated from the shop and mainline tracks by the use of rail insulating joints. Location of the insulating joints shall be chosen to avoid a vehicle bridging the insulator for a time period longer than that required to move a vehicle into or out of the shop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
734	Performance Criteria	5h	Yard track shall be electrically insulated from railroad track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6	Maintenance Shop													
735	Performance Criteria		Shop traction power shall be provided by a separate dedicated DC power supply electrically segregated in both the positive and negative circuits from the yard traction power system and the mainline system. The shop traction power system shall provide power for the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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736	Performance Criteria		a. Shop tracks b. Car wash tracks c. Blowdown pit tracks d. Other tracks associated with maintenance facilities e. Interconnecting switching tracks between the above listed facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
737	Performance Criteria		As required for safety purposes, tracks powered by the shop traction power system shall be electrically grounded to the building and building grounding system in which they are located. The design of electrical grounds for track shall include provisions that will preclude unsafe conditions for system personnel during normal and possible fault operations of the shop traction power system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
738	Performance Criteria		Track powered by the shop traction power system shall be electrically insulated from yard track by the use of rail insulating joints. Actual locations of insulators shall ensure that vehicles will not electrically connect the track powered by the shop traction power system to the yard track for periods of time longer than that required to move a vehicle into or out of a maintenance building or across an insulating joint.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7	Water Drainage													
739	Performance Criteria		Subway or below grade sections shall be designed to prevent water from dropping or running onto contact rails, negative rails and rail appurtenances, as well as the accumulation of freestanding water. Mainline water drainage systems shall be designed to prevent water accumulation from contacting the rails and rail appurtenances. Yard water drainage systems shall be designed to prevent water accumulating around ties and rail appurtenances. Shop water drainage systems shall be designed to prevent water accumulation around rail insulating joints when located immediately off the shop apron.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8	Vehicle Considerations													
740	Performance Criteria		Vehicles shall be designed such that sufficient electrical continuity is provided between trucks and car body and through couplers to safely accommodate a 100- ampere stray current flow. Stray current flow through the vehicle(s) may occur during the bridging of yard/mainline positive and negative insulators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
741	Performance Criteria		Metro rail vehicles pantograph location relative to vehicle trucks shall be designed to meet the following requirements and considerations:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
742	Performance Criteria	8a	Pantograph/truck relative locations shall be coordinated with the location of yard/mainline, and yard/shop positive and negative insulators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
743	Performance Criteria	8b	Relative positions of the pantograph contact to the OCS and the trucks shall be such that the positive contact and at least one negative contact (i.e., one truck) are on the same traction power circuit (i.e., the same side of positive and negative segregating insulators) at all times during operations. Multiple contacts to different negative (running rail) power circuits are permitted as long as one of the contacts is on the same circuit as the pantograph positive contact.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9	Fixed Facilities													
744	Performance Criteria	9a	Subway and Underground Stations (Direct Fixation Track Construction with Insulated Rail Fasteners)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
745	Performance Criteria		Reinforcing steel in the inverts of subways, portals, and underground stations shall be made electrically continuous. Reinforcing steel in plinths are not required to be made electrically continuous. Reinforcement in floating slabs insulated from the below track slab is not required to be electrically continuous. Minimum requirements shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
746	Performance Criteria		Welding of all longitudinal lap splices in the top layer of reinforcing steel in inverts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
747	Prescriptive Spec		Welding of all longitudinal top layer members in the reinforcing steel in inverts to a transverse (collector) bar at each end of the structure, at intervals along the structure not exceeding 500 feet and at each side of electrical (physical) breaks in the longitudinal reinforcing steel, such as at expansion joints. Transverse (collector) bars located on each side of breaks in the longitudinal reinforcing steel shall be interconnected electrically with copper bond cables.													
748	Performance Criteria		Electrical continuity in top layer invert reinforcing steel shall be maintained across bridging beams located at the interfaces between structures. Top-layer longitudinal steel reinforcement or dowels for bridging beams shall be welded at lap splices and interconnected through welded connections or copper bond cables to adjacent top-layer steel reinforcement in structures located on each side of the bridging beam.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
749	Prescriptive Spec		Test facilities shall be installed on reinforcing steel at each end of the structure and at transverse collector bars located at intervals along the structure not exceeding 1,000 feet. Test facilities shall consist of insulated copper wires, conduits, and enclosures terminated at an accessible location.													
750	Prescriptive Spec		Stray current monitoring assemblies, including a silver-silver chloride reference electrode and two isolated rebar probes shall be tack welded to the collector bar at each test facility, at intervals not to exceed 1000'. Coupon and reference electrode cables shall be routed in conduit common with the collector bar test wires, and terminated in the test station box.													
751	Performance Criteria	9b	Tunnel Liners: Stray current control requirements for tunnel liners will vary depending on the particular material and method of construction and must be determined on an individual basis. Minimum requirements shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
752	Performance Criteria		Stray current monitoring assemblies see Paragraph 3.10.4.B.9.a.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
753	Performance Criteria		Segmented steel tunnel liners shall have electrical continuity within and between segments installed below the concrete invert.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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754	Performance Criteria		Electrical test facilities shall be installed, in pairs, on fabricated steel tunnel liners. Minimum requirements shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
755	Prescriptive Spec		1. A maximum of three-hundred feet (300') between individual test points within a pair. 2. A maximum of one-thousand feet (1,000') between test station pairs.													
756	Performance Criteria		No special provisions are required for electrical continuity of steel reinforcement within the precast segmented liners. There are no special provisions required for providing electrical continuity in steel reinforcement within the cast in place liner.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
757	Performance Criteria		Prestressed concrete pipe with a steel cylinder used for tunnel liners shall meet the following minimum requirements:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
758	Performance Criteria		1) Electrical continuity bonds across all pipe joints. 2) A minimum of four evenly spaced longitudinal shorting straps between each layer of prestressing wire with electrical interconnections to bell and spigot rings. 3) Electrical interconnections between prestressing wire anchors and bell and spigot rings. 4) Provisions for electrically interconnecting the steel pipe cylinder through bond cables to the invert collector grid at maximum intervals of 500-feet along the tunnel. The bond cable from the steel pipe cylinder and the bond cable from the collector grid at interconnection shall terminate in an accessible enclosure with a removable bus bar.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		10	Aerial Structures (Dedicated Transit Non-Vehicular Use)													
759	Performance Criteria	10a	Bridge-Type Structures Using Columns and Bearings (Direct Fixation Track Construction with Insulated Rail Fasteners)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
760	Performance Criteria		This Paragraph applies to aerial structures and bridges for which column and bearing assembly is employed that can be electrically insulated from deck or girder reinforcing steel and will have direct-fixation track construction with insulated rail fasteners. Minimum requirements shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
761	Performance Criteria	10a1	Electrical continuity of top layer deck/girder reinforcing steel shall be provided by welding all longitudinal lap splices.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
762	Performance Criteria	10a2	All top layer longitudinal deck/girder reinforcing steel shall be electrically interconnected by welding to transverse collector bars installed at each end of the structure and at each side of breaks in longitudinal reinforcing, such as at expansion joints, hinges and abutments. Transverse collector bars installed on each side of a break shall be electrically interconnected with a minimum of two copper bond cables.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
763	Prescriptive Spec	10a3	Additional transverse collector bars shall be provided at intermediate locations along the structure to maintain a maximum spacing of 500 feet between collector bars.													
764	Prescriptive Spec	10a4	A stray current ground electrode system with an insulated bond cable shall be provided at each end of the structure and at intermediate locations to maintain a maximum spacing between ground electrode systems of 1500 feet. Each ground electrode system shall be provided an insulated bond cable that is connected to a transverse collector bar located in the electrically continuous reinforcing steel. The bond cable from the ground electrode system and the bond cable from the transverse collector bar shall terminate in the same test facility used for the terminating test wires from the transverse collector bar. The number, location and earth resistance of the ground electrode system must be determined on an individual structure basis.													
765	Prescriptive Spec	10a5	Test facilities shall be provided at each end of the structure and at intermediate locations to maintain a maximum spacing of 500 feet between test points. The facilities will house test wires from the collector bars and bond cables from the ground electrode system and collector bar, if present. The interconnection between bond cables from a ground electrode system and bond cables from a collector bar shall be made with removable bus bars or shunts.													
766	Performance Criteria	10a6	Stray current monitoring assemblies see Paragraph 3.10.4.B.9.a.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
767	Performance Criteria		Reinforcing steel in deck/girders shall be electrically isolated from columns, abutments and other grounded elements. Isolation can be established through the use of insulating elastomeric bearing pads, dielectric sleeves and washers for anchor bolts, and dielectric coating on selected components.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
768	Performance Criteria	10b	Bridge-Type Structures Using Columns and Bearings (Ballasted Track Construction with Insulated Rail Fasteners)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
769	Performance Criteria		This Paragraph covers the same type of aerial structures covered under Paragraph 3.10.4.B.10.a above, but with timber tie or concrete-tie and ballasted type of track construction. In this type of track construction, the rails shall be provided insulating track fastening devices. Minimum requirements shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
770	Performance Criteria	10b1	Electrical continuity of top layer deck/girder reinforcing steel, transverse collector bars, copper bond cables and test facilities shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
771	Performance Criteria	10b2	Stray current monitoring assemblies see Paragraph 3.10.4.B.9.a.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
772	Performance Criteria	10b3	A stray current ground electrode system with bond cables and test facilities shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
773	Prescriptive Spec	10b4	A waterproofing, electrically insulating membrane shall be provided over the entire surface of the deck that will be in contact with the ballast. The membrane system shall be multi-ply reinforced sheet material with a minimum volume resistivity of 1010 ohm-centimeter and a minimum thickness of 60 mils. The membrane system shall be provided with a protective board where in contact with ballast materials.													
774	Performance Criteria	10b5	Reinforcing steel in deck/girders shall be electrically isolated from columns, abutments and other grounded elements. Isolation can be established through the use of insulating elastomeric bearing pads, dielectric sleeves and washers for anchor bolts, and dielectric coatings on selected components.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
				No Exception= NE Exception = EX												Specs & Plans
ID	TYPE	SECTION	DESCRIPTION	LOS ANGELES	HUNTINGTON PARK	BELL	CUDAHY	DOWNEY	SOUTH GATE	PARAMOUNT	BELLFLOWER	CERITOS	ARTESIA	VERNON	VARIANCE	DOCUMENT/SECTION
775	Performance Criteria	10c	Aerial-Type Structures Using Bents and Pre- or Post-Tensioned Girders (Direct-Fixation Track Construction with Insulated Rail Fasteners)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
776	Performance Criteria		This Paragraph applies to aerial structures using bent supports with reinforcing steel extending into the deck/girders with direct fixation track construction and insulated rail fasteners. This type of construction precludes the electrical insulation of deck/girder steel from bent/column steel. Stray current ground electrodes systems are not required for these types of structures. Minimum requirements shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
777	Performance Criteria	10c1	Electrical continuity of top layer deck/girder longitudinal reinforcing steel shall be provided by welding all longitudinal lap splices.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
778		10c2	Stray current monitoring assemblies see Paragraph 3.10.4.B.9.a.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
779		10c3	All top layer deck/girder longitudinal reinforcing steel shall be electrically interconnected by welding to transverse collector bars installed at bents and on each side of breaks in longitudinal reinforcing, such as at expansion joints, hinges and at abutments (deck side only). Collector bars installed on each side of a break shall be connected with a minimum of two copper bond cables.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
780	Performance Criteria	10c4	Electrical continuity of all column/bent steel shall be provided by welding spiral/hoop steel reinforcing to two vertical column reinforcing bars. These welded connections to each of the two vertical bars are to be made at the top and bottom of the spiral. Lap splices are to be fillet welded in each of the two vertical column reinforcing bars for electrical continuity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
781	Performance Criteria	10c5	Column/bent steel is to be electrically interconnected to deck/girder steel by welding at least two vertical column bars to transverse collector bars installed at bents.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
782	Performance Criteria	10c6	Column/bent steel is to be electrically interconnected to footing steel where column/bent steel penetrates the footing by welding the two electrically continuous vertical column/bent bars to footing reinforcing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
783	Performance Criteria	10c7	Anchor plates for pre- or post-tensioned cables are to be electrically interconnected to electrically continuous longitudinal reinforcing steel by welding a cable between each anchor plate and the longitudinal reinforcing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
784	Performance Criteria	10c8	Test facilities are to be provided at each hinge and expansion joint and at every other column/bent, starting with the first column/bent from an abutment. Test facilities at hinges and expansion joints will house bonding cables from adjacent collector bars on each side of the hinge/joint. Facilities at columns/bents will house two wires from vertical column/bent steel and from the collector bar at the top of the bent.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
785	Performance Criteria	10d	Aerial-Type Structures Using Bents and Pre- or Post-Tensioned Girders (Ballast Track Construction with Insulated Rail Fasteners)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
786	Performance Criteria		This Paragraph covers the same type of aerial structures covered under Paragraph 3.10.4.B.10.c above, but with insulat ed timber-tie or concrete-tie and ballasted type of track construction. Minimum requirements shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
787	Performance Criteria	10d1	Electrical continuity of top layer deck/girder reinforcing steel and test facilities shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
788	Performance Criteria	10d2	Stray current monitoring assemblies see Paragraph 3.10.4.B.9.a.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
789	Performance Criteria	10d3	A waterproofing, electrically insulating membrane is to be provided over the entire surface of the deck that will be in contact with the ballast. The membrane system shall be multi-ply reinforced sheet material with a minimum volume resistivity of 10^10 ohm-centimeters and a minimum thickness of 60 mils. The membrane system shall be provided a protective board where in contact with ballast material.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
790	Performance Criteria	10d4	Electrical continuity in column/bent reinforcing steel shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
791	Performance Criteria	10d5	olumn/bent reinforcing steel shall be electrically inter connected to deck/girder reinforcing steel and to footing steel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
792	Performance Criteria	10d6	Anchor plates for pre- or post-tensioned cables shall be electrically interconnected to deck/girder reinforcing steel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
793	Performance Criteria	10e	Existing Bridge Structures (Ballasted Track Construction with Insulated Rail Fasteners)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
794	Performance Criteria		This Paragraph applies to existing bridge structures that are retrofitted for insulated timber-tie or concrete-tie and ballasted type track construction. Stray current corrosion control measures for existing bridges that are retrofitted with new decks must be determined on an individual structure basis, depending on material and methods of construction. Stray current corrosion control measures for existing reinforced concrete bridge decks used for ballasted track construction preclude the installation of electrical continuity in existing steel reinforcement. In this type of construction, minimum requirements shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
795	Performance Criteria	10e(1)	A waterproofing, electrically insulating membrane is to be provided over the entire surface of the existing concrete deck that will be in contact with the ballast. The membrane system shall be multi-ply reinforced sheet material with a minimum volume resistivity of 10^10 ohm-centimeter and a minimum thickness of 60 mils. The membrane system shall be provided a protective board where in contact with ballast material.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
796	Performance Criteria	10e(2)	An electrically continuous collector grid, such as steel welded wire mesh, shall be provided between the waterproofing membrane and the ballast. The collector grid shall extend the full width of the trackway.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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797	Performance Criteria	10e(3)	A stray current ground electrode system with an insulated bond cable shall be provided at each end of the structure and at intermediate locations to maintain a maximum spacing between ground electrodes systems of 1500 feet. Each ground electrode system shall be provided an insulated bond cable that is connected to the electrically continuous collector grid. The bond cable from the ground electrode system and the bond cable from collector grid shall terminate in the same test facility used for terminating test wires from the collector grid. The number, location and earth resistance of the ground electrode system must be determined on an individual structure basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
798	Performance Criteria	10e(4)	Test facilities shall be provided at each end of the structure and at intermediate locations to maintain a maximum spacing of 500 feet between test points. The test facilities shall house test wires from the collector grid and bond cables from the ground electrode system and collector grid, if present, as well as wires from two isolated coupons and a reference electrode within the stray current monitoring assembly. The interconnection between bond cables from the ground electrode system and bond cables from the collector grid shall be made with removable bus bars or shunts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
799	Performance Criteria		Stray current corrosion control measures for existing steel bridge decks used for ballasted track construction shall include the following minimum requirements:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
800	Performance Criteria		• A waterproofing, electrically insulating membrane similar to that for existing concrete bridges. • Requirements for a stray current ground electrode system on this type of construction must be determined on an individual structure basis, depending on materials and methods of construction for support columns and abutments.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
801	Performance Criteria	10f	Existing Bridge Structures (Direct-Fixation Track Construction with Insulated Rail Fasteners)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
802	Performance Criteria		This Paragraph applies to existing bridge structures that are retrofitted for insulated direct-fixation track construction. Stray current corrosion control measures for existing bridges that are retrofitted with new decks must be determined on an individual structural basis, depending on materials and methods of construction. Stray current corrosion control measures for existing reinforced concrete bridge decks used for direct-fixation track construction preclude the installation of electrical continuity in existing steel reinforcement. In this type of construction, stray current control will be limited to steel reinforcement for trackwork and include the following minimum requirements:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
803	Performance Criteria	10f1	Top-layer longitudinal steel for trackwork shall be made electrically continuous by fillet welding all lap splices.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
804	Performance Criteria	10f2	All top-layer longitudinal reinforcing steel for trackwork shall be welded to a transverse collector bar at each end of the bridge, at intervals along the bridge not exceeding 500 feet and at each side of electrical (physical) breaks in the longitudinal reinforcing steel. Transverse collector bars located on each side of breaks in the longitudinal reinforcing steel shall be interconnected electrically with copper bond cables.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
805	Performance Criteria	10f3	Stray current monitoring assemblies see Paragraph 3.10.4.B.9.a	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
806	Performance Criteria	10f4	A stray current ground electrode system with an insulated bond cable shall be provided at each end of the bridge and at intermediate locations to maintain a maximum spacing between ground electrodes systems of 1500 feet. Each ground electrode system shall be provided an insulated bond cable that is connected to the electrically continuous reinforcing steel for trackwork. The bond cable from the ground electrode system and the bond cable from the transverse collector bar shall terminate in the same test facility used for terminating test wires from the transverse collector bar. The number, location and earth resistance of the ground electrode system must be determined on an individual structure basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
807	Performance Criteria	10f5	Test facilities shall be provided at each end of the bridge and at intermediate locations to maintain a maximum spacing of 500 feet between test points. The facilities will house test wires from the collector bars and bond cables from the ground electrode system and collector bar, if present. The interconnection between bond cables from a ground electrode system and bond cables from a collector bar shall be made with removable bus bars or shunts. Test facilities shall consist of test wires, bond cables, conduits, and enclosures terminated at an accessible location.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
808	Performance Criteria	10g	Existing Box or U-Shaped Structures (Ballast Track Construction with Insulated Rail Fasteners)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
809	Performance Criteria		This Paragraph applies to existing box or U-shaped structures with a reinforced concrete invert such as retaining walls along the mainline used for ballasted-type track construction. In this type of track construction, the rails shall be provided insulating track fastening devices. This type of construction precludes the installation of electrical continuity in existing invert reinforcement steel. Minimum requirements shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
810	Performance Criteria		A waterproofing, electrically insulating membrane is to be provided over the entire surface of the existing concrete invert that will be in contact with the ballast. The membrane system shall be multi-ply reinforced sheet material with a minimum volume resistivity of 10^10 ohm-centimeter and a minimum thickness of 60 mils. The membrane system shall be provided a protective board where in contact with ballast material.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
811	Performance Criteria		The need for an electrically continuous collector grid over the membrane and a stray current ground electrode system must be determined on an individual structure basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
812	Performance Criteria	10h	New Box or U-Shaped Structures (Ballast Track Construction with Insulated Rail Fasteners)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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813	Performance Criteria		This Paragraph applies to new construction for box or U-shaped structures such as portals or retaining walls along the mainline with a cast-in-place concrete invert for timber-tie or concrete-tie and ballasted type track construction. In this type of track construction the rails shall be provided insulating track fastening devices. Reinforcing steel in the invert shall be made electrically continuous. Minimum requirements shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
814	Performance Criteria	10h1	Welding of all longitudinal lap splices in the top layer of first pour reinforcing steel in inverts for electrical continuity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
815	Prescriptive Spec	10h2	Welding of all longitudinal top layer members in the first-pour reinforcing steel in inverts to a transverse collector bar at each end of the structure, at intervals along the structure not exceeding 500 feet and at each side of electrical (physical) breaks in the longitudinal reinforcing steel, such as at expansion joints. Transverse (collector) bars located on each side of breaks in the longitudinal reinforcing steel shall be interconnected electrically with copper bond cables.													
816	Performance Criteria	10h3	Stray current monitoring assemblies see Paragraph 3.10.4.B.9.a.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
817	Performance Criteria	10h4	A waterproofing, electrically insulating membrane shall be provided over the entire surface of the concrete invert that will be in contact with the ballast. The membrane shall be multi-ply reinforced sheet material with a minimum volume resistivity of 10^10 ohm-centimeter and a minimum thickness of 60 mils. The membrane system shall be provided a protective board where in contact with ballast material.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
818	Performance Criteria	10h5	Test facilities shall be installed at each end of the structure and at transverse collector bars located at intervals along the structure not exceeding 500 feet. Test facilities shall consist of insulated copper test wires for the transverse collector bars, conduits, and enclosures terminated at an accessible location.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	OCS Pole Foundation Grounding													
819	Prescriptive Spec		All metallic components, inclusive of the pole base-plate, to be partially embedded or to come in contact with concrete surfaces shall be coated with a sacrificial or barrier coating. The sacrificial coating shall be applied to the entire component. The barrier coating shall extend a minimum of six inches into the concrete and a minimum of 1/2 inch above the surface of the concrete													
		1	At-Grade OCS Support Poles													
820	Performance Criteria		Electrical continuity shall be established between catenary support pole and pole foundation reinforcing steel to provide an adequate means for dissipating any leakage current from the contact wire and, where applicable, the messenger wire. The following minimum provisions shall be included in the design:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
821	Performance Criteria	C1a	The outermost layer of vertical reinforcing bars within the concrete foundation shall be fillet welded at all intermediate vertical lap joints and to a reinforcing bar collector ring installed at the top and bottom of the reinforcing bar cage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
822	Performance Criteria	C1b	A copper bond cable, minimum 4/0 #AWG insulated in size, shall be electrically connected between the base of the catenary support pole and the foundation reinforcing steel by thermite welded or brazed connections. The bond cable shall be routed in such a manner that it will not be susceptible to damage during construction or after installation is complete. Different electrical continuity requirements, from those described above, may be necessary depending on the actual reinforcing configuration for the support pole foundations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	OCS Poles on Aerial Structures													
823	Performance Criteria		OCS poles located on aerial structures shall generally include one of the following minimum sets of provisions, depending on the type of aerial structure. Where the aerial structure includes electrically continuous (welded) deck reinforcing steel and stray current ground electrode systems, the support poles on the structure shall be electrically intercon nected and connected to the ground electrode systems through cabling as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
824	Performance Criteria	C2a	All OCS poles installed on a particular aerial structure shall be interconnected electrically through common cabling. The common cabling between OCS poles shall be interconnected electrically through additional cabling to the stray current ground electrode systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
825	Performance Criteria	C2b	Cabling used to interconnect poles and the stray current ground electrode system shall be minimum 1/0 #AWG insulated in size. Cable(s) shall be routed in conduit and terminated in junction boxes or test cabinets that also house test wires and bond cables from the electrically continuous deck reinforcing steel and bond cables from the stray current ground electrode systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
826	Performance Criteria	C2c	Cabling associated with the OCS poles that terminates in a junction box or test cabinet shall be connected directly to the bond cable for the stray current ground electrode system. Where the aerial structure has electrically continuous (welded) deck reinforcing steel but does not include stray current ground electrode systems, the support poles shall be electrically connected to the electrically continuous (welded) deck reinforcing steel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
827	Performance Criteria	C2d	A minimum of one 1/0 #AWG insulated bond cable shall be provided from each pole to the electrically continuous (welded) deck reinforcing steel. The cable shall be thermite welded or brazed to the pole and preferably to the nearest transverse collector bar installed in the electrically continuous (welded) deck reinforcing steel for the aerial structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
828	Performance Criteria	C2e	Where it is not practical, because of excessive distance or other factors, to electrically connect the bond cable(s) from the OCS pole directly to a transverse collector bar, the bond cable(s) are to be electrically connected to at least three local upper-layer longitudinal bars in the electrically continuous (welded) deck reinforcing steel. Alternatively, OCS poles can be connected to an independent electrical ground specifically designed for OCS poles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Metro Owned Utility Structures													
829	Performance Criteria		All piping and conduit shall be nonmetallic unless metallic facilities are required for specific engineering purposes. There are no special provisions required if nonmetallic materials are used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		1	Metallic Facilities (Systemwide)													

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830	Performance Criteria		Pressure or nonpressure piping exposed within a structure or embedded in the structure shall not require special provisions. Pressure piping that penetrates the subway, portal or station walls shall be electrically insulated from the external piping to which it connects and from the structure by insulating type watertight wall sleeves. Electrical insulation of interior piping from external piping shall be made on the inside of the subway, portal or station, by the installation of in-line insulating devices. All buried pressurized piping external to subway, portal, and station structures shall meet the criteria specified for soil corrosion control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Metallic Facilities (Shop)													
831	Performance Criteria		Top-layer reinforcing steel for the at-grade shop building slab shall be made into an electrically continuous reinforcing grid through fillet welding of lap splices and the installation of collector bars and bond cables. The electrically continuous reinforcing grid for the top-layer reinforcing steel, structural steel and rails within the shop building shall be electrically connected to a common electrical ground system for the rails. See Paragraph 3.10.4.B, Traction Power System, for requirement that the negative circuit (rails) associated with shop traction power systems be interconnected to electrical grounds.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
832	Performance Criteria		The need to provide an electrically continuous grid for top-layer reinforcing steel in at-grade slabs for other facilities associated with shop traction power systems shall be considered on an individual basis. All metallic pressure piping within the shop building or perimeter of the shop steel reinforcing grid shall have the following minimum provisions:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
833	Performance Criteria		a. Electrical insulation from interconnecting pressure piping located outside the shop building or perimeter of the reinforcing grid. b. Insulating devices shall be locate above-grade, or inside the building in lieu of burying directly. c. Electrical insulation from the structure by the use of insulating type watertight wall/floor sleeves. d. Electrical connection to the common grounding network at sufficient locations such that there will be only negligible potential differences between the piping and grounding network during fault or normal operating conditions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
834	Performance Criteria		All exposed non-pressure piping and electrical conduits within the shop building shall include electrical connection to the building grounding network in accordance with NFPA 70. The connections shall be made at sufficient locations such that there will be only negligible potential differences between the piping or conduit and the grounding network during fault conditions or normal operations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Metallic Facilities (Yard)													
835	Performance Criteria		It is extremely important from the standpoint of stray current corrosion control that all buried piping and conduits located within the yard be nonmetallic, unless metallic facilities are required for specific engineering purposes. All buried pressurized metallic piping shall meet the criteria for soil corrosion control and include the following minimum additional provisions for possible stray current drainage to the yard traction power substation:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
836	Performance Criteria		a. Electrical continuity. b. Electrical insulation from interconnecting non-transit facilities and, possibly, additional insulation to establish discrete electrical units. c. Test/access facilities installed at all insulated connections and at intermediate locations as necessary. d. All metallic fencing surrounding the yard perimeter shall be made electrically continuous. e. All existing abandoned pipelines which pass through the yard shall be excavated and a minimum of two feet of pipe removed just inside the yard perimeter. f. Underground storage tanks and associated piping shall comply with the requirements for soil corrosion control. g. Prestressed concrete cylinder pip	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Facilities Owned by Others													
		1	Replacement/Relocation of Facilities													
837	Performance Criteria		Corrosion control requirements for buried utilities, installed by the authority/operator as part of transit construction, shall be the responsibility of the individual utility operator. Relocated or replaced utilities installed as part of the Metro contractual agreement by transit contractors shall include the following minimum provisions, unless otherwise directed by the utility owner to follow the owner's corrosion control standards. These provisions are directed toward ferrous and reinforced concrete pressure piping; other materials and structures will require individual review.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
838	Performance Criteria		The need for stray-current monitoring facilities shall be determined by the individual utility operators. If utilities require assistance, the following minimum provisions shall be suggested: Test facilities shall be installed at selected locations for the purpose of evaluating stray earth current effects during startup and revenue operations. Guidelines for locations of test facilities for light rail transit systems shall be as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
839	Performance Criteria		a. Electrical continuity. b. Test facilities. c. Electrical isolation by the installation of in-line insulating joints in piping at each end of relocations or replacements and at each side of trackwork for light rail transit projects. d. The need for additional measures such as application of a protective coating system and/or the installation of cathodic protection shall be based on the characteristics of the specific structure and the performance record within the environment and the possible exposure to stray currents. e. All replaced or relocated facilities adjacent to yard(s) shall be reviewed to determine the need for test facilities and possible stray current corrosion mitigation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		2	Existing Utility Structures													
840	Performance Criteria		The need for stray-current monitoring facilities shall be determined by the individual utility operators. If utilities require assistance, the following minimum provisions shall be suggested: Test facilities shall be installed at selected locations for the purpose of evaluating stray earth current effects during startup and revenue operations. Guidelines for locations of test facilities for light rail transit systems shall be as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
841	Performance Criteria		a. At all utility crossings with the system and on structures which are proximate and parallel to the system right-of-way. b. At locations on specific utility structures which are proximate to the system traction power substations. Existing facilities adjacent to yard(s) shall be reviewed to determine the need for test facilities and possible stray current corrosion mitigation. See Paragraph 3.10.4.B.5, Storage and Maintenance Yards for requirements pertaining to stray current monitoring and stray current drainage at yard traction power substation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Caltrans Structures (Joint Vehicular/Transit Use)													
842	Performance Criteria		Stray-current corrosion control for Caltrans structures, principally elevated highways with transit guideways, shall be addressed by limiting earth current levels at the source. Meeting the criteria established in Table 3.1 will provide the primary stray current control for these facilities. The need for and type of supplemental measures shall be determined by Caltrans, with technical input provided by transit designers. General criteria prepared by Caltrans for these structures are shown in Reference 3.10-1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Testing													
843	Performance Criteria		Reinforced concrete structure designs for providing electrical continuity in reinforcing steel shall include provisions for field testing to insure compliance with design specifications. Minimum testing shall include:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
844	Performance Criteria		1. Electrical continuity of test facilities. 2. Electrical continuity of reinforcing steel. Designs for the installation of trackwork shall include provisions for field testing to insure insulating track fastening devices and in-line track insulators are in compliance with design specifications. Minimum testing shall include: 3. Track-to-earth resistance test. 4. Electrical insulating tests to assure rail insulating joints between mainline track and yard track are effective. 5. Electrical insulating tests to assure rail insulating joints between yard track and shop track are effective. Baseline stray current testing shall be performed for Metro Rail facilities during pre-revenue operations and/or within 2 months after revenue operations commence. All baseline data shall be included as part of an operations and maintenance manual to be used for periodic monitoring.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.10.5	ATMOSPHERIC CORROSION CONTROL													
		A	General													
845	Performance Criteria		Subsection provides criteria for designs that will ensure that necessary function and appearance of transit structures exposed to the environment. Systemwide criteria for all areas shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
846	Performance Criteria	1	Materials shall have established performance records for the service intended. Nonmetallics shall be used unless metallics are required for special engineering purposes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
847	Performance Criteria	2	Sealants shall be used in crevices to prevent the accumulation of moisture.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
848	Performance Criteria	3	Barrier-type organic or sacrificial-type coatings shall be used on exposed carbon steel, ductile and cast iron and other metals sibject to atmospheric corrosion. The specific coating system shall address the potential for impact damage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
849	Performance Criteria	4	Design shall avoid configurations that will entrap moisture. Design to permit drainage and allow washing of pollutant particles. Avoid the use of dissimilar metal combinations where possible. Use dielectric devices between dissimilar metal combinations. When this is not possible, use coatings or sealants.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Metals Exposed to Weather													
		1	Steels and Ferrous Alloys													
850	Performance Criteria		Organic-type barrier coatings and sacrificial-type coatings shall be in accordance with Paragraph 3.10.5.E, coatings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Aluminum Alloys													
851	Performance Criteria		All aluminum allows shall receive a sealed, hard-anodized finish to provide the best weather-resistant surface.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Copper Alloys													
852	Performance Criteria		Copper and its alloys can be used where exposed to weather.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4	Stainless Steels													
853	Performance Criteria		Stainless steels used for above-grade service shall meet the following minimum requirements: Series 200, 300 or chromium-molybdenum ferritic types shall be used for exposed surfaces in unsheltered environments and where appearance is critical or a necessary consideration. Columbian/titanium stabilized grades, or extra-low carbon grades shall be used when welding is required. Stainless steel surfaces shall be cleaned and passivated after fabricated.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Metals Exposed in Stations, Tunnels and Buildings (Excluding Running Rails and Fasteners)													
		1	Steels and Ferrous Alloys													

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854	Performance Criteria	a	Where appearance is critical, exposed surfaces of steel and ferrous allows shall be provided a barrier-type organic coating to mitigate superficial corrosion.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
855	Performance Criteria	b	Galvanizing and other types of sacrificail coatings shall not require a barrier-type organic top coatings unless top coating is required for architectural purposes. Carbon steels, alloy steels, weathering steels, and cast or ductile irons exposed to seepage waters or moisture shall be coated with a high-build, barrier-type organic coating or sacrificial coating with an organic top coating. Organic-type barrier coatings and sacrificial-type coatings shall be in accordance with Paragraph 3.10.5.E, coatings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Stainless Steel Exposed in Structures													
856	Performance Criteria		Materials shall be in accordance with Paragraph 3.10.5.B.4, Stainless Steels, with the following additional requirements when surfaces will be in contact with seepage waters or moisture:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
857	Performance Criteria		Type 304, 316, 317, 444, Carpenter 20 or higher grade shall be used. Where stains or discoloration are not acceptable, series 300 shall be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
858	Performance Criteria		Barrier-type organic coatings shall not be used when continuous contact or complete immersion in seepage water is anticipated.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Aluminum Alloys													
859	Performance Criteria		Aluminum allows exposed to seepage water shall be resistant to acid chloride stress corrosion cracking. Anodized aluminum exposed to seepage water shall have a barrier coating.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4	Copper Alloys													
860	Performance Criteria		Barrier-type organic coatings shall be used when exposure to seepage of water is antipated.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
861	Performance Criteria		A heat-cured or thermosetting lacquer shall be used when discoloration is not permitted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
862	Prescriptive Spec		Brass alloys with zinc content greater than 15 percent shall not be used in areas where exposure to seepage waters is anticipated.													
		D	Miscellaneous Hardware (Electrical Equipment)													
		1	Above Grade (Exposed to Weather)													
863	Performance Criteria		Exterior surfaces of steel and ferrous components shall be provided a barrier-type organic coating or sacrificial coating for atmospheric corrosion control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
864	Performance Criteria		Exposed steel conduits, fittings and hardware shall be provided a hot-dip galvanized-type (zinc) sacrificial coating.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Inside Stations, Tunnels and Buildings													
865	Performance Criteria	a	There are no special or minimum atmospheric corrosion control criteria for electrical equipment when located in an air-conditioned environment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
866	Performance Criteria	a1	Where appearance is critical, exposed surfaces of steel and ferrous allows shall be provided a barrier-type organic coating to mitigate superficial corrosion. The barrier-type coating shall have adequate color retention, gloss retention and chalk resistance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
867	Performance Criteria	a2	Galvanizing and other types of sacrificail coatings shall not require a barrier-type organic top coatings unless top coating is required for architectural purposes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
868	Performance Criteria	b	Facilities located in a non-air conditioned environment and not exposed to seepage waters shall include one or more of the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
869	Performance Criteria	b1	Conduits and fittings shall be hot-dip galvanized	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
870	Performance Criteria	b2	Components that cannot be hot-dip galvanized shall be provided a barrier-type organic coating.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
871	Performance Criteria	b3	Unsealed cabinets shall be internally heated to prevent condensation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
872	Performance Criteria	b4	Non-oil-immersed internal metallic components of enclosures shall be coated with a barrier-type organic coating or a sacrificial type coating.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
873	Performance Criteria	b5	Vapor phase inhibitors shall be used on sealed cabinets and enclosures where the seal is maintainable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
874	Performance Criteria	b6	Electrical metallic tubing (EMT) shall not be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
875	Performance Criteria	c	Facilities located in a non-air conditioned environment and exposed to seepage waters shall include one or more of the above minimum povisions and the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
876	Performance Criteria	c1	Non-metallic or stainless steel enclosures and fasteners shall be used whenever possible.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
877	Performance Criteria	c2	Exposed steel conduits and fittings shall be hot-dip falvanized and PVC coated.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
878	Performance Criteria	c3	Exposed galvanized steel surfaces shall be coated with a barrier-type organic coating.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
879	Performance Criteria	c4	Exterior surfaces of components that are not hot-dip galvanized shall be coated with a heavy-build barrier-type organic coating.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
880	Performance Criteria	c5	Electrical metallic tubing (EMT) shall not be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Coatings													
		1	General													
881	Performance Criteria		Coatings shall have established performance records for the intended corrosion control or architectural service and be compatible with the base metal to which they are applied.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
882	Performance Criteria		Coatings shall demonstrate satisfactory gloss retention, color retention and resistance to chalking over their minimum life expectancies.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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883	Performance Criteria		Basic requirements shall include:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
884	Performance Criteria	1a	Coatings exposed to weather, water seepage and corrosive environments shall be industrial/maintenance-type products manufactured by companies that are regularly engaged in the manufactoring of such products.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
885	Performance Criteria	1b	Coatings that are not exposed to weather, water seepage and corrosive environments such as those required in stations or buildings shall be architectural or industrial/maintenance-type products manufactured by companies that are regularly engaged in the manufactoring of such products.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
886	Performance Criteria	1c	Coating specifications shall include specific requirements for the preparation and cleaning of surfaces on which organic coatings are to be applied. Requirements shall be in accordance with the coating manufacturer's instructions and referenced to the Steel Structures Painting Council (SSPC) and the National Association of Corrosion Engineers (NACE).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
887	Performance Criteria	1d	Coating specifications shall include specific requirements for the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
888	Performance Criteria	1d1	Surface preparation methods	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
889	Performance Criteria	1d2	Method of application	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
890	Performance Criteria	1d3	Number of coats and scheduling between costs	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
891	Performance Criteria	1d4	Dry film thickness	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
892	Performance Criteria	1d5	Repair of damaged coatings	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
893	Performance Criteria	1d6	Inspection of coatings	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
894	Performance Criteria	1e	Ferrous surfaces to be coated are to receive a minimum of three-coat system as follows: 1st Coat - Primer 2nd Coat - Intermediate Coat 3rd Coat - Top Coat	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
895	Performance Criteria	1f	Galvanized surfaces to be coated are to receive a pretreatment and minimum three-coat system as follows: Pretreatment - Wash Primer 1st Coat - Primer 2nd Coat - Intermediate Coat 3rd Coat - Top Coat	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
896	Performance Criteria	1g	Where complete coating systems are applied after erection, provide primer, intermediate coat and top coat of the same manufacturer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
897	Performance Criteria	1h	Shop priming is required for ferrous metals fabricated in the shop. Primers shall be compatible with field applied coatings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
898	Performance Criteria	1i	Products of the same manufacturer shall be used for succeeding coats, including shop-primed materials that are to be finish coats after erection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
899	Performance Criteria	1j	Shop priming is required for galvanized steel requiring field coating. Galvanized surfaces shall be pretreated prior to priming.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
900	Performance Criteria	1k	Where possible, hot-dipping of galvanizing is required after fabrication of components	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Metallic-Sacrificial Coatings													
901	Performance Criteria	2a	Acceptable sacrificial coatings for carbon and alloy steels for use in stations, tunnels, bridges or above grade surfaces will not be in contact with seepage waters or moisture are as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
902	Performance Criteria	2a1	Zinc (hot dip galvanizing or flame sprayed)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
903	Performance Criteria	2a2	Aluminum (hot dip or flame sprayed)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
904	Performance Criteria	2a3	Aluminum - zinc (hot dip or flame sprayed)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
905	Performance Criteria	2a4	Electroplated zinc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
906	Performance Criteria	2a5	Inorganic zinc (as a primer for vinyl, epoxy, chlorinated rubber and other compatible coatings)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
907	Performance Criteria	b	Sacrificial coatings that will be exposed to seepage waters or moisture shall be provided a high performance barrier-type organic top coating such as vinyl or epoxy.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
908	Performance Criteria	c	The use of electroplated zinc shall be limited to dry locations unless provided a barrier-type organic coating.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Organic Barrier Coatings													
909	Performance Criteria		Organic coating systems shall consist of a wash primer (for galvanized and aluminum substrates), a primer, intermediate coat(s) and a finished coat. Acceptable organic coatings for exposure to the atmosphere or moist environments are as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
910	Performance Criteria		Aliphatic polyurethanes - For interior or exterior metals. To be used as a complete system over primed surfaces or as a top coat over compatible coatings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
911	Performance Criteria		Vinyl copolymers - For interior or exterior metals. To be used as a complete system over primed surfaces or as a top coat over compatible coatings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
912	Performance Criteria		Epoxy - High build coating for corrosion control of metals in moist and wet environments.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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913	Performance Criteria		Chlorinated Rubber - High-build coating for corrosion control of metals in moist and wet environments.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
914	Performance Criteria		Fusion-bonded Epoxy - For interior or exterior metals.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
915	Performance Criteria		Polyurethene, where not exposed to direct sunlight - Top coat for interior metals in sheltered locations with compatible intermediate coat(s) and primer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
916	Performance Criteria		Alkyds, where not exposed to direct sunlight - Top coat for interior metals and exterior metals in sheltered locations with compatible intermediate coat(s) and primer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
917	Performance Criteria		Inorganic Zinc - Primer for vinyl, epoxy, chlorinated rubber and other compatible coatings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
918	Performance Criteria		Wash Primers - Pretreatment for galvanizing and non-ferrous metals prior to priming.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4	Conversion Coatings													
919	Performance Criteria		Conversion coatings such as phosphate and chromate coatings shall be used as pretreatments only for further application of organic coatings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5	Ceramic - Metallic Coatings													
920	Performance Criteria		Hybrid-type coating systems is acceptable for use on metal panels and fastening hardware when not exposed to moist environments or seepage waters.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6	Coatings for Non-Ferrous Metals													
921	Performance Criteria		Following provisions shall be included with all coatings:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
922	Performance Criteria		Wash primers shall be used on copper and copper alloys, and magnesium alloys.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
923	Performance Criteria		Topcoats shall consist of epoxy, where appearance is not critical, or with an additional topcoat of polyurethane for appearance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
924	Performance Criteria		Fusion-bonded epoxy, polyester, polyethylene, or nylon shall be applied by fluidized bed or eletrolastic spray methods.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Design Requirements													
925	Performance Criteria		Following minimum provisions shall be included with the design of all facilities:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
926	Performance Criteria	1	Crevices at joints and fasteners shall be avoided; otherwise a sealant shall be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
927	Performance Criteria	2	Bimetallic couples shall be avoided, through design modification or use of a dielectric material between dissimilar metals. Acceptable bimetallic couples, subject to review, are as follows: - Aluminum/stainless steel - Stainless steel/carbon steel - Aluminum/zinc (galvanizing)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
928	Performance Criteria		The following bimetallic couples shall be avoided through design modificaiton or use of dielectric separators:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
929	Performance Criteria	3	Aluminum/copper (except tinned metals used for electrical connections)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
930	Performance Criteria	4	Copper/steel Pump columns used for drainage water ejection systems shall have a barrier-type coal-tar expocy coating applied to all exterior submerged surfaces. Contacts between aluminum and concrete or caustic materials shall be avoided, through design modification or use of dielectric materials or barrier-type organic coatings at interfaces.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		G	Transit Vehicles													
931	Performance Criteria		These criteria are directed towards reducing vehicle maintenance and enhancing vehicle apperance by reducing corrosion:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
932	Prescriptive Spec	1	Outer shell stainless steels shall be series 200 or 300.													
933	Performance Criteria	2	Anodized aluminum and stainless steel structural components not exposed to the weather or seepage waters do not require coating or other minimal corrosion control criteria. Stainless steel members shall be Type 304, 316 or equivalent grade. Alumimum shall be 5000 or 6000 series and anodized.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
934	Performance Criteria	3	Carbon steel underframe components shall be coated with an inorganic zinc primer and an epoxy topcoat or flame sprayed aluminum with an epoxy topcoat. Aluminum underframe components shall be anodized and coated with an epoxy primer and a topcoat.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
935	Performance Criteria	4	Riveted fastening joints shall have drilled holes and elastic panels seals to prevent fretting. Fasteners shall be aluminum or stainless steel as follows: <u>Materials to be Joined:</u> -----> <u>Fastener Materials Required</u> Aluminum to Aluminum --> Aluminum or series 300 stainless steel Aluminum to 300 Series stainless steel --> 300 Series stainless steel 300 Series stainless to 300 Series stainless --> 300 series stainless steel	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3.10.6	MICROBIOLOGICALLY INFLUENCED CORROSION (MIC) CONTROL FOR FIRE PROTECTION PIPING SYSTEM													
936	Performance Criteria		Microbiologically influenced Corrosion (MIC) monitoring and mitigation system shall be provided for all protection piping systems. Pipe fittings shall be installed in all system risers in valve rooms, and in tunnel cross passages, to facilitate the injection of MIC mitigation products. Pre-action systems shall be protected with a nitrogen system installed in the valve room. THe system should be capable of producing 98% pure nitrogen designed for use in fire protection sprinkler systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		3.11	**TRACTION POWER SUBSTATION (TPSS) SITES**													
		3.11.1	GENERAL													
		3.11.2	DESIGN ELEMENTS													
		4	**GUIDEWAY AND TRACKWORK**													
		4.1	**GUIDEWAY**													
		4.1.1	BASIS FOR CRITERIA													
937	Performance Criteria		This section of the Criteria is based on requirements, established by California Public Utilities Commission (CPUC), recommendations of American Railway Engineering and Maintenance Association (AREMA), and other applicable Feredal (i.e. ADA), State (i.e. PUC) and local jurisdictions' (i.e. city) requirements and recommendations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4.1.2	SURVEY CONTROL SYSTEM													
938	Standard Criteria		Horizontal NAD83 datum and Vertical NAVD88 datum shall be used per Sections 8850, 8851, 8852 and 8853 of California Public Resources Code. Distance accuracy (horizontal control) and elevation accuracy (vertical control) shall meet National Geodetic Survey (NDS) classification of Second-order, class I per Federal Geodetic Control Committee (FGCC) Standards and Specifications for Geodetic Control Networks, Section 2, Standards, issued in September 1984 or the latest edition.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4.1.3	CLEARANCE REQUIREMENTS													
		4.1.3.1	General													
		4.1.3.2	Side Clearances - Heavy Rail Vehicle													
		4.1.3.3	Side Clearances - Light Rail Vehicle													
		4.1.3.4	Vertical Clearances													
		4.1.3.5	Circular (Bored) Tunnels													
		4.1.4	AT-GRADE GUIDEWAY													
		4.1.4.1	General													
		4.1.4.2	Sub-grade													
		4.1.4.3	Slopes and Retaining Walls													
		4.1.4.4	Drainage													
		4.1.4.5	Undertrack Structures													
		4.1.4.6	Wayside Access													
		A	Service Roads													
		B	Highway Vehicle Access Points													
		C	Hi-Rail Vehicle Access Points													
		4.1.5	RIGHT-OF-WAY, FENCING AND SIGNAGE REQUIREMENTS													
		4.1.5.1	Right-of-Way													
		4.1.5.2	Fencing													
		4.1.5.3	Wayside Signage													
		4.1.6	TRACK HORIZONTAL AND VERTICAL GEOMETRY													
		4.1.6.1	General													
		4.1.6.2	Horizontal Alignment - Tangent													
		4.1.6.3	Horizontal Alignment - Curves													
		4.1.6.4	Vertical Alignment - Tangents													
		4.1.6.5	Vertical Alignment - Curves													
		4.1.7	LRT GRADE CROSSINGS													
		4.2	**TRACKWORK**													
		4.2.1	INTRODUCTION													
		4.2.2	GENERAL													
		4.2.3	CATEGORIES OF TRACKS AND TYPES OF TRACK STRUCTURES													
		4.2.3.1	Ballasted Track													
939	Prescriptive Spec		The minimum depth of subballast measured from the bottom of the ballast at the centerline of the rail to the top of subgrade shall be 8" for mainline track and 6" for yard and secondary tracks.													
940	Prescriptive Spec		The minimum depth of ballast from the bottom of the tie at the centerline of the rail to the top of the subballast shall be 12" for mainline tracks and 8" for yard and secondary tracks.													
941	Prescriptive Spec		The ballast shoulders shall be at least 12" wide.													
942	Prescriptive Spec		The final top of ballast elevation shall be level to the top of tie except in the area 6 inches on either side of the rail where the ballast must be cribbed to maintain 1" of clearance between the bottom of the rail and the top of ballast.													
943	Standard Criteria		AREMA Size No. 4A ballast shall be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
944	Standard Criteria		Subballast shall conform to AREMA specifications.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4.2.3.2	Direct Fixation Track													
945	Standard Criteria		Direct fixation track structure shall be used for aerial, underground and semi-depressed guideways unless stated otherwise by MRDC Section 5 Structural.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4.2.3.3	Slab Track													
		4.2.3.4	Embedded Track													
		4.2.3.5	Paved Track													
		4.2.3.6	Approach Slab													
		4.2.4	TRACK GAUGE													
		4.2.4.1	Light Rail Transit System													
		4.2.4.2	Heavy Rail Transit System													
		4.2.5	ALIGNMENT AND SUPERELEVATION													
		4.2.6	CONSTRUCTION TOLERANCES													
		4.2.7	RAIL													

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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ID	TYPE	SECTION	DESCRIPTION	LOS ANGELES	HUNTINGTON PARK	BELL	CUDAHY	DOWNEY	SOUTH GATE	PARAMOUNT	BELLFLOWER	CERITOS	ARTESIA	VERNON	VARIANCE	DOCUMENT/SECTION
		4.2.7.1	Continuously Welded Rail													
		4.2.7.2	Rail Anchoring													
		4.2.7.3	Rail Welding													
		4.2.7.4	Rail Joints													
		4.2.8	GUARDRAILS													
		4.2.8.1	Restraining Rails													
		4.2.8.2	Emergency Guardrails													
		4.2.9	TIES													
		4.2.10	RAIL FASTENINGS													
		4.2.11	SPECIAL TRACKWORK													
		4.2.12	MISCELLANEOUS TRACK APPURTENANCES													
946																
		5	**STRUCTURAL-GEOTECHNICAL**													
		5.1	**INTRODUCTION**													
		5.1.2	REFERENCE DATA													
947	Standard Criteria		For the structural design, meet all applicable portions of the State of California general laws and regulations, and the codes, manuals, or specifications identified in this Section. Where the requirements stipulated in any such document or by these criteria are in conflict, use the stricter, unless otherwise noted herein.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.1.3	REFERENCE CODES													
		A	Cal/OSHA													
		B	Building Codes													
		C	Other Codes, Manuals and Specifications													
		D	Project Structural Engineer													
		5.2	**LOADS AND CONDITIONS**													
		5.2.1	GENERAL													
		5.2.2	DEAD LOADS (DC, DW)													
		A	Design of Aerial Guideways													
948	Standard Criteria		For the design of aerial guideways, unit weights and loads specified in Subsection 3.5.1 of AASHTO-CA LRFD BDS shall be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Structures Constructed by Cut-and-Cover Methods:													
949	Performance Criteria	B1	The dead load for structures constructed by cut-and-cover methods consists of the weight of the basic structure, the wegiht of secondary elements supported by structure, and the weight of the earth cover supported by the top of structure and acting as a simple gravity load.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
950	Performance Criteria	B2	Apply the dead load in stages to realistically represent the lift history of the designed structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
951	Prescriptive Spec	B3	Use a design unit weight of earth, both above and below the groundwater table, of not less than 130 pcf for the analysis of the structural frame unless specified otherwise. In making calculations with regard to dead weight resisting flotation of the structure, the actual unit weight of backfill placed over structure shall be used, but in no case shall be taken as greater than 120 pcf. Where full hydrostatic pressure below the groundwater table is used as a design load, use a buoyant design unit weight of not more than 58 pcf for earth below the groundwater table.													
952	Prescriptive Spec	B4	Cut and cover station entrance structures shall be designed for a minimum of 8 ft ground cover.													
		C	Loads from Adjacent Existing Building Foundations or Other Existing Structures													
953	Performance Criteria	C1	Determine the need for all permanent underpinning of buildings or structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
954	Performance Criteria	C2	Horizontal and vertical distribution of loads from foundations of existing buildings shall be determined by the designer in consultation with its geotechnical engineer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Miscellaneous Loads													
955	Performance Criteria	D1	Consider provisions of agreements with property owners, railroads, and other agencies regarding special loading for portions of structures that pass beneath or adjacent to their properties or facilities in establishing the loading conditions for such structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
956	Prescriptive Spec	D2	Design all aerial structures and bridges for possible future attachment of sound walls. Use the dead load for sound walls of 300 pounds per linear foot of structure per wall. The distribution of this load to the bridge girders shall follow the Caltrans requirements of sound wall load distribution to the bridge girders.													
		5.2.3	LIVE LOADS (LL, PL, LS)													
		A	Heavy Rail Vehicle (HRV)													
957	Performance Criteria		Structures subjected to train loads shall be designed for any combination of train lengths, loads and forces which produce the most critical condition.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Light Rail Vehicle (LRV) with Catenary Power Supply													
958	Performance Criteria		In all cases, the combination of train lengths used for structural design shall be the one that produces the most severe condtions on the element being designed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Roadway													
959	Standard Criteria		Base roadway LL for underground rail transit structures shall be AASHTO-CA LRFD BDS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
960	Standard Criteria		Superimposed wheel load from this loading shall be distributed in accordance with the AASHTO-CA LRFD BDS, Article 3.6.1.3.3	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Railway													
961	Standard Criteria		Railway LL shall use Cooper E 80 loads as specified in AREMA, Chapter 8, Part 1, Section 2.2.3© unless otherwise specified by the railroad company.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Pedestrian Areas													

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962	Prescriptive Spec	E1	Design station platforms, pedestrian ramps, mezzanines, and other pedestrian areas for a uniform LL of 100 psf.													
963	Prescriptive Spec	E2	Design stairways for a uniform LL of 100 psf or a concentrated load of 300 lb on the center of stair treads, whichever is critical.													
		F	Storage Space and Machinery Rooms													
964	Prescriptive Spec		Design electrical equipment rooms, pump rooms, service rooms, storage space, and machinery rooms for uniform LL of 250 psf, to be increased if storage or machinery loads so dictate. Design fan rooms and battery rooms for uniform loads of 350 psf.													
		G	Elevators, Escalators and Passenger Conveyors													
965	Performance Criteria		Design structures supporting elevators, escalators or passenger conveyors for the maximum reactions from any of the manufactured units considered for use in the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		H	Railings													
966	Standard Criteria		Design Railings in the station platforms, mezzanines and service walkways per AASHTO-CA LRFD BDS Section 13.8.2.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
967	Prescriptive Spec		Design Railings in other places of public assembly in accordance with local loads. Design railings in equipment rooms and working areas for a force of 200 lb applied in any direction at any point.													
		I	Gratings													
968	Standard Criteria		Design ventilation shaft gratings in areas that are subject to loading from vehicles to carry loading in accordance with AASHTO-CA LRFD BDS. Design gratings in sidewalks and in areas protected from vehicular traffic for a uniform LL of 900 psf. Select types of gratings according to the agency requirements having jurisdiction in that area, and applicable codes listed under Section 5.1.3.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		J	Service and Emergency Walks													
969	Prescriptive Spec		Design service and emergency walks for a uniform LL of 85 psf of walkway area.													
		K	Underground Walls, Doors and Dampers													
970	Performance Criteria		These items are subject to air pressure from the running trains.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.4	DERAILMENT LOADS (DR)													
		5.2.4.1	Vertical													
971	Performance Criteria		Lateral vehicle excursion shall vary from 4 inch minimum to 3 ft 0 inches maximum for tangent track and curved track with radii greater than 5000 ft.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
972	Performance Criteria		For track with smaller radii and where the distance from the rail to the edge of the deck slab is less than 3 ft 8 inches, the maximum excursion shall be adjusted so that the derailed wheel flange is located 8 inches from the rail traffic face of the nearest barrier, if any, or the edge of the deck.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
973	Prescriptive Spec		A vertical impact factor of 100 percent of vehicle weight shall be used to compute the equivalent static derailment load.													
974	Prescriptive Spec		For derailment loads where the vehicle wheels bear directly on the slab, the wheel loads shall be assumed to be distributed over 3 ft of the slab in a direction perpendicular to the main reinforcement.													
		5.2.4.1	Horizontal													
975	Prescriptive Spec		Aerial guideways and guideway supported on embankments more than 4 ft above the surrounding grade shall be provided with restraining rails on the inside running rail on all curves on a radius of less than 500 ft.													
976	Prescriptive Spec		In addition, a concrete curb a minimum of 8 inches high shall be provided at the outside edge of the guideway or embankment that is above and composite with the structure supporting the guideway and structurally capable of sustaining the DR prescribed.													
977	Prescriptive Spec		For guideway cross-sections having a clearance between the vehicles and the barrrier walls of between 6 inches and 3 ft 0 inches, with HRV and LRV speed of 55 mph or greater, the force due to horizontal DR shall be taken as 40 percent of the single fully loaded (AW3) vehicle acting 2 ft above the rail (DR2) or at the top of curb (DR1) and normal to the barrier wall for a distance of 10 ft along the wall.													
		5.2.5	EARTHQUAKE LOADS (EQ)													
978	Standard Criteria	A	All aerial strucutres and bridges shall be designed to resist earthquake motions in accordance with Metro Supplemental Seismic Design Criteria (Metro SSDC) Appended. In some cases, aerial structures and bridges may be under other angecy jurisdictions and design criteria specified elsewhere.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
979	Standard Criteria	B	Underground structures and earth retaining structures subject to earthquake motions shall be designed in accordance with Metro SSCD. In some cases, the nearby foundations of aerial structures and bridges may be under other angecy jurisdictions and design criteria specified elsewhere.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
980	Standard Criteria	C	Elements of above ground station structures not subjet to rail transit loading shall be designed to resist earthquake motions in accordance with the applicable building codes of Section 5.1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
981	Standard Criteria	D	Seismic forces for temporary and staged construction: Design response spectra shall be in accordance with Metro SSDC. Where Metro is silent on this subject, use AASHTO-CA LRFD BDS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.6	DYNAMIC LOAD ALLOWANCE (IMV, IMH)													
982		A	Dynamic load allowance considerations for aerial structures supporting rail transit loading shall be:													
983	Performance Criteria	A1	Dynamic load allowance shall not be used for abutments, retaining walls, wall-type piers, embedded piles, footings, and service walks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
984	Prescriptive Spec	A2	Vertical dynamic load allowance (IMV) for aerial structures shall be 33 percent of LL.													

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985	Prescriptive Spec	A3	In addition to IMV provided above, a horizontal dynamic load allowance (IMH) equal to 10 percent of LL shall be applied. This force shall be equally distributed to the individual axles of the vehicle and shall be assumed to act in either direction transverse to the track through a point at 3.5 feet above the top of the low rail.													
986		B	Design of the top slan of utility vaults and other underground structures supporting highway loading shall conform to:													
987	Prescriptive Spec		IM = 33 (1.0 - 0.125 De) >= 0%													
988	Performance Criteria	C	Structures supporting special vehicles, such as moving equipment or other dynamic loadings that cause significant impact, shall conform to the local building code or, if not covered by code, shall be considerede individually using the best technical information available.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.7	CENTRIFUGAL FORCE (CE)													
989	Prescriptive Spec		The centrifugal force shall be applied 4 feet above the top of low rail on all tracks.													
		5.2.8	LONGITUDINAL FORCE (LF) (BR)													
		5.2.8.1	Forces due to Acceleration and Deceleration													
990			The magnitude of LF shall be computed as:													
991	Prescriptive Spec	A	For decelerating trains, the LF shall be equal to 28% of LL without dynamic load allowance. Emergency braking (BR) shall be equal to 42% of LL without dynamic load allowance.													
992	Prescriptive Spec	B	For acceleratin trains, LF shall be equal to 14% of LL without dynamic load allowance.													
		5.2.8.2	Forces due to Restraint of Continuous Welded Rail (CWR)													
993	Performance Criteria		Wherever a CWR is terminated, provision shall be made to fully restrain its end. This restraint shall be assumed to introduce an LF in the end of each rail of 165,000 lbs based on 85 degrees Farenheit temperature change.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
994	Prescriptive Spec		The rail shall extend beyond the aerial or bridges structure such that a minimum of 100 rail fasteners, adjacent to each other, are engaged in the continuous at-grade or underground portions of the track.													
		5.2.8.3	Forces due to Rail Bumping Posts													
995	Prescriptive Spec		The transfer of loads due to collusion between any number of rail cars, traveling at design speed and any structure-mounted rail bumping post shall be limited to 200 kilo pounds (kips), including impact.													
		5.2.9	EARTH PRESSURES (EH, EV, ES)													
996	Standard Criteria	A	Earth pressures shall be specified in AASHTO LRFD Section 3.11	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
997	Standard Criteria	B	Surcharge load values not less than those specified in AASHTO LRFD Section 3.11.6.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
998	Performance Criteria	B1	Rail transit loading shall be based on actual axial loads, including impact factor, and car spacing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
999	Standard Criteria	B2	Vehicle [non-rail transit] loading shall be in accordance with AASHTO LRFD Section 3.11.6.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1000	Performance Criteria	B3	LL and DL from adjacent foundations of structures within the zone of influence shall be considered in computing horizontal pressures on new or existing structures. The zone of influence is defined as being a line projected downward at a slope of 1H:1V from the outside edges around the entire perimeter.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1001	Performance Criteria	B4	The lateral earth pressures to be used in design of structures either fully or partially embedded in "rock" shall be per the recommendations of the project geotechnical engineer as defined in the geotechnical section herein.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1002	Performance Criteria	B5	Earth pressures provided by the geotechnical investigation under Section 5.6, Geotechnical and Metro SSDC, take precedence if exceeding those referenced above.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.10	WATER LOAD, STREAM PRESSURE, BUOYANCY, SCOUR (WA)													
1003	Standard Criteria		All piers and other portions of structures that are subject to flood forces shall be designed in accordance with the requirements outlined in AASHTO-CA LRFD BDS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1004	Standard Criteria		Guideways that cross over flood control channels and rivers shall meet the requirements of the Los Angeles County Flood Control Districts and the Corps of Engineers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.11	FORCE EFFECTS DUE TO TEMPERATURE GRADIENT (TG)													
1005	Standard Criteria		Internal stresses and structural deformations due to both positive and negative temperature gradients shall be determined in accordance with the provision of AASHTO-CA LRFD BDS Section 3.12.3.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.12	FORCE EFFECTS DUE TO SHRINKAGE AND CREEP (SH, CR)													
1006	Standard Criteria		Stresses and movements resulting from concrete shrinkage and creep shall be incorporated into the design of the structures in accordance with AASHTO-CA LRFD BDS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.13	FORCE EFFECTS DUE TO UNIFORM TEMPERATURE (TU, TTR, TLR)													
1007		A	Provisions shall be made for stresses and deformatons resulting from temperature ranges:													
1008		A1	Concrete													
1009	Prescriptive Spec	A1a	Temperature Range = TmaxDesign - TminDesign = 60 degrees Farenheit (AASHTO-CA LRFD BDS).													
1010	Prescriptive Spec	A1b	Coefficient of expansion .0000060 inch/inch/degrees Farenheit													
1011		A2	Steel													
1012	Prescriptive Spec	A2a	Temperature Range = TmaxDesign - TminDesign = 75 degrees Farenheit (AASHTO-CA LRFD BDS).													
1013	Prescriptive Spec	A2b	Coefficient of expansion .0000065 inch/inch/degrees Farenheit													
1014		A3	Direct Fixation Track													
1015	Performance Criteria	A3a	Controlled setting temperature	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1016	Prescriptive Spec	A3b	80 degrees farenheit minimum													
1017	Prescriptive Spec	A3c	95 degrees farenheit minimum													
1018	Prescriptive Spec	A3d	Temperature rise 34 degrees farenheit maximum													
1019	Prescriptive Spec	A3e	Temperature fall 43 degrees farenheit maximum													
1020	Prescriptive Spec	A3f	Coefficient of expansion .0000065 inch/inch/degrees Farenheit													
1021	Prescriptive Spec		Temperature range specified above are base on a range of ambient air temperature of 52 degrees Farenheit (minimum) to 94 degrees Farenheit (maximum). The CWR is assumed to achieve a minimum temperature of the ambient air temperature and a maximum temperature of 20 degrees Farenheit above the ambient air temperature.													
1022		B	Transverse and Longitudinal forces due to temperature variations in the rail shall be applied in a horizontal plane at the top of the low rail as follows:													
1023	Prescriptive Spec	B1	Transverse Force (TTR): T = 151 kips/R Where R = radius of curvature in ft													
1024	Prescriptive Spec	B2	Longitudinal Force (TLR): longitudinal force per structure per rail shall be determined by the smaller of 200 kips or by: T = 0.65 x P x L Where: P = longitudinal restraint force of rail per linear foot L = average length of adjacent structures (feet)													
		5.2.14	RAIL FRACTURE (RF)													
1025	Prescriptive Spec		The final design of structures shall consider the possibility of any one CWR breaking under a tensile load of 200 kips. The break will be restrained by a longitudinal restriant force in the range of 1600 lbs to 2200 lbs per rail seat assembly. The structures shall be designed for the possibility of only one rail break at a time.													
1026	Prescriptive Spec		Structures shall be designed to resist the lesser of 200 kips from the rail break or the total available restraint available from the rail seat assemblies for the structure of that rail. Rail seat assemblies will be spaced typically at 30 inches on-center except at bonded rail joints at at special trackwork.													
		5.2.15	FORCE EFFECTS DUE TO SETTLEMENT (SE)													
1027	Performance Criteria		Requirements for allowable differential settlements are prescribed in the Section 5.6, Geotechnical.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.16	VEHICULAR COLLISION LOADS (CT)													
1028	Standard Criteria		Piers or other support elements for elevated guideways or roadways which have less than 30 ft clearance from the edge of travel way of an adjacent roadway, or less than 50 ft from the centerline of a railway track, shall be designed to meet the requirements of AASHTO-CA BDS Section 3.6.5.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.17	LRFD DESIGN SPECIFICATIONS, DESIGN LIFE, AND LIMIT STATES													
1029	Standard Criteria		Use the AASHTO-CA LRFD BDS method for the design of all structural components and connections.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1030	Standard Criteria		For structures other than bridges and underground roof systems subject to railroad or highway loading, for underground structures, this code adopts the latest version of the California Building Code, California Code of Regulations, Title 24, Part 2, California Building Standards Commissions, based on the International Building Code.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1031	Prescriptive Spec		The service life for aerial and underground structures carrying rail transit as designed under these criteria is 100 years.													
		5.2.17.1	Service Limit State (See Tables 5-2, 5-3 and 5-5)													
1032	Definition	A	Service I: Load Combination relating to operational use of the guideway with operational wind.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1033	Definition	B	Service II: Load combination intended to control yielding of steel structures and slip of slip-critical connections due to live load.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1034	Definition	C	Service III: Load Combination for longitudinal analysis relating to tension in prestressed concrete structures with the objective of crack control and to principal tension in the webs of 4segmental concrete girders.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1035	Definition	D	Service IV: Load Combination relating to tension in prestressed concrete substructures with the objective of crack control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1036	Definition	E	Service V: Load Combination relating to only control of uplight and concrete tension during derailment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1037	Definition	F	Service VI: Load Combination relating only to segmental bridges, with no live loads and full temperature gradient.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.17.2	Fatigue and Fracture Limit State (See Tables 5-2, 5-3 and 5-5)													
1038	Definition	A	Fatigue I: fatigue and fracture load combination relating to repetitive live load and dynamic response for transit and roadway vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1039	Definition	B	Fatigue II: Fatigue and fracture load combination relating to repetitive live load and dynamic response for transit and roadway maintenance and permit vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.17.3	Strength Limit State (See Tables 5-2, 5-3 and 5-5)													
1040	Definition	A	Strength I: Load Combination relating to operational use of the guideway without wind.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1041	Definition	B	Strengthn II: Load combination relating to use of Owner-specfic permit vehicles without wind.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1042	Definition	C	Strength III: Load Combination relating to non-operational use of the guideway with high velocity wind.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1043	Definition	D	Strength IV: Load Combination relating very high dead load to live load force effects ratio.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1044	Definition	E	Strength V: Load Combination relating to operational use of the guideway with operational wind.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1045	Definition	F	Strength VI: Load Combination relating to operational use of the guideway with emergency braking (BR).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.17.4	Extreme Event Limit State (See Tables 5-2, 5-3 and 5-5)													
1046	Definition	A	Extreme Event I: Load Combination relating to operational use of guideway during the Maximum Design Earthquake (MDE) seismic event for connection of superstructure only (See Metro SSDC)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1047	Definition	B	Extreme Event 1A: Load Combination relating to operational use of the guideway with the Operational Design Earthquake (ODE). See Appendices A and B.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1048	Definition	C	Extreme Event II: Load Combination relating to operational use of guideway during a vehicle or a railroad collision (CT).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1049	Definition	D	Extreme Event III: Load Combination relating to operational use of the guideway during a derailment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1050	Definition	E	Extreme Event IV: Load Combination relating to a rail fracture.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.18	APPLICATION OF LOADINGS													
1051	Performance Criteria		Where applicable, use loads and forces listed above for the design of rail transit aerial structures. Rail transit vehicle live loads, buoyancy, wind loads and other variable loads shall be reduced or eliminated to create the maximum force effect on the structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.19	MULTIPLE PRESENCE FACTORS													
1052	Standard Criteria		For structures carrying rail transit loads, tracks shall be treated as a traffic lane in applying the provisions of AASHTO-CA LRFD BDS, except the multiple presence factor for the first two loaded tracks shall be 1.0 and for three or more loaded tracks shall be 0.85.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.20	LOADING FACTORS AND LOADING COMBINATIONS, BRIDGES AND AERIAL GUIDEWAYS													
1053	Standard Criteria		Each structural component shall be designed for the appropriate load combination limit states and load factors as specified in AASHTO-CA LFRD BDS. Additionally, for precast segmentally constructed bridges, consider load combination in AASHTO-CA LRFD BDSAASHTO-CA LRFD BDS equation 3.4.1-2 for service limit state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.2.21	LOAD DISTRIBUTION													
1054			Distribute live loads in accordance with provisions of AASHTO-CA LRFD BDS by the following additions:													
		5.2.21.1	Ballasted Track													
1055	Prescriptive Spec		Axle loads may be assumed as uniformly distributed longitudinally over a length of 3 feet, plus the depth of ballast under the tie, plus twice the effective depth of slab, except as limited by axle spacing.													
		5.2.21.2	Direct Fixation Track													
1056	Prescriptive Spec		Where wheel loads are transmitted to the deck slab through rail mountings placed directly on the slab, the wheel load shall be assumed as uniformly distributed over a length of 3 ft along the rail.													
		5.2.22														
1057	Performance Criteria		Contract Plans shall clearly show all design loads including dead load, earth pressure, live load, wind and seismic design parameters used in the analysis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3	**AERIAL GUIDEWAYS AND STRUCTURES**													
1058	Performance Criteria		The aerial structures shall be designed to withstand wind loads of uniform pressure acting upon the superstructure, substructure, and live load.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.1	WIND LOAD ON STRUCTURE (WS)													
		5.3.1.1	Wind Load on Superstructure													
1059	Standard Criteria		A horizontal uniform wind load of the intensities given by AASHTO-CA LRFD BDS Section 3.8.1.2.2 shall be applied simultaneously at the centroid of all exposed areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1060	Standard Criteria		Vertical load shall be as specified in AASHTO-CA LRFD BDS Section 3.8.2.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1061	Performance Criteria		Wind loading on catenary shall be considered in the design of both the superstructure and substructure elements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1062	Standard Criteria		Loads shall be determined by the OCS consultant, but shall consider the forces specified by AASHTO-CA LRFD BDS Section 3.8.3.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.1.2	Wind Load on Substructure													
1063	Standard Criteria		Substructure shall be designed to withstand the preceding loads applied to the superstructure as they are transmitted to the substructure. A horizontal wind load of magnitude specified in AASHTO-CA LRFD BDS Section 3.8.1.2.3 in any direction shall be applied simultaneously at the centroid of the exposed projected substructure area.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.2	WIND LOAD ON LIVE LOAD (WL)													
1064	Prescriptive Spec	A	For trains operating on aerial structures with the underside of the main girders not more than 40 ft above the mean retarding surface, WL shall consist of a transverse wind load of 115 plf of a train and a longitudinal wind load of 28 plf of train. The transverse force shall be applied to the rail and superstructure as loads concentrated at the axle locations and in plane 6 ft 4 inches above the top of the lower rail. The longitudinal force shall be applied to the rails and superstructure as a load uniformly distributed over the length of the train in a horizontal plane 6 ft 4 inches above the top of lower rail.													
1065		B	For higher aerial structures, the values of WL in the transverse and longitudinal directions shall be as follows:													
1066	Prescriptive Spec		H = 41 ft to 60 ft Where: Transverse wind pressure = 126 plf Longitudinal wind pressure = 31 plf													

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1067	Prescriptive Spec		H = 61 ft to 100 ft where: Transverse wind pressure = 130 plf Longitudinal wind pressure = 34 plf													
1068	Prescriptive Spec		These WL loads also apply to the design of substructure elements supporting a signle track, or the design of substructure elements supporting 2 tracks. WL loads on a single train shall be increased 30% when both tracks are loaded; this factor accounts fully for shielding effect on vehicle-on-vehicle as the two trains run alongside each other.													
		5.3.3	SPECIAL DESIGN CONSIDERATIONS													
		5.3.3.1	Vertical Vibration													
		5.3.3.2	Fatigue													
1069	Performance Criteria		The effect of stress levels changes causes by passage of rail trains over structures shall be considered using 3 million cycles of maximum stress over the life of the structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.3.3	Uplight													
1070	Performance Criteria		There shall be no uplight at any support for any combination of loading.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.3.4	Friction													
1071	Performance Criteria		Friction shall be considered in the design where applicable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.3.5	Sound Barriers													
1072	Performance Criteria		Sound barriers, both presense and absence, shall be considered in the evaluation of stress, vibration and deflection limits.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.3.6	Bearings													
1073	Standard Criteria		AASHTO-CA LRFD BDS shall be used for design of bearings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.3.7	Camber Growth and Deflections for Aerial Guideway Structures													
1074	Prescriptive Spec		As a guide in design, the total long-term predicted camber growth, less deflection due to full dead load, shall be limited to 1/2000 of the span length for non-ballasted, prestressed concrete aerial structures, unless approved otherwise by Metro.													
1075	Prescriptive Spec		The deflection of longitudinal girders under normal live loads plus dynamic load allowance shall not exceed 1/1000 of the span length. For main canteliver girders, the deflection under normal live load with dynamic load allowance shall not exceed 1/375 of the cantilever span.													
1076	Prescriptive Spec		The differential deflection of the slab immediately below the centerline of the two rails of the same track, due to girder and slab deformations, shall not exceed 1/5000 of the span length.													
		5.3.3.8	Longitudinal Tension Stresses in Prestressed Members													
1077	Standard Criteria		AASHTO-CA LRFD BDS shall be used for allowable longitudinal tension stresses. Tension stresses are not allowed in pre-compressed tensile zones after all losses have occurred.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.3.9	Structure Deformations and Settlements													
1078	Performance Criteria		Consider all structure deformations, including foundation settlement, not only for their effects on structural behavior but also for their effect on trackwork. As a minimum, guideway piers and abutments settlement as measured at the top of concrete of the finished guideway girder deck shall be limited as prescribed in the section on settlement and deflection below.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.3.10	Additional Requirements for Precast Segmental Guideway Construction													
1079	Standard Criteria	A	Shear and torsion design to conform to AASHTO-CA LRFD BDS Section 5.8.6.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1080	Standard Criteria	B	Principal tensile stresses in webs to conform to AASHTO-CA LRFD BDS Section 5.8.5.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1081	Prescriptive Spec	C	If precast columns are used, the columns shall have access opening for future inspection. The columns shall have a solid section minimum 5 ft above finished grade or 12 ft above high water level. Vertical Post-tensioning is not allowed in solid sections.													
1082	Performance Criteria	D	Dry joints not allowed in the superstructure and substructure precast elements match cast joints.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1083	Prescriptive Spec	E	Box girders shall be transversely post-tensioned. No transverse pre-tensioning is allowed.													
		5.3.3.11	Crack Control													
1084	Performance Criteria		The design of prestressed concrete aerial structures shall consider the effect of temporary loads imposed by construction stages, forming, falsework, and construction equipment, as well as the stresses created by lifting or placing pre-cast members, stress concentration (non-uniform bearing at the ends of pre-cast beams), end block design and detailing, methods of erection, shrinkage and curing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.3.12	Special Structures													
1085	Standard Criteria		Retrofit repairs, alterations and additions necessary for the preservation and restoration of historic buildings, bridges and structures may be made without strict conformance to these criteria when authorized by Metro. See also, Chapter 3, Part A.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.4	VIBRATION CRITERA FOR STRUCTURES SUPPORTING PEDESTRIAN TRAFFIC ONLY													
1086	Prescriptive Spec		To avoid the possibility of resonant vibrations induced by pedestrian traffic, the natural frequency of the unloaded structure shall not be less than 3.0 hertz. To avoid vibrations that might be objectable to patrons, the calculated live load deflection shall be limited to 1/500 of the span length.													
		5.3.5	SEISMIC DESIGN FOR STRUCTURES SUPPORTING PEDESTRIAN TRAFFIC ONLY													

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1087	Standard Criteria		Station platforms, pedestrian ramps, pedestrian bridges, and mezzanines shall be desined to resist earthquake motions in accordance with Metro Supplemental Seismic Design Criteria (Metro SSDC). In some cases, these structures may be under other agency jurisdiction and shall be designed to resist earthquake motions in accordance with the applicable Building Code or Caltrans Seismic Design Criteria when designing pedestrian bridges.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.6	MATERIAL DESIGN REQUIREMENTS AND CRITERIA													
		5.3.6.1	Reinforced Concrete Design													
1088	Prescriptive Spec	A	Minimum material properties: For all above ground reinforced concrete cast-in place structures, including columns, cap beams, and superstructure for aerial structures and bridges, columns, beams, slabs, foundations and walls for the buildings: f'c = 4000 psi minimum.													
1089	Prescriptive Spec	B	For all cast in place drilled shaft foundations: f'c = 4500 psi minimum.													
1090	Performance Criteria	B1	Mix design shall account for construction method, reinforced clear space openings, and estimated time of placement.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1091	Prescriptive Spec	B2	Maximum 3/8-inch aggregate shall be used and rebar minimum clear spacing 5 inches unless it is demonstrated that drilled shaft reinforcing cage clear space opening of at least 10 times the maximum size aggregate is maintained.													
1092	Prescriptive Spec	B3	No accelerants shall be permitted.													
1093	Prescriptive Spec	B4	Temperature sensors shall be in the upper 20 ft and top and bottom of the middle third as measured along the length of the shaft. For purposes of temperature monitoring, the shaft diameter groupings shall be:													
1094	Prescriptive Spec	B4a	Under 8 ft													
1095	Prescriptive Spec	B4b	8 ft to 10 ft, inclusive.													
1096	Prescriptive Spec	B4c	10 ft or greater up 14 ft													
1097	Prescriptive Spec	B4d	Greater than 14 ft													
1098	Prescriptive Spec	B5	Type-IV or Type-II (moderate heat) cement may be used in lieu of temperature monitoring.													
1099	Prescriptive Spec	B6	Supplementary cementitious materials if used shall be fly ash, blast furnace slag, and natural pozzolan, excepting Class-C fly ash, which is prohibited.													
1100	Prescriptive Spec	B7	Mix design shall address the workability requirements for drilled shaft concrete over a period of time exceeding expected duration of the pour. Workability of shaft concrete shall be ensured over the extended duration of pours such that the slump measured at expected duration of pours plus 2 hrs shall not be less than 6 inches.													
1101	Prescriptive Spec	B8	Once a mix design has been approved, it shall not be changed without substantiation as described above.													
1102	Prescriptive Spec	C	For prestressed concrete: f'c = 6000 psi minimum.													
1103	Prescriptive Spec	D	For all building foundations, floor slabs, pits, and other miscellaneous foundations at yards and shops; misc. foundations other than those specified; and station platform foundations: f'c = 3000 psi minimum.													
1104	Prescriptive Spec	E	In certain cases, strengths of concrete other than those specified above might be required. These cases shall be as recommended by the designer and accepted by Metro.													
1105	Prescriptive Spec	F	Reinforcing steel: Bar reinforcement shall conform to AASHTO M 31 for billet-steel bars or ASTM A706 for low-alloy steel bars and the following requirements:													
1106	Prescriptive Spec	F1	Bars shall be deformed type													
1107	Standard Criteria	F2	Bars shall be Grade 60 or, for ASTM A706 bars or when specified for AASHTO M 31 bars, Grade 60.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1108	Standard Criteria	G	Prestressing steel: Steel relieved steel strand ASTM A416 (AASHTO M 203) (low relaxation), high strength steel bar ASTM A722 (AASHTO M 275).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.3.6.2	Structural Steel Design													
1109	Standard Criteria	A	Structural steel channels, angles, MC shapes: ASTM A36 or ASTM A50.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1110	Standard Criteria	B	Structural Steel W shapes for building frame: ASTM A992.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1111	Standard Criteria	C	Structural steel tube: ASTM A500 Gr B.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1112	Standard Criteria	D	Structural steel pipe: ASTM A53 Gr B.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1113	Standard Criteria	E	For uses requiring higher steel strengths or where economically justifiable: ASTM A242, A441, A514, A572, A588.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1114	Standard Criteria	F	Structural steel and composite steel-concrete flexural members for aerial structures shall conform to the requirements of AASHTO LRFD.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1115	Performance Criteria	G	The requirements governing LL deflections and structure deformations and settlements as outlined for reinforced and prestressed concrete design also apply to structural steel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1116	Standard Criteria	H	Bolts: ASTM A325, unless otherwise shown on the contract drawings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1117	Standard Criteria	I	Refer to AISC Manual of Steel Construction, Load and Resistance and Factor Design, latest edition, Specification for Structural Joints Using ASTM A325 or A490 Bolts for use of bolts in snug-tightened, pretensioned, and slip critical joint applications.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1118	Standard Criteria	J	Shop connections as detailed by the design-builder's or designer's lead structural engineer shall be welded unless otherwise directed by Metro. Weld in accordance with the current code or specfications of the AWS, as applicable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1119	Performance Criteria	K	It is the design-builder's or designer's lead structural engineer's responsibility to identify Fracture Critical Main Members, Secondary Members, and Components of Main Members in designing a new steel guideway or bridge and to designate or tabulate them explicitly on the contract documents. For further requirements, see Caltrans, Memo to Designers, Guidelines for Identification of Steel Bridge Members, latest edition.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4	UNDERGROUND GUIDEWAYS AND STRUCTURES													
1120	Prescriptive Spec		Approach slabs shall be installed such that the minimum depth of ballast under the ties is 12 inches.													
1121	Standard Criteria		For potential and computed zones of plastic hinge formation, the confining tie reinforcement for walls, pilasters and columns, shall not be less than provided by AASHTO-CA LRFD BDS Section 5.10.11.4.1d or ACI 318 Chapter 18, Earthquake-Resistant Structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.1	TUNNEL LINING													
1122	Performance Criteria		The materials for tunnel linings are cast-in-place concrete, precast segmental concrete, fabricated steel and shotcrete.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.1.1	Load and Resistance Factor Design (LRFD)													
1123	Standard Criteria		This section established the procedure for the design of tunnel linings utilized the Federal Highway Administration (FWHA) FHWA-NHI-09-010, Chapter 10, Tunnel Lining, current edition which incorporates LRFD.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1124	Standard Criteria		See also Section 5.2.17, LRFD Design Specifications, Design Life and Limit States.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.2	DESIGN CONSIDERATIONS													
		5.4.2.1	Lining Stiffness and Deformations													
		5.4.2.2	Durability													
1125	Prescriptive Spec		As a minimum precast concrete for precast tunnel linings shall include mico polypropylene fibers dosage at 1.5 lbs/cy.yd and exposed intrados of steel linings shall be coated with intumescent paint.													
		5.4.2.3	High Density Concrete													
1126	Performance Criteria		High desity concrete shall be considered for tunnel applications.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.2.4	Corrosion Protection													
1127	Performance Criteria		Corrosion protection aspects shall be evaluated during the design phase and shall be incorporated into the design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.2.5	Lining Joints													
1128	Performance Criteria		Cast-in-place linings shall have joints to provide relief from stresses induced by movements due to temperature changes. These linings shall have contraction joints every 30 ft and expansion joints every 120 ft.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.2.6	Specific Requirements for Flexible Earth-Tunnel Sections													
1129		A	General Requirements													
1130		A1	These design criteria apply to flexible and semi-flexible precast concrete segmental and fabricated steel segmental tunnel liners.													
1131	Performance Criteria	A2	Liners for intial ground support may be bolted or unbolted on their longitudinal or circumferential joints.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1132	Performance Criteria	A3	Permanent single pass grouted precast concrete linings shall be used for underground guideways constructed using tunnel boring machines. Concrete faces of radial joints to be convex/convex connected by two bolts of water/gas tight grommets. Segments must be reinforced with steel bar cages, which may be supplemented with steel fibers to prevent cracking and spalling.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1133	Performance Criteria	A4	Tapered liner rings shall be used to negotiate curves and correct vertical and horizontal alignment. Cruciform joints between segments are not permitted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1134	Performance Criteria	A5	Water and gas proof double gaskets shall be provided around precast concrete tunnel segments designed to resist maximum groundwater pressure and grouting pressure with a factor of safety of 1.5 and design life of 100 years.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1135	Performance Criteria		Gaskets shall be provided on all mating faces, with the double gasket interconnected with a cross gasket on either each radial or circumferential face that ensures compartmentalization of tunnel into nominal 5ft lengths.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1136	Prescriptive Spec	A6	No steel ring - timber spacer tunnel liners shall be used.													
1137	Performance Criteria	A7	Threaded inserts shall be cast in all pre-cast and cast-in-place tunnel liners for equipment mounting, with drill indicator locators to be provided in precast elements to allow installation of expansion anchors without affecting the integrity of the segment and reinforcement.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1138		B	Design of the Liners													
1139	Performance Criteria	B1	The liners shall be designed to sustain all the loads to which they will be subjected with adequate factors of safety. Such loads include:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1140	Performance Criteria	B1a	Handling loads as determined by the transport and handling system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1141	Performance Criteria	B1b	Shield thrust ram loads as determined by the shield propulsion system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1142	Performance Criteria	B1c	Erection loads including external grouting loads.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1143	Prescriptive Spec	B1d	Earth pressure, but in no case less than the full overburden for depths of cover less than 50 ft, and no less tahan 6500 lbs/ sq ft for depths greater than 50 ft.													
1144		B1e	Hydrostatic pressure													
1145		B1f	Self-weight of the tunnel structure													
1146	Performance Criteria	B1g	Loads due to imperfect liner erection, but not less than 0.5% diametrical distortion.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1147	Performance Criteria	B1h	Additional loads due to the driving of adjacent tunnels	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1148	Performance Criteria	B1i	Effects of tunnels breakouts at cross-passages, portals and shafts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1149	Performance Criteria	B1j	Live loads of vehicles moving in the tunnel or on the surface above it.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1150	Performance Criteria	B1k	Surcharge loads due to adjacent buildings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1151	Standard Criteria	B2	Seismic loads as identified in the "Metro Supplemental Criteria for Seismic Design of Underground Strucutres, Appendix, Chapter 3, Part B"	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1152	Performance Criteria	B3	Provisions shall be made in the liner segments for corrosion prevention and the elimination of stray currents from the surrounding ground area.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1153	Performance Criteria	B4	Provisions for ground structure interation and lateral support of surrounding ground shall be included.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.2.7	Specific Requirements for Rock Tunnel Liners													
1154		A	General Requirements													
1155	Performance Criteria	A1	These design critera apply to cast-in-place concrete liners and flexible or semi-flexible precast concrete segmental liners erected directly behind the tunneling machine.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1156	Performance Criteria	A2	For cast-in-place concrete liners, temporary support may be required during the excavation phase of the tunneling process.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1157	Performance Criteria	A3	Unless shown, specified or otherwise directed, the precast concrete segmental liners may be bolted or unbolted on their longitudinal and circumferential joints.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1158	Performance Criteria	A4	In appropriate circumstances the segmental liners may be expanded against the ground.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1159	Performance Criteria	A5	Tapered segmental liner rings shall be used to negotiate curves and correct horizontal and vertical alignment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1160	Performance Criteria	A6	In tunneled sections below the water table, the liners must be capable of being made watertight by means of sealing gaskets, duct sealants, chaulking or rock grouting or designed to incorporate a drainage system to relieve hydrostatic pressures behind the liner to drain to an invert drain in the tunnels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1161	Performance Criteria	A7	No steel ring - timber spacer tunnel liners shall be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1162	Performance Criteria	B	Design of the Liners	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1163	Performance Criteria	B1	The temporary support systems shall be designed to sustain the loads to which they will be subjected with adequate factors of safety for temporary conditions. Such loads shall include:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1164	Performance Criteria	B1a	Rock load determined by rock condition	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1165	Performance Criteria	B1b	Self Weight	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1166	Performance Criteria	B1c	Additional loads due to driving of adjacent tunnels	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1167	Performance Criteria	B1d	Grouting pressures	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1168	Performance Criteria	B2	The past-in-place liners shall be designed to sustain all the loads to which they will be subjected with adequate factors of safety without beneficial effects from the initial support system. Such loads shall include:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1169	Performance Criteria	B2a	Rock loads based on considerations of rock condition	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1170	Performance Criteria	B2b	Hydrostatic pressure either total or residual	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1171	Performance Criteria	B2c	Additional loads due to the driving of adjacent tunnels (if applicable)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1172	Performance Criteria	B2d	Live loads of vehicles moving in the tunnel or on the surface above it.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1173	Standard Criteria	B2e	Seismic loads as indicated in the "Supplemental Criteria for Seismic Design of Underground Structures"	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1174	Performance Criteria	B3	The precast segmental liners shall be designed to sustain all the loads to which they will be subjected with adequate factors of safety as defined by these criteria. Such loads shall include:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1175	Performance Criteria	B3a	Handling loads as determined by the transport and handling system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1176	Performance Criteria	B3b	Shield thrust ram loads as determined by the shield propulsion system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1177	Performance Criteria	B3c	Erection loads including external grouting loads.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1178	Performance Criteria	B3d	Rock loads based on considerations of rock condition	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1179	Performance Criteria	B3e	Hydrostatic pressure either total or residual	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1180	Performance Criteria	B3f	Self-weight of the tunnel structure	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1181	Performance Criteria	B3g	Loads due to imperfect liner erection	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1182	Performance Criteria	B3h	Additional loads due to the driving of adjacent tunnels	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1183	Performance Criteria	B3i	Live loads of vehicles moving in the tunnel	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1184	Standard Criteria	B3j	Seismic loads as indicated in the Metro Seismic Design Criteria, Section 5B	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.3	DETAILED STRUCTURAL DESIGN OF LINERS													
1185	Standard Criteria		The structural design of liners shall be governed by the AASHTO-CA LRFD BDS and Metro Supplemental Seismic Design Criteria	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.3.1	Loads													
1186			The loads to be considered in the design of structures are given in Section 5.2, Loads and Conditions. In addition to the loads discussed there, the following loads have additional special significance in the design of the tunnels:													
1187	Prescriptive Spec		ES = Earth Surcharge Load A minimum surcharge load of 400 psf shall be used in the design of tunnels and underground structures. In lieu of a well defined loading, a minimum value of 1000 psf shall be used when future development is a possibility.													
1188	Definition		LS = Live Load surcharge	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1189	Definition		DD = Downdrag	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1190	Definition		WA = Buoyancy	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.3.2	Load Factors and Loading Combinations													
1191	Standard Criteria		The tunnel linings shall be designed for the appropriate load combination limit states and load factors as specified under Section 5.2.20, Loading Factors and Loading Combination. Additionally for precast segmental liners, consider load comination in AASHTO LRFD equation 3.4.1-2 for service limit state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1192	Standard Criteria		The load case of the design for linings for mined tunnels given in Table 5-3 shall be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.3.3	Design Criteria for Plain Concrete Members													
1193	Performance Criteria		AAHSTO-CA LRFD BDS does not address plain concrete. The following design procedure shall be followed for strucutral plain concrete tunnel linings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1194	Prescriptive Spec		Calculate the moment capacity on the compression face of the lining as follows: ΦM_nT=5Φ⟦(fc')⟧^(1/2) S Where: M_nT = The nominal resistance of the compression face of the concrete Φ = 0.55 for plain concrete f'c = 28 day compressive strength of concrete S = the section modulus of the lining base on the gross uncracked section													
1195	Prescriptive Spec		Calculate the compressive strength of the lining as follows: ΦP_c= Φ (0.6)fc' A P_c = The nominal resistance of the lining in compression Φ = 0.55 for plain concrete fc' = 28 day compressive strenght of concrete A = the cross sectional area of the lining section													
1196	Prescriptive Spec		Check the compression face as follows: Qa/ΦPc + Qm/ΦMnc ≤ 1 Where: Qa = the axial load force effect modified by the appropriate factors Qm = the moment force effect modified by the appropriate factors													
1197	Prescriptive Spec		Calculate the tension strength of the lining as follows: ΦPt = 5Φ (fc')^1/2 Where: Pt = the nominal resistance of the lining in tension Φ = 0.55 for plain concrete fc' = 28 day compressive strength of concrete													
1198	Prescriptive Spec		Check the tension face as follows: Qm/S - Qa/ΦA ≤ ΦPt Where: Where: Pt = the nominal resistance of the lining in tension Φ = 0.55 for plain concrete fc' = 28 day compressive strength of concrete													
1199	Prescriptive Spec		Calculate the shear strength of the lining as follows: ΦVn = Φ1.33 ((fc')^1/2) (bw x h) Where: Vn = The nominal resistance of the lining in compression Φ = 0.55 for plain concrete fc' = 28 day compressive strength of concrete bw = the length of the tunnel lining under design h = the design thickness of the tunnel lining													

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		5.4.3.4	Structural Analysis													
1200	Performance Criteria		Beam Spring Models - A general purpose structural analysis program can be used to model the soil structure interaction. The computer model is constructed by placing a joint or node at poitns along the centroid of the lining. When constructing the model, the chord lengths should be about the same as the lining thickness. A subtended angle dimension of about 60/R, where R is the radius of the tunnel in feet, should produce acceptable results.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1201	Definition		Emperical Method for Soft Ground - For the beam spring model, trial and error computations that adjust the distortion of the ring in order to obtain a final solution in which the ring and the ground distortions are compatible are required for realistic soil structure interaction results. Using this method, the trust in the tunnel lining is calculated by: T = wR Where: T = the thrust in the tunnel lining w = the earth pressure at the sprign line of the tunnel due to all sources R = the radius of the tunnel	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1202																
1203																
		5.4.4	VENTILATION SHAFTS													
1204	Performance Criteria		The permanent shaft walls shall be reinforced concrete. Loadings imposed on the shaft by the surrounding ground shall be as given for underground structures and consistent with the shaft configuration. Shafts shall be inclined less than 45 degrees from the vertical.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.5	TUNNEL BREAK-OUTS													
1205	Performance Criteria		Permanent walls for tunnel break-outs in shafts, cross-passages, or any other location shall be in reinforced concrete. For tunnels lined with pre-cast segmental tunnel liners, requirements of specially segmented rings to suit break-out configurations shall be determined. Refer to NFPA 130, Fixed Guideway Transit Systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.6	PORTALS AND U-SECTIONS													
1206	Performance Criteria		Tunnels and box section entrance portals shall be designed in a manner to minimize the rate-of-change of pressure on a train passing through the portal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.6.1	Acceptable Design Methods													
1207	Prescriptive Spec	A	Provide the entrance with a flared transition so that the increase cross-sectional area approximates the cross-section of a six degree conical flare portal opening.													
1208	Prescriptive Spec	B	Design both the top and vertical sides of the entrance without a flare and provide a taptering slot in the top. From a 1 ft width at a constant area section the slot should increase to a maximum at the portal at a taper rate of 12 ft per 100 ft of length. The slot opening, therefore, be 13 ft wide at the portal for 100 ft long transition, or 7 ft wide at the portal for 50 ft long transition.													
		5.4.6.2	Exceptions													
1209			Exceptions that do not require special transition portal are:													
1210	Prescriptive Spec	A	Tunnels of a length less than 200 ft													
1211	Prescriptive Spec	B	Single track horseshoe tunnels with design train speed of 45 mph or lower.													
1212	Prescriptive Spec	C	Box sections and single track circular tunnels with design train speed of 40 mph or lower.													
1213	Prescriptive Spec	D	Portals at underground stations.													
		5.4.6.3	General Requirements													
1214	Prescriptive Spec	A	In locating portals and determining the ends of U-sections and walls, consideration shall be given to providing protection against flooding resulting from local storm runoff.													
1215	Performance Criteria	B	Adequate provision shall be made for resistance to hydrostatic uplift. Adequate provision shall be made for immediate and effective removal of water from rainfall, drainage, groundwater seepage, or any other source.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1216	Prescriptive Spec	C	U-section, with both walls continuous with a full-width base slab, shall be used for open-cut sections where the top of rail is less than 4' above the maximum groundwater table. Above that level, independent reinforced concrete cantilever retaining walls may be considered for design in accordance with the provisions of Article 5.4.8.													
1217		D	U-sections shall be analysed as continuous structures on elastic foundations. If at any station the two walls are of unequal heights, then the factor of safety against sliding shall be a minimum of:													
1218	Prescriptive Spec	D1	1.50 with no passive resistance of the soil.													
1219	Prescriptive Spec	D2	2.00 with passive resistance of soil.													
1220		E	Wall thickness for U-sections shall be designed by using:													
1221	Performance Criteria	E1	The geotechnical soils report recommendations for coefficient of lateral earth pressure, at-rest case.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1222	Prescriptive Spec	E2	Hydrostatic pressure.													
1223	Prescriptive Spec	E3	Surcharge effects.													

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1224	Prescriptive Spec	F	U-section grade slab design thickness shall be 6" greater than the wall thickness, with a minimum thickness of 24". If the weight of the grade slab (in psf) is less than 40% of the hydrostatic head (in psf) as measured from the bottom of the grade slab, then the grade slab shall be designed for uplight pressure.													
1225	Prescriptive Spec	G	If, at the last U-section segment away from the portals, the abutting at-grade trackway does not consist of a track slab, then a depressed approach slab shall be provided to permit the construction of the tie-and-ballast trackbed up to the end of the U-section base slab that avoids a sharp break in support at that point.													
1226	Standard Criteria	H	Seismic loads as given in Metro Supplemental Design Criteria, Chapter 3 Part A and B.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1227	Prescriptive Spec	I	Expansion joints spaced at no more than 100' apart shall be provided at U-section. These expansion joints shall be located in both the walls and the invert of U-section.													
		5.4.7	REINFORCED CONCRETE UNDERGROUND STATIONS AND CUT-AND-COVER SECTIONS													
1228	Standard Criteria		Underground structures and their appurtenant structural elements such as entrances shall be designed in accordance with AASHTO-CA LRFD BDS as outlined in Sections 5.1.2 and 5.1.3.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1229	Standard Criteria	A	Load combinations and load factors to be used are those provided by Table 5.5; Load resistant factors to be used are those provided by AASHTO-CA LRFD BDS Tables 3.4.1-2, 3.4.1-3, and 12.5.5-1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1230	Performance Criteria		In addition, the effects of EH, EV, ES, LS, DD, DW, and WA shall be applied simultaneously in all their maximum and minimum values to produce the envelope of moment, torsion, shear, and axial force to produce the greatest demands to the structural framing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1231		B	Foundation Pressures													
1232	Performance Criteria		Vertical pressure on foundation slabs may be divided into hydrostatic and earth pressure components. Distribution of the earth pressure moment shall be based on specified construction procedures, and shall include elastic and plastic subgrade reaction foundation effects.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1233	Performance Criteria	C	Compression forces shall not be considered in shear design of the top and bottom slab in box sections.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1234	Performance Criteria	D	Adequate provisions shall be made for corrosion control in accordance with specifications and in consultation with the corrosion consultant.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.8	REINFORCED CONCRETE RETAINING WALLS													
1235	Standard Criteria		Retaining walls shall be designed on the basis of site specified geotechnical design report prepared following the requirements outlined in Section 5.6 Geotechnical.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.9	SHAFTS													
1236	Standard Criteria		Permanent shaft walls shall be reinforced concrete. Loads imposed on the shaft by the surrounding medium and applicable surface loadings shall be determined by using an acceptable method provided in Section 5.6 Geotechnical.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.10	MISCELLANEOUS STRUCTURES													
		5.4.10.1	Gratings													
1237			The following grating types shall be adopted as standards for use in Metro Projects:													
1238		A	For light loading --> For general use not subject to vehicular loads													
1239	Prescriptive Spec		Bearing bars --> 1-1/4 in. x 3/16 in. on 1-3/16 in. centers													
1240	Prescriptive Spec		Crossbars --> 4" centers													
1241	Prescriptive Spec		Design loading --> 900 psf													
1242	Prescriptive Spec		Maximum allowable deflection --> 1/300 span													
1243	Prescriptive Spec		Grating type --> rectangular-plain													
1244	Prescriptive Spec		Material --> steel, hot dip galvanized, with non-slip granular finish on walking surface.													
1245		B	For sidewalks													
1246	Prescriptive Spec		Bearing bars --> 2 1/2" x 3/16" on 15/32" centers													
1247	Prescriptive Spec		Crossbars --> 4" centers													
1248	Prescriptive Spec		Design loading --> 900 psf													
1249	Prescriptive Spec		Maximum allowable deflection --> 1/300 span													
1250	Prescriptive Spec		Grating type --> rectangular-plain													
1251	Prescriptive Spec		Material --> steel, hot dip galvanized, with non-slip granular finish on walking surface.													
1252		C	For heavy loading --> grating subject to vehicle wheel loads													
1253	Prescriptive Spec		Bearing bars --> 4" x 1/4" on 1-3/16 in. centers													
1254	Prescriptive Spec		Crossbars --> 4" centers													
1255	Prescriptive Spec		Design loading --> AASHTO HL93													
1256	Prescriptive Spec		Maximum allowable deflection --> 1/300 span													

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1257	Prescriptive Spec		Grating type --> rectangular-plain													
1258	Prescriptive Spec		Material --> Steel, hot dip galvanized													
		5.4.10.2	Emergency Access Shafts													
1259	Performance Criteria	A	Access shall be provided to the subway as specified in Fire/Life Safety Criteria	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1260	Performance Criteria	B	Hatches on access shafts shall be readily unlatched from the inside of the subway by means of panic hardware and opened by means of a key-operated device from outside the subway in accordance with Fire/Life Safety Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1261	Performance Criteria	C	Access hatches shall be protected from surface water. Allowances must be made to divert surface water to the drainage system, away from the hatches.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1262	Performance Criteria	D	Where doors are required, they shall open in the exit direction at the subway level and at the surface level. Where locks are required, they shall be provided with panic hardware. Doors shall also meet the fire rating specified in the local codes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1263	Performance Criteria	E	All doors and hatches shall be provided with the means for future installation of intrusion detection systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.10.3	Emergency Access Shafts													
1264	Performance Criteria		When parapets are used, they shall be designed to withstand dead load, wind load, force due to thermal expansion and contraction, shrinkage force, and earthquake forces equal to the full dead load of the parapet acting at the center of mass of the component parts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.10.4	Air Pressure due to Moving Trains													
1265	Standard Criteria		Componenets including walls, ceilings, doors, elevator frames, and ductwork shall be designed to meet or exceed these pressures, as shown in Section 6 Architectural, Figure 6.1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.10.5	Elevators													
1266			The structure shall be designed for the loads described below:													
1267	Prescriptive Spec	A	Dead load of structure													
1268	Prescriptive Spec	B	Wind load of 40 psf minimum on windward side when the structure is exposed to wind.													
1269	Prescriptive Spec	C	For traction type elevators, the surface structure shall be designed to support elevator hoist beams. The end reaction of the elevator hoist beams shall be 18,000 lbs minimum. Structures supporting elevators shall be designed for the maximum reactions from any of the manufactored units considered for use in the system.													
		5.4.10.6	Escalators													
1270	Performance Criteria		The support elements shall be designed for the end reactions from the escalators. Structures supporting escalators shall be designed for the maximum reactions from any of the manufactured units considered for use in the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.11	ADJACENT PUBLIC BUILDINGS													
1271	Performance Criteria		In general, major non-Metro facilities within 20 ft radius of a major Metro facilities need to be of concern. Metro must approve the qualifications of the proposed specialist prior to commencement of any work on this specialized study.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.12	REINFORCED AND PRESTRESSED CONCRETE													
		5.4.12.1	Minimum Concrete Design Strengths													
1272	Prescriptive Spec	A	For all underground reinforced concrete cast-in-place structures including cut and cover box liner and stations, abutments, retaining walls, shafts, cross-passageways, portals, U-sections, spread footings, piles, drilled-in caissons, and basement walls: f'c = 4000 psi													
1273	Prescriptive Spec	B	For all aboveground reinforced concrete cast-in-place structures: f'c = 4000 psi													
1274	Prescriptive Spec	C	For prestressed concrete: f'c = 6000 psi													
1275	Prescriptive Spec	D	For precast prestressed members: f'c = 3000 psi													
1276	Prescriptive Spec	E	For all building foundations, floor slabs, pits and other miscellaneous foundations at yards and shops, miscellaneous foundations other than those specified, and other station platform foundations: f'c = 3000 psi													
1277	Performance Criteria	F	In certain cases, strenghts of concrete other than those specified above might be required. These cases will be as recommended by the Engineer of Record and accepted by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.12.2	Reinforcing and Prestressing Steel													
1278	Standard Criteria	A	Comply with ASTM A706 for reinforcement resisting earthquake-induced flexural and axial forces in frame members and in wall boundary members. ASTM A615 grades 40 and 60 reinforcement are allowed in these members if:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1279	Prescriptive Spec		(a) the actual yield strength based on mill tests does not exceed the specified yield strength by more than 18,000 psi													
1280	Prescriptive Spec		(b) the ratio of the actual ultimate tensile stress to the actual tensile yeild strength us not less than 1.25													
1281	Standard Criteria		(c) meet the elongation requirements of ACI 318. For aerial structures and bridges conform to the requirements of AASHTO-CA LRFD BDS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1282	Standard Criteria	B	Prestressing Steel : see section 5.3.6.1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1283	Performance Criteria	C	Spacing of reinforcement should also consider ease of concrete placement, room for embedded items, decrease in concrete coverage due to lapped splices, and the blockages that might occur by corssings of closely spaced reinforcement.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1284	Standard Criteria	D	The design of concrete structures in corrosive environment shall follow AASHTO-CA LRFD BDS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.12.3	Methods of Design													
1285	Performance Criteria	A	Underground structures and parts thereof shall be designed in accordance with strength design, load and resistance factor design, allowable stress design, or empirical design, as permitted by the applicable material chapters of the codes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1286	Performance Criteria	B	Loads and forces not covered in the above codes shall be subject to the approval of Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1287	Performance Criteria	C	Elastic and plastic subgrade reaction shall be considered for both vertical and horizontal loads during construction and for the completed structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.12.4	Joints in Cut-and-Cover Structures													
1288	Performance Criteria	A	At locations of major change in structure section, from cut-and-cover structure to open-cut structure, construction joints shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1289	Performance Criteria		Where a cut and cover box line section meets a station section: Design the connection either to absorb any differential movements or to transmit the forces that may occur under any design condition.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1290	Prescriptive Spec	B	To control shrinkage stresses in monolithically poured concrete slabs and walls to minimize cracking, provide construction joints at a spacing not exceeding 50 ft, and closer to if appropriate to the framing construction.													
1291	Performance Criteria	C	Do not use expansion or contraction joints in cut-and-cover structures. Provide continuous temperature and shrinkage requirements, as required by applicable specifications and codes, in all walls and slabs of these underground structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.12.5	Water and Gas Proofing													
1292		A	Leakage Criteria													
1293	Prescriptive Spec		Maximum water inflow measurable in drainage system into the tunneled guideways and cross passages shall be less than 1 gallon/day per 100 linear ft of tunnel and 0.5 gallons/day per 1000 sq ft of surface area respectively.													
1294	Prescriptive Spec		No detectable methane or hydrogen sulfide gas above 2.5% of the Lower Explosive Limit (LEL) for methan or 1.5 ppm or more for hydrogen sulfide shall be detectable at an air velocity of 60 ft/min.													
1295	Prescriptive Spec	B	Water Gas Proofing Systems for Cast-in Place Construction Provide external membrane water and gas proofing using High Density Polyethylene (HDPE also referred to as HCR), entirely around cut-and-cover station structures and all cast-in-place tunnel linings.													
1296		C	Water and Gas Proofing Systems for Precast Concrete Segmental Tunnel Lining													
1297	Performance Criteria		Precast concrete tunnel linings are structural systems designed to limit the inflow of water, gas, and asphalt into the tunnel by the density of the concrete and the use of gaskets at the joints between individual segments.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1298		D	Equipment Rooms													
1299	Prescriptive Spec		Where the base floor is potentially subject to hydrostatic pressure, slope the floor to drain and install equipment on raised pads.													
1300		E	Repairs													
1301	Performance Criteria		Make provision for future injection sealing of leaks in segmentally lined tunnels and cast in place underground structures without the need for drilling through concrete.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.12.6	Architectural Considerations													
1302	Performance Criteria		To ensure uniformity of structural concrete color in public areas of the stations, Standardize concrete mix and strength, the aggregate source, and the brand of cement to be used in any given area.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.13	STRUCTURAL STEEL													
1303			Use the following steel:													
		5.4.13.1	Structural Steel													
1304	Prescriptive Spec		For normal use - Steel with minimum yield stress of 36 ksi or 50 ksi subject to the preferred material specification per AISC Steel Construction Manual.													
		5.4.13.2	High-Strength Structural Steel													
1305	Standard Criteria		For uses requiring higher-strength steels or where economically justifiable - Per AISC Steel Construction Manual for applicable material specifications.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.13.3	Connections													
1306	Standard Criteria	A	Shop connections are detailed by the Contractor's designer shall be welded unless otherwise approved by Metro. Weld in accordance with the current code or specifications of the American Welding Society, Inc. , D1.1 Seris, as applicable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1307	Prescriptive Spec	B	Design field connections for high-strength bolts or welding. Use high-strength ASTM A325 bolts.													
		5.4.14	Construction of Bored Tunnels in Soft Ground (Soils and Weak Rock)													
1308	Performance Criteria		To ensure the successful implementation of Metro tunneling projects, the control of ground movement associated with tunneling is to follow best industry practice using specialized construction methods and controlled procedures to minimize ground movements and associated surface settlements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.4.14.1	Pressurized Envelope Tunneling													
1309	Performance Criteria		An envelope of pressure shall be maintained in front, around and behind the Tunnel Boring Machine (TBM) at all times comprising systems that work together that support the excavated face, the ground around the body of the TBM and the ground around the tunnel segments prior to the set of the annular grout.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1310	Prescriptive Spec		Face, TBM body and grout pressures shall be calculated using industry standard methodologies to provide adequate support with a factor of safety taking into account the interaction between them to limit ground movements and shall not be less than 10 psi. The design maximum settlement at all surface shall not exceed 0.5 in.													
		5.5	SURFACE FACILITIES													
1311	Standard Criteria		In the County and City of Los Angeles, apply the Los Angeles County Building Code, as applicable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1312	Standard Criteria		For structures other than guideways and bridges, and underground roof systems subject to railroad or highway loading, this code adopts the latest version of the California Building Code, California Code of Regulations, Title 24, Part 2, California Building Standards Commision, based on the International Building Code. This code and its amendments is referred to herein as the Building Code.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.5.1	STATIONS, BUILDINGS AND FRAMED STRUCTURES													
1313	Standard Criteria		The platform structure of the aerial stations shall have a positive connection with the guideway structure at each bent. The design of the aerial stations shall follow the AASHTO-CA LRFD BDS using the loadings specified in this criteria, Metro seismic design criteria and the loading due to canopy on the platform. The American Disabilities Act requirements between the vehicle floor and station platforms shall be considered in the analysis of dead and live load deflections and camber growth.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1314	Standard Criteria		Design the following structures and buildings (but limited to the following) including in the Project in accordance with the Building Code and its referenced codes including the California Building Code Title 24, the International Building Code, and ASCE 7 when the structures do not participate in the loads carried by the aerial guideway girders.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1315	Prescriptive Spec	A	All building framing and components for surface stations, aerial station canopies, excluding aerial station platforms, and aerial pedestrian access/ramps													
1316	Prescriptive Spec	B	Maintenance Facilities													
1317	Prescriptive Spec	C	Ancillary facilities													
1318	Prescriptive Spec	D	Foundation and soils investigations and reporting requirements shall be in accordance with Section 1802 of the Building Code, except as modified herein.													
1319	Prescriptive Spec	E	Temporary support of project facilities during the adjacent excavation for new buildings will be such that at any level, the project facilities lateral displacement shall not exceed 0.001 times its overall height above the bottom of the base slab, but not to exceed 1/2 inches without Metro's prior approval.													
1320	Prescriptive Spec	F	Areas of new buildings adjacent to project facilities where the public has access or that cannot be guaranteed as a secure area, such as parking garages and commercial storage and warehousing, shall be treated as areas of potential explosion.													
1321	Performance Criteria		NFPA 130, Standard for Fixed Guideway Transit Systems, life safety separation criteria shall be applied that assumes such spaces contain Class-I flammable or Class-II or Class-III combustible liquids. For structural considerations, separation and isolation for blast shall be treated the same as for seismic, and the more restrictive shall be applied.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1322	Performance Criteria	G	Parapets - Where parapets are used, they shall be designed to withstand dead load, wind load, force due to thermal expansion and contraction, shrinkage force, and minimum earthquake forces equal to the full dead load of the parapet acting at the center of mass of the component parts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1323		H	The structures supporting elevators shall be designed for the loads described below:													
1324	Prescriptive Spec	H1	Dead load of structure													
1325	Prescriptive Spec	H2	Wind load of 40 psf minimum on windward side when the structure is exposed to wind.													
1326	Prescriptive Spec	H3	For traction type elevators, the structure shall be designed to support elevator hoist beams. The end reaction of the elevator beams shall be 18,000 lbs minimum. The designer shall coordinate with elevator manufacturers regarding elevator beam locations.													
1327		I	Escalators													
1328	Prescriptive Spec		The support elements shall be designed for the end reactions from the escalators.													
1329		J	Elevators, Escalators, and Passenger Conveyors													
1330	Performance Criteria		Structures supporting elevators, escalators, or passenger conveyors shall be designed for the maximum reactions from any of the manufactured units considered for use in the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1331		K	Stairs													
1332	Prescriptive Spec		Stairways shall be designed for a uniform LL of 100 psf or a concentrated load of 300 lbs on the center of stair treads, whichever are critical.													
1333		L	Storage Space and Machinery Rooms													
1334	Prescriptive Spec		Electrical equipment rooms, pump rooms, service rooms, storage space, and machinery rooms shall be designed for uniform LL of 250 psf, to be increased if storage or machinery loads so dictate. Fan rooms and battery rooms shall be designed for uniform loads of 350 psf.													
1335		M	Railings													
1336	Standard Criteria		Railings in station platforms, mezzanines and service walkways shall be designed in accordance with the Building Code.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1337		N	Vehicular Surfaces													

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1338	Standard Criteria		Gratings in areas that are subject to loading from vehicles shall be designed to carry HL-93 loading in accordance with AASHTO-CA LRFD BDS. Gratings in sidewalks and in areas protected from vehicular traffic shall be designed for a uniform LL of 300 psf.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.5.2	PEDESTRIAN AREA LIVE LOAD (SEE ALSO SECTION 5.3.4)													
1339	Prescriptive Spec		Pedestrian ramps, pedestrian bridges, mezzanines, and other pedestrian areas shall be designed for a uniform LL of 100 psf. Station platform areas shall be designed for a uniform LL of 300 psf.													
		5.5.3	SEISMIC DESIGN OF BUILDINGS (SEE ALSO SECTION 5.3.5)													
1340	Standard Criteria		At grade stations, buildings, aerial station canopies and framed structures and their components shall be designed to resist earthquake motions in accordance with Metro Supplemental Seismic Design Criteria Appendix and the applicable codes of the Building Code.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1341	Prescriptive Spec		In order to meet the objectives of MRDC SSDC requirements for surface structures; for ODE level the response modification factor (R), and importance factor (Ie) shall be 1.0, and for MDE level the structures shall be treated as Category III risk buildings as defined in CBC (Ie = 1.25 and R = per CBC).	EX												
		5.5.4	BUILDING FOUNDATIONS													
1342	Standard Criteria		Foundations shall be in accordance with Section 5.6 Geotechnical.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6	**GEOTECHNICAL**													
		5.6.1	DEFINITIONS													
		A	Project Geotechnical Engineer													
		1	Design-Build (DB)													
1343	Definition		Design-builder's engineer of record's lead geotechnical engineer who shall be a California licensed professional engineer as defined by California Department of Consumer Affairs (DCA) and who shall be responsible in charge of all geotechnical work and who shall affix his stamp and seal on all project geotechnical reports. Reports shall be subject to Metro review and acceptance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Design-Bid-Build (DBB)													
1344	Definition		Lead geotechnical engineer who shall be a California licensed professional engineer as defined by DCADCCA and who shall affix his stamp and seal on all project geotechnical reports and recommendations prepared for Metro either directly or indirectly as an employee of the engineer of record or as a subconsultant to the engineer of record. Reports and recommendations shall be subject to Metro review and approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Site													
1345	Definition		Site is defined per AASHTO-CA LRFD BDS Section 10.5.5.2.3. "A site is defined as a project site, or portion of it, where the subsurface conditions can be characterized as geologically similar in terms of subsurface stratification, i.e., the strata and the groundwater conditions. This definition is modified herein to read "contiguous portion" and not exceeding 5000 ft in length.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Dry Construction													
1346	Definition		Dry Construction is defined herein as the excavation condition and concrete placement method wherein the sides and bottom of shaft may be visually inspected prior to placement of concrete and where water depth at the bottom of the shaft is not more than 3 inches at the start of concrete placement where water accumulation in the bottom of the shaft is not greater than 12 inches per hour when no water pumping is permitted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Wet Construction													
1347	Definition		Wet construction is defined herein as condition not qualifying as dry construction, the excavation condition and concrete placement through water or slurry, whether intended for excavation stabilization or result of naturally occuring hydrogeologic conditions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Non-redundant Drill Shaft Foundation													
1348	Definition		Non-redundant drill shaft foundation is defined herein as foundations consisting of two or fewer shafts per guideway bent or pier or those shafts deemed non-redundant per AASHTO-CA LRFD BDS Section 1.3.4.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Deep Foundations													
1349	Definition		Deep foundations are used herein are defined to include drilled shafts, driven piles, micro-piles, and other foundation types deriving their principal support from embedment into the subsurface and where embedment depth exceeds minimum element dimension.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		G	Shallow Foundations													
1350	Definition		Shallow foundations are used herein are generally footings for which capacity is derived principally from its bearing at shallow depth below existing or final ground surface adjacent to the foundation, e.g. embedment depth generally less than foundation width or length.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		H	Slurry Walls													
1351	Definition		Slurry walls are defined herein as concrete walls in which the concrete is placed using tremie method, below existing grade in fluid-filled panels stabilized with slurry.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		I	Secant Pile Walls													
1352	Definition		Secant piles walls are defined herein as concrete walls that are formed with overlapping concrete piles that may be reinforced with steel structural sections or cages of steel reinforcing bars. The concrete is typically placed using tremie method, below existing grade in fluid-filled drilled holes stabilized with slurry.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		J	Soil Mix Walls													

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1353	Definition		Soil mix walls are defined herein as walls that are constructed by mechanically mixing in situ soil with cementitious slurry to form a series of overlapping soil-cement columns or panels. These columns or panels may be reinforced with steel structural sections.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.2	GEOTECHNICAL INVESTIGATIONS, ANALYSIS AND DESIGN													
		5.6.2.1	Geotechnical Planning Report (GPR)													
1354	Performance Criteria		The lead project geotechnical engineer shall oversee preparation of a Geotechnical Planning Report (GPR). The GPR defines the engineering and design approach that the designer shall follow to develop the most cost-effective and technically and environmentally acceptable foundations, cut and fill slopes, retaining structures, and geotechnical designs for the aerial/bridge, underground, and at-grade portions of the project. The GPR shall define the engineering and design approach that the project geotechnical engineer will follow to develop the necessary geotechnical information for the project in accordance with the requirements of these design criteria. The GPR must address all aspects of the required geotechnical effort and foundation design and analysis, which depending on the information required by the project, shall include, but may not be limited to the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1355	Performance Criteria	A	Succinct description of the structural and civil project components that the geotechnical work scope addresses;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1356	Performance Criteria	B	Methods proposed to execute any of the identified investigation and data needs and develop sufficient data, including laboratory and field tests, for the analyses per AASHTO-CA LRFD BDS Sections 10.4.3 and 10.4.5;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1357	Performance Criteria	C	Proposed methods of analyses for the identified structural and civil components with special attention to construction methods for drilled shaft and pile foundations;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1358	Performance Criteria	D	Proposed format of geotechnical reports and topical outline;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1359	Performance Criteria	E	Proposed deflection criteria to be used for design of deep foundations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1360	Performance Criteria	F	In addition, the GPR must address: ● Additional Subsurface investigations; ● Determination of geotechnical design parameters; ● Determination of seismic design parameters ● Slope analysis and design; ● Embankment and fill settlement and slope stability analysis; ● Planned field testing programs; ● Ground improvement or treatment of in-situ soils; ● Selection, design and analysis of foundation systems; ● Lateral and vertical earth pressures; ● Instrumentation and monitoring programs; and ● Content and format of geotechnical reports.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1361	Standard Criteria	G	Note that in the context of contracting practices, GPRs are equivalent to "Draft Geotechnical Memoranda for Design".	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.2.2	Subsurface Investigations and Laboratory Testing													
1362	Performance Criteria		The lead project geotechnical engineer shall, prior to the start of any field investigations, prepare a detailed plan addressing how the planned field investigations meet the requirements of the GPR.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1363	Prescriptive Spec		The locations of these investigations shall be shown on a site plan not smaller than 1 inch equal to 200 feet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		GreenBook: 3-8.2
1364	Performance Criteria		The plan shall clearly state the types of equipment to be used, planned completion / penetration depths, sampling types and intervals, any down hole testing planned, and completion details. In addition, the plan must address management of investigation, spoil material, maintenance of traffic requirements, environmental compliance requirement, and a time line for execution of the work, including permitting and utility clearances.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1365	Standard Criteria		Investigation methods shall conform to the recommendations of Training Course in Geotechnical and Foundation Engineering: Subsurface Investigation, Participants Manual, FHWA HI-97-021 and these criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1366	Performance Criteria		The lead project geotechnical engineer shall prepare and implement a subsurface exploration and testing program with all field and laboratory testing necessary to establish the geotechnical and environmental conditions and to provide a basis for all final geotechnical and foundation designs and analyses. The program shall be developed and implemented to supplement the data provided by Metro and to obtain data as required to support the design approach and construction methods. Perform the geotechnical investigation program to establish all geotechnical parameters and subsurface conditions required for design and construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1367	Performance Criteria		The lead project geotechnical engineer shall prepare recommendations for foundation designs. All reports and recommendations shall be prepared and sealed by a California registered geotechnical engineer (G.E.), with experience in type of work specified on this project.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1368	Performance Criteria		For structures subject to the jurisdiction of local authorities, the design bearing and frictional values for foundations shall not exceed the limits given by those authorities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1369	Performance Criteria		For underground station structures and associated appurtenant structures, geotechnical data and design parameters shall be shown on the contract drawings. The project geotechnical engineer shall investigate, at the recommendation of Metro, any other areas necessary to determine ground conditions for excavation means and methods.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1370	Performance Criteria		Follow professionally acceptable standards, in planning, performing and reporting subsurface exploration programs. Among the requirements for the borings and laboratory investigations to be performed for the project are the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1371	Performance Criteria	A	Supervision – Perform all boring and in-situ testing and all laboratory classification and testing using qualified geologists or engineers under the direct supervision of a California registered professional geotechnical engineer (G.E.);	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1372	Performance Criteria	B	Location and Ground Surface Elevation – Determine the coordinate location and ground surface elevation for each boring and field investigation and show both the Station and offset and the elevation on the Project control surveys;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1373	Standard Criteria	C	Soil classification shall be performed in accordance with the Unified Soil Classification System; and	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1374	Standard Criteria	D	Geotechnical testing laboratory shall be certified by the City of Los Angeles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1375	Standard Criteria	E	For typical structural foundation investigations conducted in the state right-of way, follow the up to date guidelines in the "Caltrans Foundation Manual".	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1376	Performance Criteria		The field investigation programs shall include all necessary borings, soil/rock sampling, geophysical testing, or other in situ testing as needed to provide a basis for the geotechnical and foundation design to the satisfaction of Metro. Similarly, the laboratory testing program shall include all laboratory testing necessary to establish geotechnical design parameters to the satisfaction of Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1377	Performance Criteria		Clearly present the rationale for development of the investigation and testing programs, data interpretation and input parameter selection, together with descriptions of the methods of analysis. Include a discussion of the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1378	Performance Criteria	1	Variation in the subsurface conditions across the site(s);	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1379	Performance Criteria	2	Method of construction;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1380	Performance Criteria	3	Critical combinations of loading; and	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1381	Performance Criteria	4	Other relevant factors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.2.3	Geotechnical Data Report													
1382	Performance Criteria		Prepare in the form of a geotechnical data report(s) (GDR), a summary of all geotechnical data and findings, which depending on the information required by the project, should include, but may not be limited to the following: ● Project descriptions, ● Description of existing site condition, ● Review of existing information, ● Locations and results of borings and/or test pits, ● Geophysical testing and other in situ testing, ● Observations of groundwater monitoring wells and/or piezometers, ● Subsurface gas investigation, ● Detailed description of the geological conditions including stratigraphy, groundwater, and geologic and seismic hazards, ● Results of laboratory and in-situ tests, ● Results of corrosivity tests including chloride content, sulfate content, pH and resistivity of surface water, groundwater, and/or soil.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1383	Performance Criteria		Incorporate Boring and in-situ test locations and information from the existing and the Contractor's investigation program into the Design and Construction Drawings as the Contractor's program proceeds.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.2.4	Geotechnical Design Report													
1384	Performance Criteria		Prepare a geotechnical design report(s) that summarizes the project site geotechnical conditions, analyses and geotechnical recommendations, which depending on the information required by the project, should shall include, but may not be limited to the following: • Project descriptions including existing facilities and proposed improvements, • Summary of pertinent reports and investigations, • Physical setting of the project site, • Regional geology, seismicity, and geological hazards, • Description and summary of the results for the geotechnical investigations and testing performed for the project, • Geotechnical conditions including soil, rock, subsurface gas, surface water, and past, current and anticipated future groundwater conditions, • Project site seismicity including seismic site class, ground motions (peak ground acceleration and response spectra as required for design), faults, liquefaction potential, and probabilistic seismic hazard analysis, as applicable, • Geotechnical analyses including parameter selection, methodology, applicability to specific structural elements, calculation and results, • Geotechnical design recommendations for earth pressures, surcharges, excavation support systems, retaining structures, shallow and deep foundations, tunnels, pavement structures, cut slopes, embankments, backfill materials, shrinkage and swell potential of soil, mitigation of liquefaction consequences such as settlement, strength loss, and lateral movement, ground improvement, potential settlement, and slope stability, as applicable, • Construction considerations including site preparation, compaction requirements, protection of existing structures and utilities, geotechnical instrumentation and monitoring, groundwater inflow and control, construction sequence, material disposal, and water treatment and disposal, as applicable. • Potential settlement due to lowering of the groundwater table or draining of perched groundwater that may be related to the construction, such as from dewatering or groundwater infiltration into an excavation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.2.5	Geotechnical Data and Baseline Report													
1385	Standard Criteria		When appropriate and especially for underground and tunnel construction, the geotechnical investigation should be planned, executed and reported following the recommendations given in the booklet "Geotechnical Baseline Reports for Construction – Suggested Guidelines (Essex, 2007)."	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1386	Standard Criteria		During the course of the investigation and design several reports may be generated but the Geotechnical Baseline Report (GBR) must be the sole geotechnical interpretive document upon which the Contractor may rely. One or more Geotechnical Data Reports (GDR) may be developed by the designer and/or the designer's geotechnical engineer and will contain the factual information that has been gathered during the exploration and design phases of the project. See the Essex publication for detailed guidance regarding the content of the GDR. Note that the GDR is included as a contract document but that the GBR must be given precedence over the GDR within the Contract Document hierarchy. Should the GBR be silent on a given circumstance, the GDR should be reviewed to see if there is any data/information relative to the issue in question.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1387	Standard Criteria		During the course of development of a design, the design team may need an interpretation of the geologic data before the GBR is prepared. This need may be met by one or more Memorandum for Design. To clarify its intent, use and timing in the design process, this report (or reports) should be given a title such as "Draft Geotechnical Memorandum" or "Draft Geotechnical Memorandum for Design". It must be disclosed as available information, but it is not part of the Contract Documents: it is preliminary and the interpretations and discussions presented therein will be superseded by subsequent interpretations and baselines in the GBR. Preparation of an interpretive report, such as a Geotechnical Interpretive Report (GIR), "is superfluous, a potential source of confusion, and is strongly discouraged" (Essex, 2007).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1388	Standard Criteria		In summary, "The GBR should be the sole geotechnical interpretive document upon which the Contractor may rely. The GBR should be limited to interpretive discussion and baseline statements, and should make reference to, rather than repeat or paraphrase, information contained in the GDR, drawings, or specifications)" (Essex, 2007) see chapters 5 and 6 of the Essex document for further discussion of the suggested content and format of GBRs.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.2.6	Geotechnical Designs													
1389	Performance Criteria		Project structures and improvements shall be designed so that imposed loadings do not exceed soil resistance while limiting deflections, as applicable, to prescribed maximums.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1390	Standard Criteria		Foundations supporting aerial guideways and transit rail retaining walls shall be designed in accordance with the requirements of AASHTO-CA LRFD BDS Chapter 10 and 11, and Caltrans Seismic Design Criteria. Foundations for buildings, retaining walls, and appurtenances not governed by these design criteria, shall be designed in accordance with the Building Code as defined in Section 5.1.3, Subsection C.4. (California Building Code Chapter 18, Soils and Foundations). Presumptive load resistance values (i.e., maximum allowable bearing pressures and lateral resistance) shall not exceed the maximum values specified without substantiating data from the project geotechnical engineer pursuant to the above geotechnical reporting requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1391	Prescriptive Spec		Additionally, for aerial guideway designs a minimum of 50% of the bent locations shall have been investigated in accordance with Geotechnical Investigations (listed above), prior to the completion of the design report required by the following subsection.													
		5.6.2.6.1	Deep Foundations													
1392	Performance Criteria		Design of deep foundations shall be based on project-specific information developed for the location(s) and foundation type planned. Soil and rock engineering properties shall be based on the results of field investigations as presented in the Geotechnical Data Report; use of presumptive values shall not be allowed for final design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1393	Prescriptive Spec		Bottom clean out of drilled shafts constructed using the wet method shall be verified by Miniature Shaft Inspection Device® (MiniSID) or approved equal.													
1394	Standard Criteria		See Section 5.1.3 for codes, manuals and specifications for the design of deep foundations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1395	Prescriptive Spec		Where permanent steel casing is used and is relied upon for structural capacity, its thickness shall have a minimum wall thickness of 3/4 inch and be provided with internal shear lugs if composite action is to be relied upon. Additionally, the design basis of the steel section shall be reduced to account for corrosion over the life of the structure based on actual soil and ground water conditions; in lieu of a site specific corrosion study, a presumptive value of 1/4 inch shall be used. Steel casing shall not be considered for structural support in extremely aggressive environments.													
1396	Standard Criteria		Construction tolerance for all drilled shafts shall be in accordance with AASHTO-CA LRFD BDS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1397	Prescriptive Spec		For guideway shafts greater than 5 feet in diameter, the drilled shafts shall be designed assuming they are offset at the top of the shaft a minimum of 6 inches. For further detailed information see Baseline Standard Specification Section 31 63 30 - Drilled Concrete Shaft Foundations.													
1398	Prescriptive Spec		Tops of deep foundations, including top of drilled shafts or pile caps where multiple shafts or piles are employed, shall be a minimum of 2 feet below lowest adjacent finished grade. The upper 5 feet as measured from lowest adjacent grade shall be discounted in any axial and lateral load analyses except where it can be shown that measures are provided to prevent future excavations around the pile within three diameters from the shaft or pile group exterior surface.													
		5.6.2.6.2	Shallow Foundations and Misc. Structures													
1399	Definition	A	Shallow Foundations Per AASHTO-CA LRFD BDS Section 10.2 Definitions: "Shallow Foundation— A foundation that derives its support by transferring load directly to the soil or rock at shallow depth."	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1400	Performance Criteria	A	Design of shallow foundations, e.g., spread and strip footings, shall be based on project-specific information developed for the location(s) and foundation type(s) planned. Soil and rock engineering properties shall be based on the results of field investigations as presented in the Geotechnical Data Report; use of presumptive values shall not be allowed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1401	Standard Criteria	A	Designs of shallow foundations supporting rail structures or attached appurtenances shall be as required in AASHTO-CA LRFD BDS Section 10.6 and in accordance with FHWA-SA-02-054 (Geotechnical Engineering Circular No. 6 Shallow Foundations)). Shallow foundations for support of structures under the purview of the Building Code, buildings not directly supported off the aerial guideway, shall be designed in conformance with the requirements of the Building Code, Section 1805 (Footings and Foundations) Shallow foundations shall have a minimum ground cover of 2 feet as measured from top of footing to finished grade.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1402	Performance Criteria	B	Miscellaneous Structure Foundations Design of foundations for miscellaneous structures shall be in accordance with the above requirements for shallow foundations, excepting that presumptive values may be used. These include, but are not limited to miscellaneous structures such as light standards, signs, and other uninhabited structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.2.7	Settlement and Deflection													
1403	Performance Criteria		Allowable foundation settlements and lateral deflections (deformations), except as prescribed herein, shall be established by the project structural engineer in consultation with the project geotechnical engineer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.2.7.1	Deep Foundations													
1404	Prescriptive Spec		Settlement of deep foundations (i.e., drilled shafts or driven piles) shall be limited to no more than 1/2 inch total vertical deflection as measured at the pile head or top of pier cap after placement of the pier. Total settlement measured after placement of the guideway girder shall be limited to not more than 1 1/2 inches. Differential settlement between adjacent bents spaced not more than 100 feet apart shall be limited to no more than 1 inch; this maximum decreases proportionately for lesser bent spacing and increases by ½ inch per 100 feet for bent spacing exceeding 100 feet.													
1405	Performance Criteria		Lateral deflection limitations for design of deep foundations for non-seismic loading shall be determined by the project structural engineer and systems engineer in consultation with project geotechnical engineer. Deflections of deep foundations under extreme or earthquake loadings shall be established by the project structural and geotechnical engineers but not greater than the deflection and rotation which would result in a deflection of 18 inches at the top of rail.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.2.7.2	Shallow Foundations													
1406	Prescriptive Spec		Shallow foundations shall be designed to limit total settlement to no more than 1 inch and differential settlements to no more than 1/2 inch.													
		5.6.2.8	Hydrostatic Uplift (Buoyancy)													
1407	Prescriptive Spec		Factor of safety calculated by comparing the dead weight of the structure and the backfill above the structure against the hydrostatic pressure acting on the bottom of the structure shall be at least 1.1. Side friction between the structure and the earth shall not be included as resistance against hydrostatic uplift.													
1408	Standard Criteria		If piles are used to resist the uplift, follow requirements of AASHTO-CA LRFD BDS. See water load in Section 5.2 of this document for criteria on the design groundwater elevation for the evaluation of hydrostatic pressure and buoyancy.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.3	SOIL-STRUCTURE INTERACTION													
		5.6.3.1	Approach to Structural/Geotechnical Design Problems													
1409	Performance Criteria		Soil-structure interaction is a stress-strain issue in the mechanics of both structural and geotechnical materials. The investigation of this subject shall be conducted for the design of both underground structures and the foundations of bridges and aerial guideways. To arrive at a design solution for a structure whose structural elements interface with the ground's soil media, the pressures and distortions at their interface shall be demonstrated to be compatible. Geotechnical parameters selected for design must consider the uncertainties in the soil or rock properties, and for any parameter that could potentially have significant effect on the design of the structure, sensitivity analysis using a range of values shall be performed as appropriate. The final analytical solution shall include all the variable, static and dynamic forces that are imposed on and impact both the structure including all appendages and its surrounding ground media by this Structural/Geotechnical Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1410	Performance Criteria		Either one or both of two rational approaches shall be selected and used to assist in arriving at the practical engineering design and the safe and economic construction of underground structures and the foundations of bridges and aerial guideways. The appropriate analytical choice for design depends on the final GPR and the actual planned construction together with the collective judgment of the structural and geotechnical engineers involved. Some guidelines to be considered are offered here.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1411	Performance Criteria	Approach 1	Approach 1 Subgrade Reaction Springs Coupled with the Finite Element Structural Model The material stress-strain solution discussed here is the use of subgrade reaction in the analysis of soil-structure interaction problems expressed very simply as: kS = p/S Where: kS = the subgrade reaction in pounds per cubic inch p = pressure on an element such as a foundation in pounds per square inch S = the corresponding settlement in inches Subgrade reaction is represented in analysis as a linear spring element intended to duplicate the same response as the Modulus of Elasticity of the ground would in the actual structure being designed. A finite element model of the structure is produced and the subgrade reaction soil springs intended to represent the response of the soil to movement of the structure are attached to node points on the structure model. A substantial amount of trial and error analysis is required in arriving at a compatible structure-ground solution, and it takes experienced designers to understand the impact of various structural configurations and directions of movement in the ground media (for example vertical versus horizontal & etc.) have on the value of the subgrade reaction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1412	Performance Criteria	Approach 2	Approach 2 Finite Element or Difference Analysis of a Continuum of the Ground Media's Soil Modulus of Elasticity Coupled with the Structural Model In this case ES and µ are derived from the geotechnical investigation and applied as parameters in the finite element or finite difference program itself. Where: ES = Stress-strain modulus or modulus of elasticity of the soil in pounds per square inch µ = Poisson's ratio = Strain perpendicular to the applied stress/strain in direction of applied stress A finite element or finite difference model of the structure and its surrounding soil continuum, and any nearby underground or surface structures or other features impacting the results of the analysis are modeled simultaneously. There are times when this approach is the most appropriate, such as estimating the surface settlement due a tunnel being bored below, or to estimate the influence on the ground due to a bored tunnel following behind and closely adjacent to one already bored. Also, the design of mined tunnels and stations require this approach in a design using sequential support of excavation. Another example might be the deep caissons of a major bridge crossing or the complex ground conditions being encountered by a long submerged tube tunnel where such detailed analyses are anticipated by the client. The problem arises from the black box nature of complicated finite element programs. The designer shall verify the accuracy of such methods to the satisfaction of the Metro by a written report and with calculations that explain the theory, the input values, and the results. The designer shall also verify that the person writing the program actually understands the intricacies of every problem; and that the person providing the stress strain parameters for computation understands which bracketed material values will produce the most critical results. For quality assurance verification the designer shall demonstrate the validity of the results of the analysis using less complex, more visually understandable analytical comparisons.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.3.2	The Design of Cut and Cover Stations													
1413	Performance Criteria		For the purpose of the scope of these criteria, Approach 1, the use of subgrade reaction springs is judged to be the more appropriate design method, especially for major cut and cover construction such as those for station shells. The structural configurations are complex, involving multiple levels of station with varying depths of cover and methods of temporary and permanent ground support. Station shells are complicated by end walls and their interfaces with tunnels, and by ventilation shafts, entrances, and other appurtenant facilities intersecting with the shell whose proportions vary and are subject to varied construction sequencing throughout the station's length. Also, loading conditions require that both elastic and ductile plastic distortions must be accounted for during the life of the structure. In addition, the process of design covers conceptual, preliminary, and final design phases in which operational, passenger access, and architectural planning decisions require frequent alterations to the structural/geotechnical configuration of the station making the frequent repetition of the long process presented by Approach 2 impractical.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.3.3	The Design of the Foundation for Bridges and Aerial Guideways													
1414	Performance Criteria		A simplified application of Approach 1 can be used for the design of regular footings for the piers and abutments of bridges and aerial guideways. This approach can also be extended to multiple pile footings where the piles act mainly in tension and compression. For deep foundations using a single large diameter drilled shaft, or a combination of drilled shafts, where the lateral distortion of the piles takes an active role in the response of the foundation to static and dynamic loading, either a more refined application of Approach 1 should be used or Approach 2 should be implemented.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.3.4	Geotechnical Investigation and Testing													

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1415	Performance Criteria		Several methods are available for determining the geotechnical stress-strain data used by both Approach 1 and Approach 2: ● Unconfined compression tests ● Triaxial compression tests ● In-situ tests - Standard penetration tests - Cone penetration tests - Pressuremeter - Plate-load tests Test results shall be evaluated by a qualified geotechnical engineer, but also values based only on the observation of ground conditions by the geotechnical engineer are an acceptable approach to conceptual and preliminary design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.3.5	Load Effects on Soil Modulus and Subgrade Reaction Characteristics													
1416	Performance Criteria		The designer's prediction of the soil resistance at any point along a structural element subjected to loading shall address the stress-strain characteristic of the soil. The characteristics are shared by problems that involve values of both KS and EY. These properties shall be those existing after the structural element has been installed. Construction has an especially significant influence on clayey soils. In addition, there are four classes of loading that shall be considered:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1417	Performance Criteria		**Static Loading** – Static loads shall be considered as short term and not repeated; and sustained loads where the soil is not susceptible to consolidation and creep. (For example, over consolidated clays, soft rocks, and clean sands)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1418	Performance Criteria		**Sustained Loading** – The effect of sustained loads shall be considered. These are the most common condition for the design and construction of underground structures. If the soil resisting sustained loading is granular material that is freely-draining, the creep can usually be assumed to be small. If the soil is soft, saturated clay, the stress applied to the soil by the structural element can cause a considerable amount of additional deflection and a reduction in the effective value of the soil modulus or subgrade reaction. An example of a sustained load that cannot be reversed is the removal of soil from a deep excavation. The elastic and plastic relief at the bottom of the trench causes the ground to rise where it is excavated causing a permanent reduction in the soil modulus or subgrade reaction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1419	Performance Criteria		**Cyclic Loading** – The factors that shall be considered for structures subjected to cyclic loading are the frequency, magnitude, duration, and direction. Some of the cases are wind load and the live load and impact of rail vehicles on the foundations of aerial guideways. In the case of deep underground stations, the construction equipment being used for excavation can cause a cyclic reduction in the effective value of the soil modulus or subgrade reaction at the bottom of the excavation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1420	Performance Criteria		**Dynamic Loading** – The effect of dynamic loading shall be considered for structures such as machine foundations and earthquakes. The deflection from the vibratory load of a machine foundation is usually small and can be solved using the dynamic properties of the soil. For earthquake loading, a rational solution shall proceed from the definition of the free-field motion of the soil due to the earthquake. Seismic free-field motion is discussed in the Appendix of this criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.4	SUPPORT OF EXCAVATION STRUCTURES													
		5.6.4.1	General													
1421	Performance Criteria	A	Contract drawings and specifications shall cover traffic diversions, mandatory restrictions, and necessary construction staging by public authorities and utility companies as applicable. Acceptable locations for construction access ramps, or any other construction facility that affects the work shall also be indicated.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1422	Performance Criteria	B	Detailed design of the excavation support systems including temporary decking, shoring walls, and bracing shall be prepared by the contractor and reviewed by Metro and shall comply with Metro Rail Standard Drawings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1423	Performance Criteria	C	The Metro designer shall perform a conceptual preliminary design of decking, sheeting, and bracing utilizing the criteria that will appear in the contract documents. The design shall be for the purposes of evaluating the support of excavation system associated with the underground situation, for determining the need for supplementing or revising the criteria, and for arriving at a cost estimate for decking, sheeting, and bracing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1424	Performance Criteria	D	The designs shall not be shown in the contract documents except to the extent necessary to clarify unique situations not adequately addressed by the written criteria. In any event, detail design of decking, sheeting and bracing shall not be shown.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1425	Performance Criteria	E	It shall be a requirement in the contract documents that the design of support of excavation structures shall be prepared by an engineer registered in the state of California. The review and acceptance of the designs submitted by the contractor shall be made by an engineer registered in the state of California.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.4.2	Groundwater Cutoff Walls													
1426	Performance Criteria		When an excavation will be below the groundwater table, and lowering the groundwater table is not permitted or could cause excessive settlement, the use of groundwater cutoff walls such as slurry walls, secant pile walls, or soil mix walls shall be considered and evaluated along with factors including the local subsurface conditions, base stability, and methods to seal the bottom of the excavation and any gaps in the walls due to utilities going through the excavation against groundwater infiltration into the excavation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.5	PROTECTION OF EXISTING FACILITIES													

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1427	Performance Criteria	A	The lead structural/geotechnical engineer shall investigate all structures including buildings, and utilities within the influence zone of construction and prepare the necessary designs for their protection. Review by the project geotechnical engineer is required. For the purposes of protection of existing facilities, the influence zone of construction includes any areas that may temporarily or permanently experience movement, change in load, or vibration due to the construction. Examples of construction activity that may impact existing facilities include tunnel excavation, cut-and-cover excavation, dewatering, embankment construction, grouting, and pile driving.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1428	Performance Criteria	B	Evaluate potential impacts on existing facilities due to construction using methods acceptable to Metro, considering each facility's construction, structural systems including foundation, finishing, age, material, use, conditions, past movement if data is available, and other factors relevant to the evaluation. For buildings that may be affected by ground movement, evaluate the buildings based on Boscardin and Cording (1989) and Cording et al. (2010), or other methods acceptable to Metro, as appropriate.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1429	Prescriptive Spec	B	Unless more stringent criteria for movement are required based on the evaluation of potential impacts, for any particular structure, differential vertical movement across the structure shall not exceed 1/2 inch, and slope of differential vertical movement across each bay of the structure shall not exceed 1/600.													
1430	Performance Criteria	C	Seek and obtain the approval of each utility owner and/or agencies having jurisdictions of the utility with regards to any requirements for the protection and/or relocation of the utility, and comply with any applicable codes, standards, specifications, practices, and criteria including movement and loading, of the utility owner and/or agencies having jurisdictions of the utility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1431	Performance Criteria	D	The design of the support of excavation shall consider and include requirements for the installation and removal of temporary bracing systems to limit ground movement for the protection of facilities, including maximum distance of excavation below an installed brace and the amount of preload. The design shall comply with Metro Rail Standard Drawings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1432	Performance Criteria	E	Ground freezing as a method to stabilize soil under or around facilities shall not be used unless otherwise approved by Metro, based on evaluation to demonstrate that ground movement due to freezing and other construction activities under and around the facilities meet the criteria for the protection of existing facilities specified herein.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.6.6	HAZARDOUS MATERIALS INVESTIGATION AND ANALYSIS													
1433	Performance Criteria		The contractor shall provide a Site Assessment study for the selected alignment(s). A site reconnaissance shall be performed to observe surface conditions, access limitations, and current activities along the proposed alignment(s). An inventory of potential contaminant sources on and adjacent to the right-of-way shall be completed based upon visual observations. A record review shall be performed using, but not limited to, historic photographs, fire insurance maps, and business directories to characterize the past activities along the alignment. To supplement information gathered from records review, the contractor shall meet with regulatory agency staff and other persons having knowledge and usage of past sites and adjacent or surrounding property.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1434	Performance Criteria		The contractor may be asked to perform additional studies as supplemental tasks to the base scope. Subsurface investigations are to include laboratory testing for environmental criteria – hydrocarbons and metals are of primary concern. Gas, soil, and groundwater samples are necessary. Other related tasks shall include, but are not limited to, identifying and recommending mitigation measures, seeking site closures from the affected jurisdictional agency, acquiring Regional Water Quality Control Board permits for the discharge of groundwater and potable water, studying aerially-deposited lead (ADL), performing lead paint and asbestos surveys for any buildings to be demolished, and investigating construction air quality impacts to schools, day care centers, and hospitals. If any of these investigations require entry onto private property, the contractor shall provide detailed information regarding the planned work, and Metro will seek permission. Any mitigation identified as part of the above investigations shall be included in the cost estimate. Results of above investigations and testing shall be included in the Report.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5.7	**CONSTRUCTION INSTRUMENTATION MONITORING PROGRAM**													
1435	Performance Criteria		The designer shall draw on Metro's standard specifications and drawings to prepare contract specifications and drawings for construction instrumentation and monitoring to be implemented by the contractor. The contractor is responsible for furnishing, installing, maintaining, monitoring and removing geotechnical instrumentation for the proposed tunneling and excavations as indicated. The contract specifications shall provide for the action levels at which corrective measures are required by the contractor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6	**ARCHITECTURAL**													
		6.1	**CRITERIA**													
		6.1.1	INTRODUCTION													
		6.1.2	DEFINITIONS													
		6.1.3	REFERENCE DATA													
		6.1.4	NOT USED													
		6.1.5	STATION/PLATFORM SIZING													
		A	Dimensioning													
1436	Performance Criteria	1	Dimensional requirements for the platform are established by either Fire/Life Safety requirements or day-to-day patronage estimates as established in the EIR/EIS. Where calculations under the two lead to different numbers, the more stringent of the two shall control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Station Capacity - (Covered by Fire/Life Safety Critera)													
1437		1	Emergency Conditions													

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1438	Performance Criteria		All stations must meet the requirements for emergency evacuation as established by Metro Fire/Life Safety Criteria. Emergency exit calculations, number and capacity of exits, entraining and de-training load requirements and definitions and occupancy and occupant load determinants are contained in Fire/Life Safety Criteria and shall be used when determining the size of station exit stairs and other vertical circulation elements. The Designer shall prepare exit-capacity requirements for each station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.1.6	DESIGN GUIDELINES													
		A	Station and Facility Accessibility													
1439	Standard Criteria		The Station and facility design shall comply with all applicable accessibility codes, including but not limited to the FTA's adopted Access Board's Americans with Disibilities Act Accessibility Guideliones (ADAAG) and California Title 24 CCR.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1440	Performance Criteria		Where the circulation path is different, signage complying with ADAAG and Metro Signage Standards shall be provided to indicate direction to and identify accessible entrance and accessible route. Platform barriers complying with ADAAG requirements shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Site Development													
1441	Performance Criteria		Existing building relationship, future joint developments as well as neighborhood ethnic and cultural characteristics shall all be taken into consideration by the Designer, when site planning.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Entrances													
1442	Performance Criteria		Designs shall maintain a clear, highly visible and distinct Metro identity for ease of recognition by our patrons and for operational and maintenance purposes; to this end each station entrance shall have a prominent Station Identifier (Metro Pin) incorporated into the site plan.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		1	Underground Stations													
1443	Performance Criteria	1a	It is assumed that various business enterprises located near the stations will wish to have direct access from the station to their facilities. Any such entrances including any required CCTV coverage, signage or other associated appurtenances shall be financed and maintained by the private enterprises and shall have lockable close-down doors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1444	Performance Criteria	1b	Entrances shall be designed so that the station can be closed for a short period of time every day, or for a longer period of time in emergencies. Closure facility shall be at the top of all entrance stairs/escalators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1445	Performance Criteria	1c	Station entrance design as well as materials, textures, and finishes shall conform to Metro System Criteria, and Metro entrance portal and canopy designs.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1446	Performance Criteria	1d	Entry canopies shall be provided to have weather protection for outdoor escalators and elevators at underground and aerial stations, and shall not conflict with future joint developments.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Aboveground Stations													
1447	Performance Criteria	2a	Entrance areas located at street level, above or below freeway median, shall have free area and ticket vending equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1448	Performance Criteria	2b	Access to platform, from entrance areas above or below platform, shall be by ramp, stairs, escalator and elevator.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1449	Performance Criteria	2c	Stations shall have unpaid area(s) or free area(s) which shall be separated by Fare gates and barriers with paid area(s).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1450	Prescriptive Spec	2d	Station access walkways and ramps shall have handrails/guardrails on either side, 34 to 38 inches high for handrails, 42 inches high for guardrails.													
1451	Standard Criteria	2e	Crosswalks and all pedestrian crossings shall be defined by a continuous detectable warning, 36 inches wide and in compliance with ADAAG, Section 705 Detectable Warnings, and 406, Curb Ramps.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Patron Circulation													
1452	Performance Criteria		Circulation will be facilitated by the practice of intuitive wayfidning, which utilizes specific design principles that incorporate visual and spatial cues to help direct transit patrons through the station environment. Some basic principles which shall be considered in planning station circulation are as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1453	Performance Criteria	D1	People tend to keep to the right, and for that reason, right-hand flows are recommended, although not mandatory.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1454	Performance Criteria	D2	Any cross-flow of passengers is highly undesirable, and the layout should be such that passenger flows moving in the opposite direction shall be separated at all times.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1455	Performance Criteria	D3	Dead-end conditions shall be avoided wherever possible.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1456	Performance Criteria	D4	Whenever there is more than one opening, people tend to move towards the nearest one, even if they are unsure it is the right one.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1457	Performance Criteria	D5	People will tolerate longer delays in entering than exiting stations, but designs of stations shall attempt to eliminate waiting.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1458	Performance Criteria	D6	Circulation patterns and station layouts shall enable the patron to know where they are and where they are going at all times.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1459	Performance Criteria	D7	Queuing distances shall be maintained at all stations, to promote and guarantee ease in circulation and access to trains.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Platform/Concourses													
		1	Platform Configuration													
1460	Performance Criteria	1a	All station platforms shall be raised, either center or side platform types depending on traffic conditions, site constraints, or station layout.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1461	Performance Criteria	1b	In general, at-grade stations shall be end loaded. Aerial or underground station entry points shall be evenly distributed to reduce congestion and travel distance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1462	Prescriptive Spec	1c	Freestanding columns that are to be within 10'-0" of platform edge shall be located away from locations of vehicle doors during station stops to minimize congestion. Columns beyond 10'-0" shall have no restrictions in their placement.													
1463	Performance Criteria	1d	Elevator, escalator and stair queuing space shall be free of any and all obstructions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Platform Area													
1464	Performance Criteria		Station platforms shall be sized to accommodate site-specific patronage projections.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1465	Prescriptive Spec		The minimum area (excluding elevator, escalator, stair queuing space, and the 24 inch platform safety edge strip) shall accommodate the peak 15-minute entraining load at 10 sf/person or the peak 15-minute de-training and entraining loads at 7 sf/person.													
1466	Standard Criteria	2a	The platform edge pavers shall be consistent with various rules and regulations implemented by the ADAAG and Title 24 CCR.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1467	Standard Criteria	2b	Platform barriers shall be consistent with various rules and regulations implemented by the ADAAG, Title 24 CCR, and California Public Utilities Commission.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Platform Widths - See Standard and Directive Drawings													
		4	Platform Lengths													
1468		4a	System Stations													
1469			The length of platforms shall be as follows:													
1470	Prescriptive Spec		Metro Purple Line = 450'	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1471	Prescriptive Spec		Metro Red Line = 450'	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1472	Prescriptive Spec		Metro Green Line = 270'	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1473	Prescriptive Spec		Metro Blue line = 270'	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1474	Prescriptive Spec		Metro Gold line = 270'	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1475	Prescriptive Spec		Metro Exposition line = 270'	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1476	Prescriptive Spec		Future LRT Lines = 270'	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		5	Underground Station Vertical Clearances													
1477		5a	Platform - See Standard and Directive Drawings													
1478	Prescriptive Spec	5a1	Any station elements that could be targeted for theft or vandalism (e.g. light fixtures, speakers, cameras, ect.) shall be located at a minimum of 9'-3" above traveled pathways. Horizontal canopy framework that could lend itself to climbing shall be located above 9'-3".													
1479	Performance Criteria	5a2	Platform barrier shall be provided to stop or deter patrons with vision impairments from walking off the platform between rail cars. See Standard and Directive Drawings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1480	Performance Criteria	5a3	Warning line or stand behind line shall be designed into platform. See Standard and Directive Drawings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1481	Performance Criteria	5b	Concourse layout - see Standard and Directive Drawings	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Station Amenities													
		1	Weather Protection													
1482	Performance Criteria		A minimum protection from the rain shall be provided for the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1483	Prescriptive Spec	F1a	Fare Vending equipment including a minimum 3'x3' area in front of the area													
1484	Performance Criteria	F1b	Fare gates	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1485	Performance Criteria	F1c	Map viewing areas - Customer information panels - shall be located in conformanec with Mettro Signage Standards at plaza, concourse, and platform locations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1486	Performance Criteria	F1d	75% of required platform seats	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1487	Performance Criteria	F1e	50% of boarding platform area	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1488	Standard Criteria	F1f	Outdoor escalators - Comply with the requirements of ASME A17.1, Section 807	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1489	Prescriptive Spec	F1g	Outdoor elevator - Provide canopy above door and entrance area. Minimum 4'-0" projection full width of shaft front closure.													
		2	Windscreens and Sound Barriers (where needed) for Aerial and At-Grade Stations													
1490	Prescriptive Spec		To protect patrons from strong wind-blown rain, transparent windscreens shall be provided on aerial station platforms. A mimimum of 5% of the peak 15-minute entraining load, with design headways considered, shall be protected. The design shall assume that rain falls at a 10 degree angle from vertical.													
		3	Seating													
1491	Performance Criteria		Ticketing Area No seating shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1492	Performance Criteria		Concourse Area No seating shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1493	Prescriptive Spec		Platform Level Passenger seating (with minimum of 12 LF per platform) shall be distributed to two or more locations. See Metro Rail Architectural Standard and Directive Drawings													
1494	Performance Criteria		Plaza Level All seating must be designed to discourage lying down and vandalism, using design elements such as armrest dividers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		4	Trash Receptacles													
1495	Prescriptive Spec		Maximum travel distance to the nearest receptable on the concourse or platforms shall be 70'. A minimum of one receptacle per fare vending area and two minimum per platform shall be provided.													
		G	Ancillary Space Requirements													
1496	Performance Criteria	G1	Ancillary spaces shall be provided in subway stations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1497	Standard Criteria	G1A	TC&C rooms and Auxiliary Power rooms, if located at track level, should have at least one means of access that does not require GO-175 procedures to access the room.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1498	Performance Criteria	G2	Acillary spaces for at grade or aerial stations may be required at or near each station. In addition to the mechanical and electrical requirements of each space, the following shall be incorporated into the design:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1499	Performance Criteria	G2a	Specify Metro-standard doors, hardware, interior paints, and lighting fixtures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1500	Prescriptive Spec	G2b	Provide reasonable access to a permanently maintained service vehicle parking stall (less than 200 ft travel distance)													
1501	Performance Criteria	G2c	Provide permanent vehicular access to the emergency generator. This access is required only in an emergency condition; access may be on and across walks, plazas, ect.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		H	Safety and Security													
1502	Performance Criteria		See Metro Safety and Security and Fire Life/Safety Criteria Manual.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		I	Queuing Distance Requirements													
1503	Performance Criteria		Adequate space shall be provided around the fare vending machines, standalone validators, and future or current provided fare collection gates to allow patrons to buy their tickets and pass through the gates without undue crowdin and exiting through this space in case of emergencies. Minimum queuing distance requirements are given on Table 6.3.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		J	Accessibility Provisions													
1504	Performance Criteria		The criteria referenced and contained herein are based on space, equipment and human factors as related to wheelchairs, walking aids and reach limitations, and shall be incorporated into the design and specifications for all Metro Rail Public Facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		1	Federal Requirements													
1505	Performance Criteria	J1a	Where public parking is provided, the minimum number of accessible spaces shall be determined as shown in Section 6.12, Table 6.6.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1506	Prescriptive Spec	J1a1	Access aisles adjacent to accessible spaces shall be 60 inches wide minimum.													
1507	Prescriptive Spec	J1a2	One in every 6 accessible spaces, but not less than one, shall be served by an access aisle 96 inches wide minimum and shall be designated "van accessible"													
1508	Prescriptive Spec	J1b	Accessible walks from an accessible parking space, a public sidewalk or public transportation stop to an accessible station entrance shall be provided with a minimum 60 in x 60 in level zone suitable for wheelchair passage or rest, spaced at no more than 200 ft apart, when the width of the accessible walk is less than 60 inches.													
1509	Performance Criteria	J1c	All handrails for stairs, ramps and along accessible walks shall comply with the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1510	Prescriptive Spec	J1c1	The nominal diameter or horizontal cross section of the gripping surface of a handrail shall be 1-1/4 in to 1-1/2 in.													
1511	Performance Criteria	J1c2	The top of a handrail shall be mounted at a height which complies with Title 24, CCR, measured from the finished floor, ramp surface or tread nosing to the top of the handrail.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1512	Performance Criteria	J1d	In the design of signage and station identification, the following requirements shall be met	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1513	Performance Criteria	J1d1	Metro will provide digital graphic templates, to be used as a guide by the Signage and Environmental Graphic Design Professional, for all signage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1514	Prescriptive Spec	J1d2	For raised or recessed letters, numbers of symbols, the height shall be 5/8" (min) to 2" (max).													
1515	Prescriptive Spec	J1d3	Character identification shall be mounted at a height of 48" to 60" above finished floor (AFF), to the baseline of the top line of the tactile lettering, mounted on the wall at the latch side of the door.													
1516	Performance Criteria	J1d4	A combination of upper and lower case lettering shall be utilized in a visual (non-tactile) signage, arranged to provide greater readability to persons with visual impairments, per Metro Signage Standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1517	Performance Criteria	J1d5	Doors leading into hazardous areas that might prove dangerous to a blind person shall be made quickly identifiable by tactile/Braille signage, mounted on the wall at the latch side of the door.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1518	Prescriptive Spec	J1e	The mounting height of handrails in elevator cabs shall be 31" to 33 above the floor to top of rail.													
		2	State Requirements													
1519	Performance Criteria		The State of California regulations pertaining to barrier-free design are contained in Title 24 of the California Code of Regulations (CCR), Parts 2, 3 and 5. These regulations are adopted by reference, with exceptions as noted in Article 1.6.98-B.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		K	Seismic Criterion for Equipment - See Section 5 - Structural Criteria													
1520	Performance Criteria		Seismic Criterion for Equipment - See Section 5 - Structural Criteria	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		L	Accessiblity and Maintenance													
		1	Underground Stations													
1521	Performance Criteria		TC&C, C&S, and Auxiliary Power rooms shall be accessible by means other than the emergency walkways at track level.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	At-Grade and Aerial Structures													
1522	Prescriptive Spec		C&S buildings shall be accessible by means other than the emergency walkways at track level, unless the C&S building is located between the tracks. In that case, there shall be a 4 ft walkway from the platform to the C&S building, with at least 6 ft of clearance between the edges of the walkway to the nearest edge of rail.													
		6.2	**ADVERTISING**													
		6.2.1	INTRODUCTION													
1523	Performance Criteria		Revenue-generating advertising displays are permissible in Metro Rail stations as well as on the interior and exterior of Metro Rail vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1524	Performance Criteria		Consistent with Board-approved Policy Com-6, "Metro System Advertising,", any recommended contracts for revenue-generating advertising dispays on Metro Rail will be brought to the Metro Board for review and approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.2.2	BASIC GOALS													
1525	Performance Criteria		Metro will:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1526	Performance Criteria	A	Use station advvertising to generate revenue, but only to the extent that the advertising does not interfere with the station's visual and design elements including signage, artwork, patron convenience, safety and security, or adversely affect combustible loading.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1527	Performance Criteria	B	Ensure that advertising, by its placement and treatment, does not interfere with orderly patron circulation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1528	Performance Criteria	C	Discourage defacement or damage by placement and form of advertising.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.2.3	CRITERIA													
1529	Performance Criteria	A	Metro communications department shall review and approve all proposed advertising locations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1530	Performance Criteria	B	Advertisements will be carefully located, adjacent to areas of heavy traffic, but not obstruct or retard passenger flow.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1531	Performance Criteria	C	Advertising shall not be visible from outside Metro Rail Underground stations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1532	Performance Criteria	D	Provisions shall be madee for advertising kiosks or other equipment displays to be reviewed on a case by case basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1533	Performance Criteria	E	Capital and operating costs shall be sponsor/vendor's responsibility	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1534	Performance Criteria	F	For related information, refer to Subsectin 6.10, Signage and Graphics.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.2.4	STANDARD ADVERTISING PANEL FOR UNDERGROUND STATIONS													
1535	Performance Criteria	A	Platform Level: Future advertising panels shall be used per Architectural Directive Drawing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.3	**ARTWORK**													
		6.3.1	INTRODUCTION													
1536	Performance Criteria		Project-specific art programs shall be developed by, and executed through, Metro Arts and Design, after thorough evaluation of stations, guideway and track elements, and support facilities for high-impact, art and design approaches that knit the project into surrounding areas and promote a sense of place.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.3.2	GENERGAL GUIDELINES													
1537	Performance Criteria	A	In general, and as determined by Metro Arts and Design, art shall be fully integrated into the project design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1538	Performance Criteria	B	Art programming allows for expressive variation and is considered "Elements of Variability"	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1539	Performance Criteria	C	The Artwork must be of high quality, be site specific, require minimal maintenance, as articulated in the Metro Art Guidelines for Materials and Finishes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1540	Performance Criteria	D	Artwork materials and locations shall be identified with safety and security in mind and shall be designed to be minimally impacted by graffiti and vandalism.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1541	Standard Criteria	E	Artworks shall be compliant with the Americans with Disabilities Act (ADA) requirements as determined by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.3.3	OVERVIEW													
1542	Performance Criteria	A	In order to ensure adherence with the aesthetic, sustainable and qualitative integrity of the holistic Metro portfolio of artworks, curatorial visuon and oversight, and related public engagement are led by Metro Arts and Design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1543	Performance Criteria	B	Art programming integration opportunities and fabrication materials emphasize maximum engagement with transit customers, appropriate scale, and significant enhancement to the transit environment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1544	Performance Criteria	C	Metro Arts and Design identifies public art opportunity locations within the station and corridor environment and will interface with the Architect and the Design Team at key stages in the design of the project.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1545	Performance Criteria	D	Metro Arts and Design is the lead art program point of contact to all Metro and Consultant/Contractor project team members from the planning stages through project completion, activation, operations and close out.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1546	Performance Criteria	E	Metro Arts and Design works with members of the local communities to research and/or assemble information and unique insights regarding their communities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1547	Performance Criteria	F	Metro Arts and Design plans, schedules, coordinates, and facilitates all external artwork meetings, presentations, and community outreach as determined for public communication of the art program and the specific art programs.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1548	Performance Criteria	G	Design workshops, value engineering exercises, and modifications affecting the architecture and aesthetics of the project are to be coordinated with Metro Arts and Design, in order to achieve art program integration and to conform to Metro standards for safety, durability, and maintenance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1549	Performance Criteria	H	Artworks shall be placed in such a manner that they do not impede patron or operator view.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1550	Performance Criteria	I	Artwork asset management responsibilities are determined after project delivery approach has been selected.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1551	Performance Criteria	J	Construction drawings and specifications shall incorporate artwork locations and installation references to accurately reflect artwork locations and guidelines provided by Metro Art and Design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1552	Performance Criteria	K	Artist's design concepts will be reviewed for integration constructability, engineering, attachments, location, suitability materials and finishes, safety and security concerns, and rough or of magnitude design, construction, and if applicable, maintenance requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.3.4	ARTIST PARTICIPATION													
1553	Performance Criteria	A	Based on the type of artist services agreement, the artist may provide artwork:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1554	Performance Criteria	A1	Design Services	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1555	Performance Criteria	A2	Design and art fabrication services	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1556	Performance Criteria	A3	Design, art fabrication, and installation services	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.3.5	THIRD PARTY: IMPACTS TO EXISTING ARTWORKS													
1557	Performance Criteria	A	In the event that existing third party artworks are impacted, all activities and communications regarding artwork impacts will be coordinated through Metro Arts and Design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.3.6	STATE OF GOOD REPAIR AND FACILITY REFURBISHMENTS													
1558	Performance Criteria	A	Art programming opportunities will be identified by Metro Arts and Design for State of Good Repair projects.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1559	Performance Criteria	B	Metro Arts and Design will contract with artists, conservators, legal counsel, and any professional and/or specialty services relative to the State of Good Repair and/or refurbishment plans.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1560	Performance Criteria	C	In the event that existing artwork is impacted by refurbishment projects, Metro Arts and Design will identify impacted artwork and will develop plans and specifications for its protection, removal, replacement, reinstallation or relocation, as required to ensure that the original integrity of the artwork is kept whole.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1561	Performance Criteria	D	In the event an impacted artwork is removed, relocated, or destroyed due to broader Metro construction or refurbishment, the proejct shall provide Metro Arts and Design with the funding resources to store, relocate, and/or commision a new, equivalent artwork, inclusive of artist fees, fabrication, installation, and associated staff hours.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.3.7	JOINT POWERS AUTHORITY (JPA)													
1562	Performance Criteria	A	Metro Arts and Design coordinates with JPA staff or designee in charge of the public art obligation for the project, to establish conformace with Metro artwork guidelines, including artist contract language for eventual conveyance and ownership by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1563	Performance Criteria	B	Metro Arts and Design reviews projects and project area design and artwork submittals including concept design, design development, drawings, and conservation and maintenance recommendations, to ensure that all artwork enhancements comply with the Metro Art Guidelines for Materials and Finishes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1564	Performance Criteria	C	Metro Arts and Design inspects artwork for completeness before JPA conveyance to Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1565	Performance Criteria	D	The JPA transfers all artist contracts, material samples, warranty information, shop drawings, maintenance recommendations and products of design to Metro Arts and Design at completion of the project.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1566	Performance Criteria	E	Metro Arts and Design shall review any proposals for construction phase or mitigation artwork incorporated into the project.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.3.8	JOINT DEVELOPMENT: DEVELOPER IMPACTS TO EXISTING METRO ARTWORKS													
1567	Performance Criteria	A	Metro Arts and Design coordinates with Metro Joint Development, Strategic Initiatives, and Metro Real Estate Administration departments at the early stages of contractual agreements with private developers, to review, modify, or incorporate language affecting the resolution of existing artworks at Metro property under consideration.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1568	Performance Criteria	B	Existing artworks at project plazas, concourses, platforms, station areas, support facilities, or other project entities may require demolition, alteration, salvaging and storing or removal to another Metro designated site.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1569	Performance Criteria	C	Artworks commissioned by Metro are considered Metro assets and as such, have legal and cost factors that require Metro Arts and Design recommendations and instructions for the private developer, artists, and related Metro departments.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1570	Performance Criteria	D	Metro Arts and Design reviews developer's project plans, renderings, construction drawings, and specifications, to determine possible impacts on existing artworks and offers recommendations as to a course of action.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1571	Performance Criteria	E	Funding to address impacts to existing artworks and proejct architectural treatments associated with possible protection, demolition, removal or modifications to the artworks shall be identified in the developer's project budget.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1572	Performance Criteria	F	Developer's projet budget expenses may entail replacement by a new, equivalent, Metro Arts and Design commissioned artwork, inclusive of: artist fees, fabrication and installation costs, associated staff hours, and any other costs associated with the complete integration of artworks into the project site, adjusted for inflation, based on Consumer Price Index (CPI).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.3.9	JOINT DEVELOPMENT: DEVELOPER INITIATED PUBLIC ART AND ARTS PROGRAMMING													
1573	Performance Criteria	A	Artist, cultural facility, and/or other design professional participation on the project design team is encouraged from the outset of architectural design to ensure full Art Plan integration.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1574	Performance Criteria	B	Developers should consult both with the County and the governing municipality to determine any arts fee compliance requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1575	Performance Criteria	C	As the development project evolves, Metro Arts and Design (and any additional regulatory agency, as required) will review Art Plans in the schematic and fina design stages, and will make recommendations to ensure that the proposals in publicly accesssible locations adhere to, and contribute to, the project as a whole.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1576	Performance Criteria	D	Artworks commissioned by developers for Metro property are not considered Metro assets and will not be maintained by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.4	**CODES**													
		6.4.1	INTRODUCTION													
1577	Performance Criteria		This chapter lists the building codes, legal regulations and criteria to which the design of Metro Rail stations and facilities shall conform.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1578	Performance Criteria		In the event that a condition is found which is not covered by these codes, regulations and criteria outlined herein, the Designer shall refer the matter to Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.4.2	BASIC GOAL													
1579	Performance Criteria		Providing facilities which are free of recognized hazards that could compromise the health and safety of the public or the Metro Rail System patrons and employees.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.4.3	APPLICABLE CODES AND STANDARDS													
		A	Compliance													
1580	Performance Criteria	1	The design of stations and facilities shall comply in all respects with the codes and standards listed below and with Metro Fire/Life Safety Criteria Manual.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1581	Performance Criteria	2	These codes and standards shall in each instance be the latest edition or issue, and the most recent revision, amendment, or supplement adopted by the local justification at the date of notice to proceed with the final design of each specific project, or as directed by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1582	Performance Criteria	3	With the exception of the variances decribed herein, where the requirements of more than one code or standard are applicable, the more restrictive shall govern.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Codes Standards - All designs shall comply with all applicable accessibility codes and regulations including but not limited to:													
1583	Definition	1	American National Standards Institute, Inc. (ANSI)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1584	Definition	2	Access Board Accessibility Guidelines for Buildings and Facilities (ADAAG) effetive November 29, 2006, and CALDAAG, latest edition.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1585	Definition	3	American Society of Testing and Materials (ASTM)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1586	Definition	4	California Building Code (CBC)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1587	Definition	5	California Code of Regulations (CCR), Title 8, Industrial Properties	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1588	Definition	6	California Code of Regulations (CCR), Title 19, Public Safety	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1589	Definition	7	California Code of Regulations (CCR), Title 24, Building Standards Code	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1590	Definition	8	California Code of Regulations (CCR), Title 24, Part 2 (State Building Code)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1591	Definition	9	California Public Utilities Commission (CPUC) General Orders	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1592	Definition	10	Los Angeles City Building Code	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1593	Definition	11	Los Angeles City Fire Code (LA Fire Code)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1594	Definition	12	Los Angeles County Building Code	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1595	Definition	13	Los Angeles County Fire Code (LA Co Fire Code)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1596	Definition	14	NFPA 101, Fire Safety Code	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1597	Definition	15	NFPA 130, Fixed Guidewy Transit Systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1598	Definition	16	Underwriters Laboratory, Inc. (UL) 44, 83, 555	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1599	Definition	17	Building Code of Local Jurisdiction	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1600	Definition	18	ASME A17.1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1601	Definition	19	National Design Specification of Wood Construction	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Applicable Documents													
1602	Definition	1	Occupational Safety and Heath Act (CAL-OSHA)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1603	Definition	2	Subway Environmental Design Handbook Vol. 1, 2nd Edition	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1604	Definition	3	American Public Transportation Association - Rapid Transit Design Guidelines	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.5	**CONCESSIONS**													
		6.5.1	INTRODUCTION													
1605	Definition		The concessions permitted by Metro shall conform to the general standards set forth below:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.5.2	BASIC GOALS													
1606	Definition	A	To provide limited facilities and spaces for concessions which shall be required for the convenience of Metro Rail Systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1607	Definition	B	To ensure that concession operation does not produce a negative impact on the Metro Rail System, in the form of litter, security, pest infestation, or other undersirable conditions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1608	Definition	C	To ensure that concession operation does not interfere with patron circulation and transit operation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1609	Definition	D	To generate revenue.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.5.3	DESIGN CRITERIA													
1610	Definition	A	Concessions may be located only on the concourse level in the Free Area in grade separated stations. No concessions operations shall be allowed on the platforms. No food or drink shall be permitted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
				No Exception= NE Exception = EX												Specs & Plans
ID	**TYPE**	**SECTION**	**DESCRIPTION**	**LOS ANGELES**	**HUNTINGTON PARK**	**BELL**	**CUDAHY**	**DOWNEY**	**SOUTH GATE**	**PARAMOUNT**	**BELLFLOWER**	**CERITOS**	**ARTESIA**	**VERNON**	**VARIANCE**	**DOCUMENT/SECTION**
1611	Definition	B	No food, requiring on-site preparation or refrigeration, beverage or tobacco concessions are permitted in the stations or in designated operational zones on station entry plazas and on the platform areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1612	Definition	C	All physical components to be consistent with Metro design criteria regarding materials, dimensions, close-down, fire/life safety requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1613	Definition	D	Built-in mechanical vending machines for newspapers, postage, and automatic teller machines could be allowed in Metro designed free areas of station. All plans shall meet the requirements of local city codes, and be prepared by licensed professionals.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1614	Definition	E	Signing and graphics associated with vending machines and manned concessions shall conform to Metro Signage Standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1615	Definition	F	Concessions shall not obstruct lines of sight, create cul-de-sacs, obstruct passenger flow, or present firelife/safety problems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1616	Definition	G	Concessions shall consist of two basic types:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1617	Definition	G1	Built in	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1618	Definition	G2	Free Standing	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1619	Definition	H	Wet concessions are not allowed unless prior written approval is granted by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1620	Definition	I	Concessions shall be part of a total station design and shall not be an element tackled on as an afterthought.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.5.4	SPECIFIC CRITERIA													
1621	Definition	A	Coin-Operated Equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1622	Definition	A1	Coin-operated newspaper vending machines may be authorized for stations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1623	Definition	A2	Provisions for possible future vending machines shall be limited to space that is available, and that conform to Metro station design standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1624	Definition	A3	Conession Vending Machines - If provided, standard configuration and materials shall be specified to assure uniform stocking of repair parts for maintenance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.6	**LANDSCAPE**													
		6.6.1	INTRODUCTION													
1625	Definition		Designs shall be consistent with the guidance provided by this criteria; the Preliminary Engineering Design Drawings; Project Guideline Specifications; and Project Standard Detail Drawings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A	Codes and Standards													
1626	Definition		The following are incorporated into these design criteria by reference and shall be adhered to, in the specification of plant materials:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1627	Definition		American Standard for Nursery Stock ANSI Z60.1, adopted by the American Association of Nurserymen, Inc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1628	Definition		Bailey's Standard Cyclopedia of Horticulture	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1629	Definition		Standardized Plant Names, American Joint Committee on Horticulture Nomenclature (AJCHN)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.6.2	OBJECTIVES													
1630	Definition		Provide a landscape design that:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1631	Definition	A	Will be recognized by the community as a yardstick of innovation and excellence and within budget constraints	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1632	Definition	B	Ensures the safety and comfort to the Metro Rail systems patrons.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1633	Definition	C	Adds to the character and identity of the existing neighborhood.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1634	Definition	D	Is responsive to and complimentary with station architecture, art, signage, graphics and lighting design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1635	Definition	E	Is compatible with local climate conditions, conserves water resources, uses reclaimed water system for irrigation and uses native plants, where feasible.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1636	Definition	F	Requires minimum maintenance, and reasonable initial cost	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1637	Definition	G	Does not impede motorists, train operators, or pedestrian sight lines.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1638	Definition	H	See Metro Sustainable Design Guidelines in Design Criteria Section 2, Environmental Considerations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1639	Definition	I	Shall not interfere with Wayside Support Systems, such as OCS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1640	Definition	J	Heat resistant	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.6.3	COORDINATION													
		A	Design Team													
1641	Performance Criteria		The Landscape Architect shall coordinate design and production of constrution drawings with Designers and Metro Arts and Design to ensure that landscaping, facilities architecture, signage, site engineering and station art are visually and functionally compatible.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Local Agencies													
1642	Performance Criteria		The Landscape designer shall ensure that local code requirements are satisfied and shall coordinate all discussions involved with regulations, criteria or policies of local agencies.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.6.4	DESIGN CRITERIA													
		A	Compatibility with System Design													
1643	Prescriptive Spec	1	A maintenance free clearance of 10 ft must be provided and maintained between trees and overhead contact system (OCS) lines.													
1644	Performance Criteria	2	Maintenance of a clean trackway to prevent contamination of ballast, thereby ensuring positive drainage away from the track, is also critical to safe operations. Plants located at ballast edge shall be small-leaf, everygreen plants to minimize plant litter in the ballast.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1645	Prescriptive Spec	3	No trees, fences or shrubs shall be installed, planted or maintened above 4ft above top of rail within 250 ft of any grade crossing.													
1646	Performance Criteria	4	Planting shall be designed to promote safety and security of Metro passengers. Planting shall be designed to avoid concealed places, blind corners and obstructions for emergency response personnel and equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1647	Performance Criteria	5	Plant material shall not encroach upon walkways, bike paths, or station platforms.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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ID	TYPE	SECTION	DESCRIPTION	LOS ANGELES	HUNTINGTON PARK	BELL	CUDAHY	DOWNEY	SOUTH GATE	PARAMOUNT	BELLFLOWER	CERITOS	ARTESIA	VERNON	VARIANCE	DOCUMENT/SECTION
1648	Performance Criteria	6	Plant material shall be selected and located so as to avoid conflicts with utlities, including overhead lines and hydrants.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1649	Performance Criteria	7	Whenever possible existing native vegetation and habitat shall be preserved or restored.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1650	Performance Criteria	8	No foliage shall be installed or maintained above the trackway.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1651	Performance Criteria	9	Design barriers to planted areas to minimize access by pedestrians.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1652	Performance Criteria	10	Plantings shall be designed to allow plants to attain their ultimate height and spread. To prevent concealment issues, mature plants shall not exceed 36 inches in height (CPTED).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1653	Performance Criteria	11	Plant materials shall be selected to minimize plant litter on walkways, bike paths or station platforms.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1654	Performance Criteria	12	Utilize mulch generously to minimize weed growth and loss of soil moisture.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1655	Performance Criteria	13	Avoid the use of plants that are dense in foliage from the ground up designed to form screens and hedges adjacent to buildings or walls if obscured views are created. A clear view across the ROW is to be preserved.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1656	Performance Criteria	14	No creeping vines shall be planted on any fencing along the right-of-way to allow maximum visibility both in and out.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Site Preparation													
1657	Performance Criteria	1	Finish grading shall be sloped sufficiently to afford adequate drainage, yet minimize erosion.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1658	Performance Criteria	2	All slopes shall be stabilized to prevent physical failure, erosion and maintainance problems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1659	Performance Criteria	3	Retaining walls shall be treated to prevent defacement. Plantings are recommended as a long-term deterrent to graffiti.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1660	Performance Criteria	4	A suitable soils report from a recognized soils testing agency shall be obtained. The soils report shall also include recommendations to alleviate problem soils conditions, if necessary.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Selection of Plant Materials													
1661		1	Considerations for the selection of plant materials shall include:													
1662	Performance Criteria		Initial cost	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1663	Performance Criteria		Long Term Operational/Maintenance costs	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1664	Performance Criteria		Local availability	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1665	Performance Criteria		Attractiveness	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1666	Performance Criteria		Growth Rate	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1667	Performance Criteria		Tolerance to drought, wind, pollutants, and abuse	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1668	Performance Criteria		Hardiness	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1669	Performance Criteria		Soil and drainage conditions	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1670	Performance Criteria		Sun/shade preferences	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1671	Performance Criteria		Maintenance characteristics including leaf and limb litter	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1672	Performance Criteria		Potential damage to adjacent paved areas by roots	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1673	Performance Criteria		Watering requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1674	Performance Criteria		Attraction of rodents or insects	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1675	Performance Criteria		Native to Southern California and local environs	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1676	Performance Criteria	2	Growth Rate	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1677	Performance Criteria		Select trees with moderate growth rate that shall not grow aggressively out to the ROW or to adjacent streets.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1678	Prescriptive Spec		Shade trees shall be selected which produce a relatively mature canopy within 4-5 years of installation. Ground covers shall be selected to provide complete coverage within 2 years of installation. Once established, no plant material shall need maintenance more than 4 times yearly in order to contain it within its designated planting areas.													
1679		3	Environmental adaptability/ soils testing													
1680	Performance Criteria		Plant material shall generally have low water requirements, be hardy, long lived and be resistant to disease.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Street Trees													
1681	Prescriptive Spec		Street trees shall be selected and spaced to conform to local requirements. Tree selectionshall require coordination with local agency. Where no existing local requirements apply, selection and spacing shall be approved by Metro.													

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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1682	Prescriptive Spec		Minimum size for trees located in paved pedestrian areas shall be 24" box minimum. Trees shall be spaced between 20 and 50 ft apart, depending on species and local agency requirements.													
		E	Entry Plazas													
1683	Performance Criteria		Planting design is encouraged for separating vehicles and pedestrians. Planting design and walkway layouts are encouraged to create recognizable pedestrian patterns and discourage pedestrian encroachment into planting areas; reinforce public gathering spaces, and integrate joint-use projects into the station plaza area.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Station/Park-and-Ride Lots													
1684	Performance Criteria		Trees shall be planted in parking areas between stalls, in the parking row-end islands or in stalls specifically designed for planting as determined by the Designer, in order to reduce monotony of parking lots and to provide a comfortable transition between the car and the station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		G	Metro Rail At-Grade Right-of-Way													
1685	Performance Criteria		At-grade right-of-way landscape treatment shall be consistent with stated objectives with an emphasis on minimal maintenance and safety.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		H	Maintance													
1686	Standard Criteria		Landscape designs shall minimize maintanance requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		I	Tree Protection and Support													
1687	Prescriptive Spec		All trees in pedestrian areas shall be staked. For non-pedestrian areas, trees less than 36" box size shall be staked. Trees larter than 36" box size shall be guyed.													
		J	Irrigation													
1688	Performance Criteria		Design shall focus on long-term low water usage, conserving water resources, and using reclaimed water system for irrigating if available.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.7	**MATERIALS**													
		6.7.1	INTRODUCTION													
1689			Designer shall assure that the goals of safety, durability, and economy are achieved.													
		6.7.2	BASIC GOALS													
		A	Safety													
		1	Fire Resistance and Smoke Generation													
1690	Performance Criteria		Reduce hazard from fire by using materials with minimum burning rates; smoke generation, and toxicty characteristics for station finishes, consistent with requirements of Metro Fire/Life Safety Criteria	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Attachment													
1691	Performance Criteria		Eliminate hazard from dislodgement due to temperature change, vibration, wind, seismic forces, aging, or other causes, by using proper attachments and adequate bond strength.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		3	Slip-resistant walking surfaces													
1692	Prescriptive Spec		Entrances, stairways, platform edege strips, sidewalk grates, and areas around equipment shall have high slip-resistant properties. The following static coefficients of friction as defined in ASTM C1028 shall be provided as a minimum:													
1693	Standard Criteria		<u>Coefficient of Friction</u> Public horizontal surfaces --> 0.6 min. per ADAAG Non-public horizontal surfaces, exterior --> 0.6 min Non-public horizontal surfaces, interior --> 0.5 Platform edge strips --> textured visually-contrasting material conforming to ADAAG Section 705, Detectable Warnings and 406, Curb Cuts, and California Code of Regulations (CCR), Title 24 Stairs, ramps, sloping sidewalks --> 0.8 per ADAAG Area around equipment --> 0.6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Durability													
1694	Performance Criteria		The materials must maintain their good appearance throughout their useful life. Materials shall be colorfast.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Ease of Maintenance													
		1	Cleaning													
1695	Performance Criteria		Reduce cleaning costs by using materials which do not soil or stain easily, which have surfaces that are easy to clean in a single operation, and on which minor soiling is not apparent.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Repair or Replacement													
1696	Performance Criteria		Reduce cleaning costs by using materials which do not soil or stain easily, which have surfaces that are easy to clean in a single operation, and on which minor soiling is not apparent.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Resistance to Vandalism													
1697	Performance Criteria		A six millimeter thick anti-graffiti sacrificial film shall be installed for protection of glass surfaces and anti-graffiti coatings for protection of concrete surface as well as other finish material such as tile, steel shall be installed with Metro recommended products as indicated in Metro Baseline Specifications. Metro Arts and Design will provide direction with regard to anti-graffiti protection and maintenance of artworks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Aesthetic Qualities													
1698	Performance Criteria		Create a feeling of warmth, attractiveness, quality, and design excellence to instill pride in the facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F														
1699	Performance Criteria		See Sustainable Design Guidelines in Design Criteria Section 2, Environmental Considerations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.7.3	GENERAL CRITERIA													
		A	Surface													
1700	Performance Criteria		Surfaces visible to the public shall receive applied architectural finishes consistent with Metro Systemwide Station Design Standards approach.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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		B	Color													
1701	Prescriptive Spec		To provide uniform contrast ratio in all Metro Rail System Stations, a 6 inch wide black porcelain tile pre-warning strip shall be placed adjacent to the 24 inch yellow, tactile platform edge paver, in compliance with ADA and Title 24 (CCR), as indicated in Metro Rail Architectural Standard Drawings.													
		C	Texture													
1702	Performance Criteria		Smooth surfaces are preferred over rough ones for ease in cleaning and because they are less prone to catch settling dust. Routh surfaces are desirable where a slip-resistant feature is important, and are acceptable where surfaces are difficult to reach.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Unit Size													
1703	Performance Criteria		Units shall be large enough to reduce the number of joints yet small enough to conceal minor soiling and scratches and to facilitate replacement if needed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Joints													
1704	Performance Criteria		Floor finish joint width shall comply with Title 24 CCR (1/4" minimum to 3/8" wide maximum). Floor finish joints shall comply with Federal and State Accessibility Standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Cost													
1705	Performance Criteria		Within the station budget, materials shall be selected for long life, low maintenance, replacement considerations and overall aesthetic and functional qualities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		G	Availability													
1706	Performance Criteria		Materials shall be selected which are readily available.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		H	Nonproprietary Materials													
1707	Performance Criteria		In order to obtain competitive bids and to comply with Federal Regulations, proprietary items shall only be used where it is established that no other material would meet the particular design requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		I	Installation Standards													
1708	Performance Criteria		Materials shall be detained and specified to be installed in accordance with industry standards and manufacturer's printed directions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		J	Flammability													
1709	Standard Criteria		Interior finishes shall meet requirements of the California Building Code (CBC), Chapter 8, and the Fire/Life Safety Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1710	Standard Criteria	J1	Finishes for all protected exitways shall be Class I as defined by the CBC and Class A as defined by NFPA 101.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1711	Standard Criteria	J2	Finishes in all other areas shall be Class II as defined by the CBC and Class B as defined by NFPA 101.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1712	Standard Criteria	J3	Combustible adhesives and sealants may be used when they meet the requirements stated above.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		K	Pressure Resistance Criteria													
1713	Performance Criteria		Miscellaneous items in underground structures are subject to air pressure caused by running trains; Ceilings, wall finishes and doors shall meet the pressure resistance criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.7.4	LIST OF FINISHED MATERIALS													
1714	Performance Criteria		For the use of items listed as "Acceptable", installation is subject to location and environmental considerations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A	Floor Finish Materials - Provide slip-resistant Surface for All Flooring.													
		1	Non Acceptable Materials													
1715	Performance Criteria	1a	Monolithic Materials: 1) Bituminous toppings 2) Synthetic resin toppings 3) Resinous Terrazzo Tile	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1716	Performance Criteria	1b	Unit Materials: 1) Resilient tile and sheet products - in public areas 2) Wood products 3) Marble 4) Mosaic Tile 5) Glazed ceramic tile 6) Glazed porcelain tile 7) Architectural concrete and precast concrete pavers for public areas in underground stations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Wall Materials													
		1	Non Acceptable Materials													
1717	Performance Criteria	1a	Monolithic Materials: 1) Rough concrete (within 9 ft of floor immediately adjacent to public circulation and flow areas) 2) Plaster 3) Exposed steel 4) Curtain wall assemblies	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1718	Performance Criteria	1b	Unit Materials: 1) Gypsum board (acceptable for 2 hr rated enclosure at smoke exhaust duct where passing through ancillary space) 2) Plastics 3) Wood 4) Vitreous mosaic tiles 5) Brick 6) Structural glaze faced concrete masonry units 7) Crystalized glass panels 8) Granite 9) Quarry tile	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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1719	Performance Criteria	1c	Surface-Applied Finishes: 1) Vinyl wall covering 2) Paint 3) Special epoxy coatings 4) Clear sealers 5) Acid-resistant applied coating	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Ceiling Materials													
		1	Non Acceptable Materials													
1720	Performance Criteria	1a	Surface-Applied Materials: 1) Gypsum plaster	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1721	Performance Criteria	1b	Unit Materials 1) Acoustic tile (ceramic and mineral, glass and wood fiber 2) Gypsum board in public areas only 3) Suspended plaster systems 4) Wood 5) Plastic 6) Rigid cellular glass blocks	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Door Materials													
		1	Non Acceptable Materials													
1722	Performance Criteria	1a	a. Anodized aluminum doors and frames b. Fluoropolymer finished doors and frames c. All upward-acting sectional doors d. All non-tempered, non-safety glass	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Smoke Exhaust Duct Cladding													
		1	Acceptable Materials													
1723	Performance Criteria	1a	a. Non-corrosize metal - natural brushed finish b. Non-corrosive metal with applied coating	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Unacceptable													
1724	Performance Criteria	2a	a. High polished stainless steel ceiling or smoke exhaust duct cladding	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Canopy Materials													
		1	Acceptable Materials													
1725	Performance Criteria	1a	Underground Station: 1) Stainless Steel - public areas 2) Painted galvanized steel - Ancillary areas	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1726	Performance Criteria	1b	Aboveground Stations: 1) Stainless steel - public areas 2) Painted galvanized steel - Ancillary non-public areas	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Nonacceptable													
1727	Performance Criteria		a. Aluminum b. Uncoated steel c. Uncoated galvanized steel d. Wood	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.8	**TOILET AND DRAINAGE SYSTEMS**													
		6.8.1	INTRODUCTION													
1728	Performance Criteria		Toilet facilities must be compliant with ADA, CBC and other applicable accessibility regulations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.8.2	BASIC GOALS													
1729	Performance Criteria	A	To provide toilet facilities for system staff with provisions for emergency access by patrons.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1730	Performance Criteria	B	To minimize maintenance, operations and security requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1731	Performance Criteria	C	To standardize plumbing fixtures and fittings throughout the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1732	Performance Criteria	D	To standardize toilet room accessories throughout the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1733	Performance Criteria	E	To standardize station drainage throughout the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1734	Performance Criteria	F	Provisions for individuals with disabilities	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.8.3	STAFF TOILET													
1735	Performance Criteria	A	Each underground station shall have one staff toilet. Each such toilet shall be located within the ancillary space adjacent to the station entrance passageway.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1736	Performance Criteria	B	A typical layout of staff toilet facilities is shown in Directive Drawings. Station planning requirements will, however, establish the specific layout required for each station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1737	Performance Criteria	C	Provision must be made for emergency use of toilet facilities by patrons, including the disabled, subject to the controls described elsewhere in these criteria. To accommodate the elderly and the disabled toilet rooms shall meet the requirements of ADAAG and Title 24 (CCR).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1738	Performance Criteria	D	Staff toilet rooms shall be located next to the staff security room.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1739	Performance Criteria	E	Locate a storage room next to the staff toilet with a plumbing wall in between, so that the storage facility can be converted to a toilet in the future. Provide floor drain in storage room.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1740	Performance Criteria	F	Each toilet room shall have the following accessories:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1741	Performance Criteria	F1	Paper towel dispenser and waste receptable, recessed type.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1742	Performance Criteria	F2	Soap dispenser, recessed type	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1743	Performance Criteria	F3	Toilet tissue dispenser, recessed type	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1744	Performance Criteria	F4	Toilet seat cover dispenser and sanitary napkin disposal, recessed type.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1745	Performance Criteria	F5	Sanitary napkin-tampon dispenser, recessed type.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1746	Performance Criteria	F6	Mirror and shelf	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1747	Performance Criteria	F7	Coat hook	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1748	Performance Criteria	F8	Grab bar	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1749	Performance Criteria	F9	Air dryer	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.8.4	TOILET FIXTURES AND TRIM (SEE DIRECTIVE DRAWINGS)													
		6.8.5	TOILET ROOM ACCESSORIES													
		A	General Requirements													
1750	Performance Criteria	A1	All necessary items shall be fully recessed into the wall. Maximum protection from finished wall shall not be greater than 5/8 inch.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1751	Performance Criteria	A2	All accessories shall be constructed of Type 302 or 304 stainless steel, heavy gauge unless otherwise noted. Exposed surfaces shall have No. 4 satin finish.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1752	Performance Criteria	A3	Toilet room equipment which requires manual operation by the disabled, such as toilet paper racks, towel dispensers, and disposer units, shall comply with the requiremenets of Title 24 (CCR).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Specific Requirements													
1753	Performance Criteria		Actual accessories to be used shall be uniform systemwide. They shall be covered by a standard specification.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.8.6	DRINKING FOUNTAIN													
1754	Performance Criteria		A drinking fountain will be provided in the Staff/Security Room, and ancillary areas. No drinking fountains for public use shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.8.7	DRAINAGE IN STATIONS													
		A	Entrances													
1755	Standard Criteria	A1	At entrances to underground stations, the first 25 ft (min) of floor under cover, shall be sloped at a minimum of 1% to drain toward the floor mat at the entrance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1756	Performance Criteria	A2	Recesses for stainless steel grating at the floor shall be provided, under cover, at all station entrances. The length of the grating shall equal the width of the entrance. The width of the grating shall be approximately 10 inches.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1757	Standard Criteria	A3	Access walkways to at-grade stations shall be sloped to drain positively, and shall not exceed a cross slope of 2%.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Concourse													
1758	Performance Criteria	B1	Except at entrances, floors shall be level in transverse direction and level or sloped to align with the structure in the longitudinal direction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1759	Performance Criteria	B2	Provide floor drains at all hose bibb locations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Platforms													
1760	Performance Criteria	C1	Platforms shall be level at right angles to the track and parallel with the structure in the longitudinal direction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1761	Performance Criteria	C2	Provide floor drains at all hose bibbs located at platforms which do not slope toward trainway. Pitch floor within 3'-0" of hose bibb towards drain at 1% rate.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Roof Areas													
1762	Standard Criteria	D1	Within the station, all roofs shall be pitched to drain. Underground structural ceilings shall be pitched at 2% minimum to provide for drainage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1763	Standard Criteria	D2	Water shall not be allowed to spill over the edge of exterior roofs, but shall be carried away by concealed leaders to the storm drainage system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.9	**SANITATION AND MAINTENANCE**													
		6.9.1	INTRODUCTION													
1764	Performance Criteria	A	The Maintenance and sanitation concept assumes that Metro will provide all necessary maintenance equipment and facilities regardless of whether the maintenance work forces consist of Metro Rail employees or contract personnel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1765	Performance Criteria	B	Station maintenance activities are classified under three general categories: 1. Inspection and Service 2. Preventive Maintenance 3. Corrective Maintenance Work under the first 2 categories will be performed on a prescheduled routine basis. Work under the 3rd category will be provided on an as-needed basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1766	Performance Criteria	C	Most station maintenance activities will be performed during revenue hours.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1767	Performance Criteria	D	Maintenance will be performed to those areas of station complex beyond the exterior surfaces of the station building, or buildings, including the canopies and other appendages thereto, and within the boundaries of the station site.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.9.2	BASIC GOALS													

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1768	Performance Criteria	A	To create easily maintained environments with high level of cleanliness throughout the system, which will instill pride and encourage the use of the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1769	Performance Criteria	B	To provide facilities for efficient maintenance program which operates at a minimum cost.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1770	Performance Criteria	C	To integrate maintenance elements in the stations as part of station design, without detracting from the appearance of the stations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1771	Performance Criteria	D	To provide uniform interchangeable facilities within each station or between stations where possible, to facilitate replacement of damaged items.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.9.3	GENERAL PRINCIPLES													
1772	Performance Criteria	A	Maintenance and operation programs requiring the use of trainway areas and equipment shall be avoided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1773	Performance Criteria	B	Horizontal ledges shall be avoided to minimize the collection of dust. Wherever possible in above-grade stations, the exposed top surfaces of outriggers, beams, parapets and window ledges, shall have a minimum slope of 30 degrees to horizontal in order to prevent the collection of dust and debris.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1774	Performance Criteria	C	Bases shall be flushed with wall or recessed. Provide cove base, integral with floor, not less than 6" high at all points of intersection between floors and walls, partitions, columns, and other surfaces in all public areas, and in toilet, custodial, trash and battery rooms.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1775	Performance Criteria	D	Handrails, door pulls, and other protruding elements shall have a 1-1/2 inch minimum clear space behind them.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1776	Performance Criteria	E	All station facilities and amenities shall be designed and located to require limited maintenance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1777	Performance Criteria	F	Signs, advertising panels, and art work shall be designed and located to require limited maintenance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1778	Performance Criteria	G	Cleanouts and access panels shall be located inconspicuously and, where possible, placed in pipe chases and nonpublic areas. In public areas, panels shall be provided with locks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1779	Performance Criteria	H	Wall mounted items of equipment, including movable equipment, shall be flish. Such equipment must be accessible to persons with disabilities, including wheelchair users.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1780	Performance Criteria	I	Notches in walls for flush mounted equipment shall not extend down to the floor unless necessary to provide access for persons with disabilities. Bottoms of such notches shall not be less than 6" above the adjacent and floor at any point.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1781	Performance Criteria	J	Structural and architectural elements which must project from walls shall be held at least 12" above the floor to facilitate cleaning. Where an element must project more than 3" from a wall, verify that floor and wall surfaces below or adjacent to the projecting element are accessible for cleaning using equipment listed in the specific Metro Rail Station Maintenance Plan.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1782	Performance Criteria	K	Signs, handrails, benches, ect. Shall be securly anchored with tamperproof screws or bolts. If heads must be exposed, use flush spannerhead screws. Use Allen-head screws if heads are concealed from view.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1783	Performance Criteria	L	Duplex receptables for maintenance tools at the platform area shall be installed at columns or mapcases.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1784	Performance Criteria	M	Separate trash receptables are to be provided for normal refuse, recyclable newsprint or other items at designated locations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1785	Performance Criteria	N	Standard trash receptables are to appropriately signed and installed adjacent to station entries, concourses, platforms and walkways.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.9.4	SPECFIC REQUIREMENTS													
		A	Entrance													
1786	Standard Criteria	A1	Provision shall be made at each entrance for a 110-volt ac waterproof outlet and a 3/4" hose bibb in adjacent locked stainless steel cabinets.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1787	Performance Criteria	A2	Trash Receptacles shall be located at all entrances, bus drop-off areas, Kiss-and-Rise areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Concourse													
1788	Performance Criteria	B1	Pairs of utility outlets consisting of a 3/4" hose bibb and a 110-volt ac waterproof outlet shall be provided throughout public and ancillary spaces, located so that no portion of floor area is more than 100 ft from such a pair.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1789	Performance Criteria	B2	Metro standard trash receptables shall be located at key points where people stop; at vending machines, fare gates, seating areas, ect.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1790	Performance Criteria	B3	Architectural Standards and Directive Drawings indicate specific details and recommended mounting locations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Custodial Room and Custodial Closet in Underground Station													
1791	Performance Criteria		These rooms shall be located close to the elevators. Two facilities are required at each station, one at concourse/passageway and one at platform level.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1792	Performance Criteria	C1	Custodial Room: Items in this area shall include:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1793	Prescriptive Spec	C1a	Mop sink - 36" x 24", floor-mounted with 6" high rim and stainless steel rimguard, waste connection fitting.													
1794	Prescriptive Spec	C1b	Hot and cold water, single spout with pail hook at 3'-0" above bottom of mop sink, equipped with 4'-0" length low-pressure hose.													
1795	Prescriptive Spec	C1c	Floor drain													
1796	Prescriptive Spec	C1d	110-volt ac waterproof directly adjacent to scrubber storage space.													
1797	Prescriptive Spec	C1e	Two adjustable shelves 10'-0" minimum x 1'-0" deep for storage of cleaning supplies.													

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1798	Prescriptive Spec	C1f	Two adjustable shelves 6'-0" minimum x 1'-6" deep for storage of toilet supplies, ect.													
1799	Performance Criteria	C1g	Ten sets of stainless steel cam-action tool holding clips.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1800	Performance Criteria	C1h	Space for double bucket and vac-scrubber machine.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1801	Performance Criteria	C1i	See Custodial Room Layout, Directive Drawings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Trash Room in Underground Station													
1802	Performance Criteria		This room is to be located at the concourse/passageway level in close proximity to the elevator. Items in this area shall include:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1803	Prescriptive Spec	D1	110-volt ac waterproof outlet.													
1804	Prescriptive Spec	D2	Cold water hose bibb, 3'-0" above water.													
1805	Performance Criteria	D3	Floor drain under hose bibb.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1806	Performance Criteria	D4	Ventilation: Provide mechanical ventilation per Section 8.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1807	Performance Criteria	D5	Sprinkler System: (See Fire/Life Safety Criteria)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1808	Prescriptive Spec	D6	3'-6" x 7'-0" access door.													
1809	Performance Criteria	D7	See trash room layout, directive drawings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Platform													
1810	Standard Criteria	E1	Pairs of locked stainless steel utility cabinets shall be located throughout this area. See Section 6.9.4.B for description and spacing requirements, similar to concourse areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1811	Standard Criteria	E2	Metro standard trash receptacles shall be located on each platform. See Architectural Standard and Directive Drawings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.10	**SIGNAGE AND GRAPHICS**													
		6.10.1	INTRODUCTION													
1812	Standard Criteria	A	All signage shall be ADAAG compliant for readability and accessibility. All signage and graphics shall fully conform to the most current version of the Metro Signage Standards as developed by Metro Arts and Design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1813	Standard Criteria	B	Design and location of signs and graphics shall be uniform throughout the Metro Rail System, and shall conform to Metro Signage Standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1814	Performance Criteria	C	Messages shall be simple, clear, and concise.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1815	Performance Criteria	D	Signs shall have precedence over artwork and advertising with regard to their location and prominence.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1816	Performance Criteria	E	Certain sings shall have priority over others, such as, signs directing passengers to normal and emergency exits.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.10.2	BASIC GOALS													
1817	Performance Criteria	A	To guide passengers through the system in the most efficient and least complicated manner.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1818	Performance Criteria	B	To provide orientation and information required by the passenger to aid directional decision-making.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1819	Performance Criteria	C	To provide a safe trip for passengers, and to warn passengers and non-passengers of potential system hazards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1820	Performance Criteria	D	To provide fast safe exit in case of emergency.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1821	Performance Criteria	E	To allow passengers to know where they are and where they are going, at all times.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1822	Performance Criteria	F	Critical signs, such as those with warning and emergency information, shall be provided in both English and Spanish.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1823	Performance Criteria	G	There shall be a minimum of 1 station identifier (Metro Pin) per entrance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1824	Performance Criteria	H	Messages, type faces, colors, materials of signs and Metro Pin station identifier shall be uniform to assure legibility and clarity of messages for efficient functioning of the overall station as well as economical purchase of the signs and their long term maintenance per Metro Signage Standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1825	Performance Criteria	I	As the individual station design is developed, a signing layout shall be prepared by the Designer in cooperation with Metro for all signs and provision of electrical power, where required, shall be the responsibility of the Designer unless specifically noted otherwise and shall be reviewed and approval by Metro Arts and Design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1826	Performance Criteria	J	Transit Passneger Information System (TPIS) is required in all stations to provide transit information as well as limited advertising messages.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1827	Performance Criteria	K	Artwork shall be coordinated with signing to avoid conflicts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1828	Performance Criteria	L	Signage shall be located so as to not obstruct the view of motorist, pedestrian, and train operator.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.10.3	DEFINITIONS													
		6.10.4	GENERAL REQUIREMENTS													

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1829	Performance Criteria	A	Signs shall conform to Metro Signage Standards and be reviewed and approved by Metro Arts and Design during the design stages of the Project. All signage must meet applicable accessibility requirements, including ADA, CBC and other applicable codes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1830	Performance Criteria	B	Signs shall be kept to the minimum necessary for passenger guidance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1831	Performance Criteria	C	The message on each sign shall be consise, clear and simple for easy understanding. International signs and symbols shall be utilized only as necessary, and defined.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1832	Performance Criteria	D	Signs shall occur at key points of separation and at intervals frequent enough to allow passengers of any station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1833	Performance Criteria	E	Sign design shall be uniform for Metro Rail system to aid immediate recognition by the passenger of any station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1834	Performance Criteria	F	Signs shall meet accessibility standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1835	Performance Criteria	G	Signs shall neither conflict with nor obstruct traffic control devices.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.10.5	SIGNAGE SYSTEM													
1836	Performance Criteria		The Designer shall follow the signage system noted in the most current vision of Metro Signage Standards, both constructed/fabricated items and text, for furnishing to the Contractor for application to the project.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.11	**STATION CONTROL**													
		6.11.1	INTRODUCTION													
1837	Performance Criteria		This section describes the supervision, administration, security, and monitoring requirements of stations and how they shall be accommodated in the station design as presently anticipated.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.11.2	BASIC GOALS													
1838	Performance Criteria	A	To provide for public safety	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1839	Performance Criteria	B	To ensure efficient operation of the station and to provide optimum service to patrons.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1840	Performance Criteria	C	To deter crime and vandalism	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1841	Performance Criteria	D	To accomplish the above with a minimum of manpower by utilizing automatic devices and remote control equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.11.3	PLANNING CONSIDERATIONS													
		A	General Considerations													
1842	Performance Criteria	A1	All stations shall be designed to not require the presence of a station agent.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1843	Performance Criteria	A2	The station design shall eliminate nooks, recesses, and "places to hide", wherever possible to minimize surveillance problems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1844	Performance Criteria	A3	Station supervision and administration functions shall be handled by remote control systems, closed circuit television, passenger assistance telephones, and public address systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Underground Stations													
1845	Performance Criteria	B1	All underground station entrances, including entrances to pedestrain bridges, must be capable of being closed each day by means of rolling grills.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1846	Performance Criteria	B2	Main entrances shall be capable of remote unlocking and opeing from Central Control and the station emergency management panel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1847	Performance Criteria	B3	Elevators shall dwell at concourse level when shut down, and subject to remote unlocking and starting from Central Control and the station emergency management panel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Aboveground Stations													
1848	Performance Criteria	C1	Design of passenger stations shall be open, with long, unbroken lines of sight, eliminating all dark or obscure areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1849	Performance Criteria	C2	Any equipment or surfaces accessible to the public such as fare machines, emergency or passenger assistance telephones, shall be of rugged, vandal-resistant design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1850	Performance Criteria	C3	Means shall be provided for two-way voice communications.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1851	Performance Criteria	C4	Illumination levels shall be selected to maintain the level of security in stations during non-daylight hours.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.11.4	RAIL OPERATIONS CONTROL (ROC)													
1852	Performance Criteria		The Rail Operations Control shall control and monitor traction power systems, train controls, communications, and CCTV Security monitoring functions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1853	Performance Criteria	A	Security functions of the Rail Operations Control and Transit Police Dispatch Center. Responsibilities include:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1854	Performance Criteria	A1	Supervision of Passenger Activity	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1855	Performance Criteria	A1a	Monitoring and controlling closed circuit television equipment (CCTV).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1856	Performance Criteria	A1b	Monitoring fare vending and fare collecting activities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1857	Performance Criteria	A1c	Providing information and assistance to patrons.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1858	Performance Criteria	A1d	Acting in emergencies such as illness or assault.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1859	Performance Criteria	A1e	Reversing fare gates and monitoring escalators as required for changing traffic flow.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1860	Performance Criteria	A1f	Controlling entrance and exit of special personnel, disabled patrons.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1861	Performance Criteria	A1g	Monitoring and activation of elevators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1862	Performance Criteria	A2	Supervision of Station Operation and Security	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1863	Performance Criteria	A3	Transit Police Dispatch Center	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.11.5	STAFF/SECURITY ROOM IN UNDERGROUND STATION													
		6.11.6	FARE GATES, GATE TELEPHONES (G-TEL) AND FENCES													
1864	Prescriptive Spec	A	Height of fence adjacent to fare collection gates shall be:													
1865	Prescriptive Spec	A1	5'-0" in all conditions													
1866	Performance Criteria	A2	Fences shall visually open to provide surveillance	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1867	Performance Criteria	B	Portions of barriers, which are to be removed in future to accommodate additional fare gates, shall be constructed on a modular system based on the width of the fate gate unit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1868	Performance Criteria	C	Where bars, slats or pickets are used, the maximum spacing shall be a 4" on center opening.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1869	Prescriptive Spec	D	Fences shall be a maximum 5'-0" high adjacent to fare gates.													
1870	Performance Criteria	E	Fare gate, G-TEL and fence barrier locations and layout for Subway, Aerial, and At-Grade stations, see Metro Architectural Standard and Directive Drawings for HRT and LRT.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.11.7	STATION CLOSEDOWN													
		A	Underground Stations													
		B	Aboveground Stations													
		6.11.8	PRIVATE ENTRANCES													
1871	Performance Criteria		Refer to Metro Adjacent Construction Design Criteria	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.11.9	SECURITY ALARMS AND LOCKS													
		6.11.10	SECURITY AREAS													
		6.12	**PEDESTRIAN CIRCULATION, PARKING FACILITIES AND SITEWORK**													
		6.12.1	INTRODUCTION													
1872	Performance Criteria		The location and boundaries of station sites, adjacent street improvements, and station location shall be established by the Designer and set forth on the Preliminary Engineering Plans for each station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.12.2	BASIC GOALS													
1873	Performance Criteria		Site designs adhere to the architectural concept of a systemwide cost effective approach to design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.12.3	PRIORITY ACCESS MODES													
		A	General													
1874	Performance Criteria		Since all modes of access to a station cannot be given equal priorities, a hierarchy has been established, measured by the convenience of access and proximity to station entrances from the various modes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Pedestrians													
1875	Performance Criteria		The pedestrian mode shall be given first priority for reasons of safety.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Bicycles													
1876	Performance Criteria		Bicycle mode shall be given second priority. Bicycle parking shall be as close as possible to the station entrances.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Buses													
1877	Performance Criteria		Bus access to and from the site shall not be compromised by other modes of transportation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Kiss-and-Ride													
1878	Performance Criteria		Second vehicular priority shall be given to the Kiss-and-Ride facility and Kiss-And-Ride spaces shall be as close to the station entrance as possible without interfering with the bus facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Park-and-Ride													
1879	Performance Criteria		Whenever possible, the walking distance from the station entrance to the most remote parking space shall not exceed 1,320 ft.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		G	Summary													
		6.12.4	PEDESTRIAN ACCESS													
		A	General													
1880	Standard Criteria		The pedestrian access to the station shall be as direct and safe as possible, and shall be accessible in accordance with ADAAG and Title 24 (CCR).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Approaches													
1881	Prescriptive Spec	B1	Pedestrians crossings at streets wider than 4 lanes shall have a refuge area at least 4 ft wide between opposing lanes, and shall allow easy use by all patrons.													
1882	Prescriptive Spec	B2	The width of the crossing shall be at least equal to the width of the adjacent pedestrian walk, but not less than 7 ft.													
1883	Performance Criteria	B3	Pedestrian crosswalks shall have good visibility for both pedestrians and drivers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1884	Performance Criteria	B4	No pedestrian walkways shall have a slope greater than 5%.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1885	Performance Criteria	B5	No pedestrian ramp shall have a slope greater than 8.33%.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1886	Performance Criteria	B6	Parking areas shall be arranged to minimize the number of pedestrian crossings of streets and access roads which carry vehicular traffic.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		C	Walkways													
1887	Performance Criteria	C1	Isolated and remote or hidden pedestrian walkways shall be avoided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1888	Performance Criteria	C2	Effective width of exterior walks equals total width minus obstatcles. An additional 1'-0" foot fringe area per side shall be subtracted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1889	Performance Criteria	C3	Walks shall have a continous surface.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1890	Standard Criteria	C4	Walkways crossing rail tracks to reach station platform shall be level and flush with the top of rail at the outer edge and between rails, except for a maximum 2-1/2" gap on the inner edge of each rail to permit passage of wheel flanges. Such crosswalks shall be defined by a continuous detectable warning strip 36" wide in the direction of travel and in compliance with ADAAG Section 705, Detectable Warnings and 406, Curb Ramps, and Title 24 (CCR)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1891	Prescriptive Spec	C5	The boundary between the areas shall be bounded by a continuous detectable warning strip which is 36" wide in the direction of travel.													
1892	Prescriptive Spec	C6	The recommended width of pedestrian walkways shall be as follows: - Walkways over tracks: 15'-0" (preferred), 10'-0" minimum - Walkways through bus stop areas: 12'-0" (preferred), 8'-0" minimum - Walkways adjacent to long-term parallel parking: 8'-0" (preferred), 6'-0" minimum - Walkways adjacent to short-term parallel parking: 10'-0" (preferred), 8'-0" minimum - Crosswalks: 12'-0" (preferred), 10'-0" minimum													
1893	Performance Criteria	C7	Warining signs or signals shall be provided on Pedestrian gates at crossings of light rail and/or railroad tracks, as well as adjacent roadways in accordance with Traffic Control section of this criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.12.5	BICYCLE ACCESS													
		A	General													
1894	Performance Criteria		In all cases, bicycle access shall be as direct and safe as possible.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1895	Performance Criteria	A1	Provisions shall be made for access to and from stations by bicycle parking, wayfinding signage within Metro property, and other facility desgin elements at station sites.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Bicycle Parking													
1896	Performance Criteria	B1	Bicylce parking shall consist of the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1897	Performance Criteria	B1a	Short-term Parking - An inverted-U bicycle rack that allows 2 bicycles to be securly affixed to the rack.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1898	Performance Criteria	B1b	Long-term (paid-secure) bicycle parking - requires a fee payment. Two types of paid-secure bike parking are:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1899	Performance Criteria	B1b1	A bicycle locker allows for the secure-access and storage of a single bicycle to one or more registered users at one time. The standard bicycle locker material and finish shall be stainless steel with 50% openness.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1900		B1b2	Metro Bike Hub - access is granted to registerd users.													
1901	Performance Criteria	B1c	Smart bike parking systems and solutions that offer more security options than short-term bike racks but require less space than bike lockers may be proposed and considered.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1902	Performance Criteria	B1d	Bicycle Parking Baseline Specifications - Refer to Metro Systemwide Baseline Section 12 93 12 for specifications for Bicycle Lockers and Racks and Enclosed Bike Parking.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1903	Performance Criteria	B1e	Bike Module Floor Plan - Refer to AS-013 Standard Drawing for space requirements when designing bicycle parking facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1904	Performance Criteria	B2	Required number of Bicycle Parking Spaces: For each station, bicycle parking spaces shall be provided for current/operating year, as defined in the project environmental analyses for both short-term and long-term (paid secure) bike parking.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1905	Performance Criteria	B2a	Formula and guidance shall be used:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1906	Performance Criteria	B2a1	Formula to determine Total Required Bicycle Parking Spaces: Number of total bike parking spaces shall equal peak period boardings multiplied by bicycle access mode share.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1907	Performance Criteria	B2a1a	Peak period boardings: Projected three-hour AM (6-9) or four-hour PM (3-7) peak boarding, whichever is larger	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1908	Performance Criteria	B2a1b	Bicycle access mode share (%): 2.5% for current/operating year demand and 4% of Future demand.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1909	Performance Criteria	B2a1c	Alternative bike parking demand supported by station site-specific analyses and supplemented by community input while meeting minimum quantity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.12.6	VEHICULAR ACCESS													
		A	General													
1910	Performance Criteria	A1	Entrances to sites shall be from secondary roads where possible, with provision for queuing space provided at their intersections with arterial roads.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1911	Prescriptive Spec	A2	Separate access points into the site from the same street shall be at least 150 feet apart.													
1912	Performance Criteria	A3	Use of residential streets for entrance sites shall be avoided if possible. If residential streets must be designated as access roads, provisions must be made to mitigate impact to local residential traffic patterns.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Separation of Access Modes													
1913	Performance Criteria		Separation of vehicular modes of access shall be provided whenever possible due to the differing circulation needs and priorities assigned to buses, Kiss-and-Ride, and Park-and-Ride.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.12.7	BUS FACILITIES													
		A	General													
1914			Uses shall be given priority in terms of vehicular access.													
		B	Separation of Access Modes													

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1915	Performance Criteria	B1	Bus lanes shall be one-way only through the station site.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1916	Prescriptive Spec	B2	Bus lanes shall be 20 feet wide minimum to allow buses in motion to pass stalled buses.													
		C	Bus Bays													
1917	Performance Criteria	C1	Sawtooth bus bays will be used in off-street bus terminals only.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1918	Performance Criteria	C2	Bus bays shall be designed to allow loading and unloading of passengers from the right side of the bus to pedestrian paths.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1919	Performance Criteria	C3	Bus bays will be oriented so that bus patrons do not need to cross traffic to reach the station entrance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Free Body Transfer													
1920	Performance Criteria	D1	Free body transfer is the term used for separate and unrestricted access to and from stations to the bus areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1921	Performance Criteria	D2	If Metro decides to implement free body transfer, since fares are not collected at these points, fare gates or some form of barrier outside of the station entrance must be provided to separate the bus passengers from other transit patrons who will be paying fares or using transfers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.12.8	KISS-AND-RIDE FACILITIES													
		A	General													
1922	Performance Criteria	A1	Convenience, safety and appropriateness to the overall site and neighborhood are prime design objectives.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1923	Performance Criteria	A2	Kiss-and-Ride facilities shall have second priority in vehicular access and where possible shall have separate access points.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1924	Performance Criteria	A3	If provided, must have a designated area for persons with disabilities as specified in the ADAAG.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Access Roads													
1925	Performance Criteria	B1	Access roads shall be single lane, yet allow space to maneuver around a stopped vehicle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1926	Performance Criteria	B2	When possible, the Kiss-and-Ride vehicle shall be able to recirculate on-site in the event a space is not available.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1927	Performance Criteria	B3	Kiss-and-Ride traffic shall not be routed through the Park-and-Ride areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Configuration													
1928	Performance Criteria	C1	When possible, Kiss-and-Ride spaces shall be oriented so that the waiting driver can watch the station exit. See Civil Criteria for Parking Stall Dimensions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1929	Performance Criteria	C2	Although drive-through spaces promote better circulation, the fact that many people will exchange seats with the initial driver and that Kiss and-Ride spaces will be used for short-term parking (probably metered) during the nonpeak hours, site constraints will dictate whether drive-through or dead-end spaces are provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1930	Performance Criteria	C3	Drop off zones shall be incorporated into the Kiss-and-Ride areas to promote better a.m. services and for taxis when they cannot use Kiss and-Ride spaces in the nonpeak hours.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.12.9	PARK-AND-RIDE FACILITIES													
		A	General													
1931	Performance Criteria	A1	Park-and-Ride facilities shall be provided at designated stations. The amount of parking space at a particular station will depend upon the traffic potential, the ability of the street system to feed the station, and availability of land. (See Preliminary Engineering Drawings for specific station requirements.)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1932	Performance Criteria	A2	Parking facilities may be at-grade, at-grade initially with provision for structured parking in the future, or structured parking with expansion capability. Refer to station-specific Plans for Park-and-Ride requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1933	Performance Criteria	A3	If paid parking is incorporated in the Park-and-Ride areas, payment for parking shall be made when the vehicle exits the area or by some metering method. Though installation of control devices may not be made initially, the ability to have paid parking at or near the parking stalls or upon exit must be designed into all Park-and-Ride facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1934	Performance Criteria	A4	The facilities for Park-and-Ride shall be designed for self-parking.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	At-Grade Parking													
1935	Performance Criteria	B1	Large parking lots shall be subdivided into sections to reduce the scale. Walkways and landscaping may be used for this purpose. However, vehicular movement from each section to the next shall not be restricted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1936	Performance Criteria	B2	Although landscaped, the parking areas shall be open enough to maintain good surveillance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Parking Structures													
1937	Performance Criteria	C1	Parking garages shall be concrete structures and conform to the criteria set forth in Paragraph 6.12.9.A.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1938	Performance Criteria	C2	Space shall be provided for minimum two (2) elevators in the event the parking structures exceed 3 levels (2 levels above-grade).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1939	Performance Criteria	C3	Elevator locations shall be as close as practical to the station entrance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1940	Performance Criteria	C4	Parking structures shall conform to the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1941	Prescriptive Spec	C4a	Minimum vehicular clearance height 7 feet 0 inches													
1942	Standard Criteria	C4b	Ramp Grades per California Building Code (CBC) and City requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1943	Prescriptive Spec	C4c	Width of entrance/exit lanes 12 feet													
1944	Prescriptive Spec	C4d	Aisle turning radii 16 feet inside, 30 feet outside													
1945	Prescriptive Spec	C4e	Curb height 6 inches.													
1946	Performance Criteria	C5	Parking garages that include parking for Metro transit customers shall comply with signage and wayfinding in conformance to Metro Signage Standards (refer to Section 6.10 Signage and Graphics).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.12.10	FACILITIES FOR ELDERLY AND DISABLED													
		A	General													
1947	Performance Criteria	A1	These provisions are intended to make all station sites and facilities used by the public accessible to and functional for the elderly and disabled.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1948	Performance Criteria	A2	Parking spaces as close as practical to the station entrance shall be set aside and identified in the Park-and-Ride area for use by individuals with physical disabilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1949		A3	See Civil Design Criteria for additional requirements.													
		B	Parking Facilities													
1950	Standard Criteria		Accessible parking spaces shall be provided in accordance with ADAAG Sections 502 and 208, Parking Spaces, and Title 24 (CCR).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1951	Standard Criteria		Accessible parking spaces shall be located as near as practical to a primary entrance to a facility (building or boarding platform). The space shall be located so that a person with a disability does not wheel or walk behind parked cars other than his/her own. Pedestrian ways shall be provided so as to ensure an accessible pathway from each such parking space to the facility; walks and sidewalks shall conform to ADAAG Section 403, Walking Surfaces.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1952	Prescriptive Spec		Number of Accessible Parking Spaces: <u>Minimum Total No. of Parking Spaces</u> --> <u>Spaces Required</u> 1 to 25 --> 1 26 to 50 --> 2 51 to 75 --> 3 76 to 100 --> 4 101 to 150 --> 5 151 to 200 --> 6 201 to 300 --> 7 301 to 400 --> 8 401 to 500 --> 9 501 to --> 2% of total 1001 + --> 20 +1 for each 100 over													
		C	Walkways													
1953	Performance Criteria	C1	Ramps and curb cuts shall be provided as required to provide safe, smooth transition of finish grade, and convenient circulation by the patrons with disabilities to and from the station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1954	Standard Criteria	C2	For details of curb cuts, refer to Title 24 (CCR) and Caltrans Specifications, and to ADAAG Section 406, Curb Ramps, of ADA Accessibility Guidelines.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.13	**VEHICLE DATA AND CLEARANCES (SEE DIRECTIVE DRAWINGS)**													
		6.14	**VERTICAL CIRCULATION**													
		6.14.1	INTRODUCTION													
1955	Performance Criteria		This section lists the main principles and standards relevant to the design of vertical circulation including escalators, elevators, stairs, and pedestrian ramps.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1956	Performance Criteria	A	All stations shall require some form of vertical circulation, in the form of ramps, stairs, escalators and elevators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1957	Performance Criteria	B	Escalators and stairs must be so situated that they carry passengers directly to the platform at a location convenient for boarding their particular train. Changes of direction shall be avoided when possible. These vertical elements must be strategically located at all levels to make this direct route possible.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1958	Performance Criteria	C	Ultimate quantity of stairs and escalators required in the foreseeable future shall be determined. Even though only some of these escalators shall be installed when the system opens to accommodate Design Year loading, the station design must be such that it shall permit the ultimate quantity to be installed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1959	Performance Criteria	D	At underground stations, elevators from street level to concourse level, and from concourse level to platform level, and for aerial stations elevator from street to platform, shall be provided as required to make the system accessible to the disabled, and for use by Metro Rail personnel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1960	Standard Criteria	E	Vertical circulation elements shall be accessible in compliance with relevant ADAAG and Title 24 (CCR) requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1961	Performance Criteria	F	At-grade stations shall have, in order of preference, sloping sidewalks, ramps, and/or stairs. Besides stairways, grade-separated or aerial stations, depending on height, shall require other vertical circulation elements such as elevators or escalators or both.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.14.2	BASIC GOALS													
1962	Performance Criteria	A	Safety, achieved through proper relationship of basic vertical circulation elements and the details of construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1963	Performance Criteria	B	Maximum convenience for patrons, achieved through the establishment of uniform circulation patterns throughout the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1964	Performance Criteria	C	Comfort, achieved through proper sizing and layout of the vertical circulation elements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1965	Performance Criteria	D	Facilities designed to provide for the patrons with disabilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1966	Performance Criteria	E	Standard design to facilitate maintenance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1967	Performance Criteria	F	Interim maintenance and warranty maintenance scope of work must include the following. Required maintenance shall be of the same standard as all other Metro transit elevators and escalators, and shall include Metro's standard maintenance check charts as shown in Attachments C and D. The interim and warranty maintenance scope of work shall also cover all repairs and damages above and beyond regular maintenance including vandalism for the period of one year beginning with ROD.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.14.3	STATION LAYOUT REQUIREMENTS													
1968	Performance Criteria	A	All stations must have at least one main accessible entrance/exit to the street level plus either one additional entrance/exit for regular use or one emergency exit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1969	Performance Criteria	B	Where changes in level occur escalators and stairs shall be provided in accordance with the following minimum criteria: Two (2) stairs and two (2) escalators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1970	Performance Criteria	C	Additional stairs and escalators shall be provided between the platform and concourse and between the concourse and street to clear the platform of detraining passengers prior to the arrival of the next train.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1971	Performance Criteria	D	The capacities of vertical circulation elements shall be assumed as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1972	Prescriptive Spec	D1	Escalators: 48 inches nominal width:													
1973	Prescriptive Spec	D1a	Per Exit Lane "Up" Direction capacity - 35 ppm Travel speed - 50 fpm													
1974	Prescriptive Spec	D1b	Per Exit Lane "Down" Direction capacity - 40 ppm Travel speed - 60 fpm													
1975	Prescriptive Spec	D2	Stairs and Ramps Over 4 Percent Slope: 22 ppm (per 22 inch-wide exit lane).													
1976	Prescriptive Spec	D3	Horizontal Corridors and Ramps under 4 Percent Slope: (per 22 inch wide exit lane). Per Exit Lane capacity - 50 ppm Travel speed - 200 fpm. Note: For ramps and horizontal corridors, a 1 foot 0 inch buffer space shall be provided at side walls, and shall not be considered as exit lane space.													
1977	Prescriptive Spec	E	An unobstructed run-off or queue space shall be provided at each end of all stairs and escalators. Where stairs and/or escalators oppose one another at the same level, the total unobstructed run-off/queue space may be reduced by 25 percent. (See Table 6.3 herein).													
1978	Prescriptive Spec	F	All vertical circulation elements shall comply with the requirements as referenced under Codes Section; and under Metro Fire/Life Safety Criteria.													
1979	Prescriptive Spec	G	Elevators or ramps shall be required in all stations, from the street level to concourse level and from concourse level to each platform level, to provide access for maintenance equipment and those patrons who would have difficulty using stairs or escalators.													
1980	Prescriptive Spec	H	Handrails for ramps shall be continuous, 34 to 38-inches in height.													
1981	Prescriptive Spec	I	Guardrails for ramps shall be continuous, min. 42-inches in height.													
		6.14.4	STAIRS FOR UNDERGROUND AND ABOVE GROUND													
		A	General Requirements													
1982	Performance Criteria	A1	Noncombustible materials shall be used for stair construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1983	Performance Criteria	A2	All treads, landings, and nosings shall have slip-resistant surfaces.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1984	Prescriptive Spec	A3	At least one shallow sloping trough, 3-inches wide, shall be provided at the side of each surface to concourse stair to facilitate cleaning. Treads of stairs exposed to the weather shall have a one-half (0.5) percent slope sideward toward the trough.													
		B	Standard Stair Widths (Minimum)													
1985	Prescriptive Spec	B1	For Public Use: 5 feet 6 inches.													
1986	Prescriptive Spec	B2	For Service Stairs (staff use only): 3 feet 8 inches.													
1987	Prescriptive Spec	B3	Emergency Stairs: 3 feet 8 inches.													
1988	Prescriptive Spec	B4	Emergency stairs adjacent to Area of Rescue: 4 feet 7 inches minimum (48 inches between handrails).													
		C	Stair Landings													
1989	Prescriptive Spec	C1	For straight run stair, minimum and recommended length of landing: 4 feet 0 inches.													
1990	Performance Criteria	C2	For return stair, minimum width of landing must be at least equal to width of stair.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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1991	Performance Criteria	C3	Concealed reverse landings will be avoided in public stairs.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Treads and Risers													
1992	Performance Criteria	D1	Public stairs running parallel to and adjoining escalators shall have a tread and riser relationship with a component of 30 degrees.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1993	Performance Criteria	D2	All other public stairs shall have a tread and riser relationship with a component within the comfort range of from 30 degrees to 35 degrees.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1994	Performance Criteria	D3	The maximum height of riser at public stairs shall be 7-inches. Minimum tread shall be 11 inches.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1995	Performance Criteria	D4	Number of risers in any one run of public stairs shall not exceed 22.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1996	Performance Criteria	D5	Number of risers in any one run of public stairs shall not exceed 22.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1997	Performance Criteria	D6	Tread and riser dimensions shall be uniform in any one stair.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1998	Performance Criteria	D7	Minimum allowable number of risers: three. Where a change in elevation is less than 18 inches, a ramp shall be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1999	Performance Criteria	D8	Minimum headroom at public stairs measured vertically from the line of nosings: 8 feet 6 inches. Continuous soffits, without obstructions, shall be held to 10 feet 0 inches.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2000	Performance Criteria	D9	Emergency stairs shall have a maximum 7 inch riser and a minimum 11 inch tread. The number of risers in any one run of stairs shall not exceed 20. The minimum clear headroom shall be not less than 6 feet 8 inches measured perpendicular to the tread at nosing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2001	Performance Criteria	D10	Tread riser formula: The ratio of risers to treads shall fall within the following limits: 2R + T = 24 to 25.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2002	Performance Criteria	D11	The upper approach and all treads of exterior stairs is marked with a strip of clearly contrasting color a minimum of 2" in width a maximum of 1" from the tread nose or landing. The upper approach and lower tread of interior stairs shall have contrasting color striping a minimum of 2" in width and a maximum of 1" from the tread nose or landing. All contrasting color strips are at least as slip resistant as the other treads of the stair."	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Handrails													
2003	Prescriptive Spec	E1	Height of railing: shall be uniform, not less than 2 feet 10 inches and not more than 3 feet 2 inches measured vertically from the top of the tread, at the nosing, to the top of the handrail. (2 feet 10 inches at landings and 3 feet 8 inches around well openings or concourse edge.)													
2004	Prescriptive Spec	E2	Handrails may extend a maximum of 3-1/2 inches into required stair width.													
2005	Prescriptive Spec	E3	Handrails, except center handrails, shall be continuous through landings for the full length of the stair.													
2006	Prescriptive Spec	E4	Handrails shall extend a minimum of 12 inches beyond the top riser and 12 inches + 1 tread width beyond the bottom riser.													
2007	Prescriptive Spec	E5	Continuous handrails must be provided on both sides of all stairs.													
2008	Prescriptive Spec	E6	Maximum allowable stair width without a center handrail: 7 feet 4 inches. Center handrails shall be provided on narrower stairs where needed or required to aid circulation. All stairs (except monumental stairs) in excess of 7 feet 4 inches wide must have center handrails spaced no more than 7 feet 4 inches apart.													
2009	Prescriptive Spec	E7	Where a balustrade is not solid, the distance between vertical balusters must not exceed 4 inches.													
2010	Prescriptive Spec	E8	Handrail ends shall be returned to wall, or curved down 90 degrees where free-standing.													
2011	Performance Criteria	E9	Handrail material in public areas shall be #4 brushed finish stainless steel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2012	Performance Criteria	E10	At public stairs avoid horizontal design of intermediate rails, to avoid ladder type effect, to discourage children to climb rail.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2013	Performance Criteria	E11	Center handrails at public entrance stairs in underground stations shall have illuminated linear LED light, shall have air space between rail and light fixture, and shall comply with ADA requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.14.5	PEDESTRIAN WALKWAYS AND RAMPS													
2014	Prescriptive Spec	A	Sloping walkways not to exceed 1 foot 0 inches in 20 feet 0 inches (5%) maximum. Ramps not to exceed 1 foot 0 inches in 12 feet 0 inches (8.33%) maximum.													
2015	Prescriptive Spec	B	Ramps (slope greater than 5%) must meet code requirements for ramps landings, for each 2'-6" vertical rise maximum, including slope, edge protection, etc.													
2016	Standard Criteria	C	General requirements for ramp widths, landings, and handrails are as noted for stairs. See provisions for individuals with Disabilities section of these criteria for ramp requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2017	Standard Criteria	D	Surface of ramps shall be slip-resistant. Coefficient of friction shall be 0.8 per ADAAG.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2018	Performance Criteria	E	Cleaning trough not required for ramps.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.14.6	ESCALATORS													
		A	General Requirements													

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		A1	Escalators may be furnished and installed under a separate systemwide contract.													
		A2	Direction - dual direction													
		A3	Width - All escalators shall be 48 inches nominal width.													
		A4	Speed and Capacity													
2019	Performance Criteria		The speed of escalators shall be 90 feet per minute (fpm) in both "up" and "down" directions. They shall be capable of operating 24 hours nonstop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A5	Rise and Slope													
2020	Performance Criteria		Rise (H) is the true vertical distance between working points (W.P.). All escalators shall be installed with the line of stop nosings 30 degrees from the true horizontal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A6	Structural Considerations													
2021	Performance Criteria		A slip connection at the head of escalators in above ground stations, and at the foot of escalators in below ground stations, shall be provided by the escalator manufacturer to allow for movement (deflection, torsion, etc.) due to the load on the station structure caused by the train as it moves in and out of the station. Escalator truss work and other structural members are not to receive loads other than those imposed by the escalator itself.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A7	Floor Slope													
2022	Performance Criteria		Landing plates must be level. Adjacent floors shall be sloped away from the escalator. The texture of the floor in proximity to the landings shall contrast with the finish of the surrounding area for detection by the visually impaired.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A8	Space and Safety Requirements for Escalator Machine Space													
2023	Performance Criteria	A8a	Within the machine space there shall be no obstruction, such as supporting posts for the upper support beam, partitions, etc. This area shall be reserved for the installation of motors and drivers, however, the control shall be a locable cabinet with direct line of sight to the escalator.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2024	Performance Criteria	A8b	Machine space shall be provided with natural or mechanical ventilation to avoid overheating of electrical equipment and to ensure safe and normal operation of the escalator.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2025	Performance Criteria	A8c	Escalator Control Equipment:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2026	Performance Criteria	A8c1	Remote Escalator Control Panels mounted to the side of the escalator shall be provided whenever feasible (see Item 4 below), whether available from the escalator manufacturer or purchased from another supplier.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2027	Performance Criteria	A8c2	A small remote escalator control panel mounted on the side of the escalator railing panel shall be provided at one landing of each escalator, and positioned to provide a clear line of sight to both the top and bottom landings when an operator is using the controller functions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2028	Performance Criteria	A8c3	All major mechanical escalator equipment, including escalator controller equipment, shall be located out of public view within a secured back-of-house ancillary space.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2029	Performance Criteria	A8c4	In the case where it is not possible to use a remote escalator control panel due to distance constraints between the remote panel and the mechanical control equipment that do not allow the remote panel to operate, the escalator mechanical control equipment shall be placed in a closet adjacent to the escalator(s) such that the operator line of site is maintained from bottom to top of the escalator to the greatest extent feasible.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2030	Performance Criteria	A8c5	The closet shall be constructed to be flush with adjacent public corridor walls, or seamlessly integrated with other adjacent station equipment in a manner acceptable to Metro. The closet doors and any required ventilation louvers shall be stainless steel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2031	Performance Criteria	A8c6	In the case of retrofits only, where remote control panels are not feasible as described in Item 4) above, and a closet is not available in the required location and construction of such is not feasible, a stainless steel cabinet shall be provided and located so that the operator line of site from the bottom to the top of the escalator is maintained. (Note: Cabinets or stand alone controllers are not permitted in station public areas in the case of new station construction.) The location and design of the cabinet shall comply with the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2032	Performance Criteria	A8c6a	The overall size/dimensions of the cabinet shall be minimized. All operational control equipment (including, but not limited to control switches and cooling equipment) shall be placed within the interior of the cabinet to maintain a streamlined appearance and to avoid any tampering by members of the public.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2033	Performance Criteria	A8c6b	The cabinet shall be floor-mounted and recessed to be flush with the surrounding wall finish. As necessary to create a flush condition, a wall clad in architectural grade finish material matching the surrounding interior station wall finish (i.e., tile, stainless steel, etc.) shall be constructed around the cabinet, extending floor-to-ceiling and to the nearest wall corners. All electrical conduits shall be located within the cabinet or imbedded within adjacent walls and floors, not visible to public view, and all affected architectural wall and floor finishes shall be restored to their original appearance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2034	Performance Criteria	A8c6c	If a flush condition is not feasible as described in Item b) above, the stainless steel cabinet shall be placed directly against a wall or column in a location that is out of main pedestrian or accessibility circulation paths and major station interior view corridors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2035	Performance Criteria	A8c6ci	The cabinet placement shall not block any station artwork or revenue-producing ad space, nor shall any part of the cabinet extend beyond the wall or column surface where it is placed. No cabinet shall be placed against an open railing within, or visible from the public areas of the station. Cabinet placement locations with in the vicinity of artwork or signage must be coordinated with Metro Arts and Design to ensure required maintenance footprints and access areas are preserved.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2036	Performance Criteria	A8c6cii	The cabinet shall have stainless steel access doors capable of opening 180 degrees with a robust vandal resistant flush-mounted locking system to prevent unauthorized intrusion to the controller space.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2037	Performance Criteria	A8c6ciii	The cabinet shall have a streamlined appearance, with all control switches, cooling equipment, support legs and other appendages concealed within the stainless steel cabinet. Primary ventilation shall be provided on the top (horizontal) panel of the cabinet to avoid or minimize ventilation louvers or perforations on the side exterior panels and doors of the cabinet, so that a smooth, streamlined appearance is maintained. Access panels separate from the main cabinet doors shall be eliminated, or minimized where unavoidable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2038	Performance Criteria	A8c6civ	All electrical conduits shall be imbedded in walls or floors of public areas, and shall not be visible above, below or extending from the side of the cabinet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2039	Performance Criteria	A8c6cv	All architectural wall and floor finishes affected by the cabinet and electrical conduit construction shall be restored to their original appearance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2040	Performance Criteria	A8d	Any floor-mounted equipment other than escalators and their drive machines will be placed on reinforced concrete housekeeping pads. Minimum pad height shall be 4 inches.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2041	Performance Criteria	A8e	All machine pits shall be provided with removable covers over the full area of the machine pit. Covers shall be removable by one man without use of special equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2042	Performance Criteria	A8f	Escalator finish materials shall be #4 brushed finish stainless steel. Moving handrail is to be black rubber. (See Architectural Standard Drawings for further information.)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A9	Safety Requirements for Escalator Treads													
2043	Performance Criteria	A9a	At the top and bottom of each escalator run, at least three contiguous treads shall be level beyond the comb plate before the risers begin to form.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2044	Performance Criteria	A9b	All escalator treads shall be marked by a strip of clearly contrasting color, 2 inches in width, placed parallel to and on the nose of each step. The strip shall be of a material that is at least as slip resistant as the reminder of the tread. The edge of tread shall be apparent from both ascending and descending directions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2045	Performance Criteria	A9c	Noise Attenuation Requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2046	Performance Criteria		Noise produced by escalators operating individually in either direction under no load and under maximum load in the station environment shall not exceed 55 dBA 5 feet above the tread at the entrance combs at both ends of the escalator.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A10	General Requirements													
2047	Performance Criteria	A10a	Stop controls on site (inaccessible to public) and at the ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2048	Performance Criteria	A10b	Public-accessible emergency stop buttons at top and bottom of escalator. When activated, the emergency stop button shall cause an alarm at the ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2049	Performance Criteria	A10c	All escalator steps must be visible from the switch when stopping or starting escalators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2050	Performance Criteria	A10d	Stairs must accompany escalators (side by side).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2051	Performance Criteria	A10e	Provide weather protection for outdoor escalators – comply with the requirements of ASME 17.1 Section 807.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2052	Performance Criteria	A10f	Escalators shall be heavy duty transit escalators, and the design shall fully incorporate APTA Heavy Duty Transportation System Escalator Design Guidelines.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2053	Performance Criteria	A10g	Keys for restarting escalators shall match existing Metro escalator keys.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2054	Performance Criteria	A10h	Provide connections to Metro’s SCADA system for remote monitoring and/or control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.14.7	ELEVATORS													
		A	General Requirements													

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2055	Performance Criteria	A1	Elevators shall be installed in all stations, Metro facilities, and parking structures where there are differences in level. Depending on the configuration of the station, Metro facilities, and parking structures, the minimum number of two elevators shall be used to serve the separated areas and levels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2056	Performance Criteria	A2	Travel between elevators at their overlap (concourse) level shall require passing from the paid area to the free area or vice versa through the accessible gate. Elevators shall be located to keep the travel distance through the accessible gate to a minimum.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2057	Performance Criteria	A3	The elevators at street level shall be located so that it is near a loading zone. In stations with parking facilities, parking for persons with disabilities shall be located near the elevators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2058	Performance Criteria	A4	Elevators used by disabled in stations and parking structures shall be glazed or have transparent glass door panels at the front and transparent glazed panels at the rear wall of the elevator cabs and shafts to allow an unobstructed view both into and out of the car.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2059	Performance Criteria	A5	Interior Elevator Finishes shall be vandal resistant. Elevator finish materials shall be #4 brushed finished stainless steel on all glazed wall surfaces, doors, frames, sills, ADA push plates, and trim. Interior stainless steel shall be textured finish Regidized 5. WL or 6. WL or equivalent. Floor and ceiling materials are to be as directed by Metro. Transparent surfaces shall be laminated glass. (See Architectural Standard and Directive Drawings for further information.)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A6	Elevator Enclosures:													
2060	Performance Criteria	A6a	Walls of the enclosure must be transparent. The hoistway doors shall be safety glazed and are of standard design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2061	Performance Criteria	A6b	Concourse to platform - safety glazed in a metal framed system with safety glazed hoistway doors. Enclosure and hoistway doors are of Standard design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2062	Performance Criteria	A6c	Street level platform - safety glazed with safety glazed hoistway doors at the front and safety glazed panel at the rear wall. Hoistway doors are of standard design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2063	Performance Criteria	A6d	Outdoor elevators – provide weather protection for elevator door and entrance area. All outdoor elevator structures shall be weather proof and shall not allow access to hoistway by pigeons or other vermin.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A7	Elevator Cabs (All Standard Design)													
2064	Performance Criteria	A7a	Type A - stainless steel opaque walls with safety glazed doors at the front and safety glazed panels at the rear wall.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2065	Performance Criteria	A7b	Type B - safety glazed in a metal framed system with safety glazed doors. Front panels alongside doors shall be stainless steel opaque walls.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2066	Performance Criteria	A7c	All concourse to platform elevator cars shall be Type B.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2067	Performance Criteria	A7d	Visibility into cab at all points of travel to enhance security. Elevators in stations are to be located so as to make the requirement for visibility of cab effective on all four sides.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2068	Performance Criteria	A7e	An accessible intercom device connected to security center at the ROC. (See Communications Section for additional information).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2069	Performance Criteria	A7f	Door size shall be: 3'-6" center double door complying with Los Angeles City Building Code, Los Angeles County Building Code or California Building Code.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2070	Performance Criteria	A7g	Speed 150 fpm.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2071	Performance Criteria	A7h	Elevator floors shall be stainless steel diamond plate in the form of a pan with welded seams to prevent intrusion of liquids below the floor surface.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2072	Performance Criteria	A7i	Elevator control panels, pushbuttons, and ADA push plates shall be vandal resistant.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2073	Performance Criteria	A7j	Required fire safety signage and other lettering shall be engraved into the control operating panel instead of a plastic mounted sign.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2074	Performance Criteria	A7k	Elevator doors shall be constructed with stainless steel cores as well as skins to prevent corrosion from the inside out.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2075	Performance Criteria	A7l	Elevator stop switches shall be keyed switches. No push/pull button type stop switches are to be installed in transit elevators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2076	Performance Criteria	A7m	Fireman's service key shall match existing Metro elevators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2077	Performance Criteria	A7n	Provide connections to Metro SCADA system for remote monitoring and/or control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2078	Performance Criteria	A7o	Key for elevator stop switches shall match existing Metro elevators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2079	Performance Criteria	A8	Elevators shall be heavy duty transit elevators. The elevator design shall fully incorporate APTA Heavy Duty Transportation System Elevator Design Guidelines.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.15	**INTERCHANGING STATIONS**													
		6.15.1	INTRODUCTION													
2080	Performance Criteria		The following information identifies functional criteria for Interchange Stations. An Interchange Station is defined as a Metro Rail Station that connects two rail or bus rapid transit lines. These operational requirements apply to all new interchange stations. Functional criteria primarily focus on trackway configuration, maintenance facilities and support requirements. Design criteria relating to station passenger circulation, security, Fire/Life Safety, facilities for elderly and disabled patrons, and bus and auto access are contained elsewhere in the Metro Rail System Design Criteria and Standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.15.2	BASIC GOAL													
2081	Performance Criteria		To ensure that Interchange Station designs provide the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2082	Performance Criteria	A	Adequate passenger-carrying capacity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2083	Performance Criteria	B	Convenient and timely passenger transfers between rail lines.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2084	Performance Criteria	C	Required train movements through provision of pocket tracks and crossovers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.15.3	FUNCTIONAL CRITERIA													
2085	Performance Criteria		Functional criteria apply primarily to trackway configuration and its impact on train operations. These criteria are categorized according to the type of train operation at the Metro Rail station as follows: those applicable to a terminal station (T), to a midline station with a turnback function (MT), and to a midline station with through operation (M).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A	Operations													
2086	Performance Criteria	A1	Designers shall incorporate features to provide for use of across platform transfers whenever possible, and particularly where required by the Operating Plan due to large rail to rail transfer volumes. (T, MT, M)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2087	Performance Criteria	A2	Station design shall be adequate to handle the train movements required by the Operating Plan in and through the station. The following shall be considered:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2088	Performance Criteria	A2a	The number of trains which must be in the station at one time and the time required to clear routes in and out of the stations. At design minimum headways, track configuration shall allow for the reversing of trains without occupying the station platforms. (T, MT)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2089	Performance Criteria	A2b	Crossover capability requirements between tracks in both directions and at both ends of the station platform(s). (T, MT)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2090	Performance Criteria	A2c	Turnback requirements. (T, MT)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2091	Performance Criteria	A2d	Gap train storage requirements. (T, MT)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2092	Performance Criteria	A2e	Midday storage requirements. (T)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2093	Performance Criteria	A2f	Overnight storage requirements. (T)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2094	Performance Criteria	A2g	Requirements for storage of maximum length failed trains. (T, MT)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2095	Performance Criteria	A3	Station design shall provide the ability to construct future extensions while minimizing the impact to normal operations. (T, MT, M)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Maintenance													
2096	Performance Criteria	B1	When a non-revenue track connection between lines is specified as a requirement, the Designer shall provide a track design to move equipment of one line across another to reach maintenance or operating facilities. The track's clearances and traction power shall accommodate vehicles from both lines, thus providing an overlap zone to couple dissimilar cars for towing or to permit change over from one type of current collection to another. (T, MT, M)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2097	Performance Criteria	B2	Station design shall provide personnel access to stored cars for car cleaning and maintenance. (T)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2098	Performance Criteria	B3	Facility design shall provide space for storing supplies and equipment and shall have appropriate utilities. (T, MT)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Support Requirements													
2099	Performance Criteria	C1	Station design shall provide appropriate facilities for bus operating personnel in accordance with Operating Plan requirements if the rail interchange is a major bus stop/layover point. (T, MT, M)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2100	Performance Criteria	C2	Station design shall provide washrooms and supervisor's booth for rail personnel in accordance with Operating Plan requirements. (T, MT)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1		6.16	**PROVISIONS FOR INDIVIDUALS WITH DISABILITIES**													
		6.16.1	INTRODUCTION													
2101	Performance Criteria		The following design requirements render the Metro Rail System accessible, and usable by, the elderly and individuals with disabilities. The system shall contain specific design provisions for the reduction or elimination of barriers that impede the use of the system by persons with disabilities. The policy to be implemented is to accommodate all persons who, without intervention or assistance by others, can arrive at and enter the system, and to facilitate use by individuals with disabilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2102	Performance Criteria		Only the minimum requirements for design and construction are incorporated into the ADA Accessibility Guidelines. Related regulatory provisions of other government agencies having jurisdiction and Metro Rail Design Criteria shall be used for additional guidelines in designing and constructing the Metro Rail System to be free of architectural or transportation barriers including California Title 24 (CCR)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.16.2	CODES AND STANDARDS													
		6.16.3	SYSTEMWIDE CRITERIA													
		A	Signage and Graphics													
2103	Standard Criteria		Signage shall conform to the standards specified in ADAAG Section 703, Signs. The International Symbol of Accessibility shall be displayed according to ADAAG. Signage is required to identify accessible facilities and elements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2104	Standard Criteria		Raised and braille characters, complying with ADAAG Section 703, Signs, shall be provided at signs identifying station names, signs bearing instructions and all information for use of emergency phones, automatic fare vending, collection and adjustment equipment, and where required by ADAAG. For elevator graphics, see Standard and Directive Drawings and Signing and Graphic Section of Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Emergency Warning Systems													
2105	Standard Criteria		Emergency warning systems shall include both audible and visible alarms, in accordance with ADAAG Section 703, and Title 24, CA Code of Regulations "Requirement for the Accommodation of the Disabled in Public Accommodations".	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Controls													
2106	Standard Criteria		All equipment required to be accessible shall be positioned and mounted in such a way that wheelchair users can use the controls as required by ADAAG Section 308, Reach Range, and Title 24, Section 3105. Anthropometric standards are addressed in ADAAG. This requirement applies to, but is not limited to, the following equipment: emergency and system information telephones, and fare vending, collection and adjustment equipment at stations/stops.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2107	Standard Criteria		Installation height of manual fire alarm initiating devices shall be as specified in ADAAG Section 308, Reach Range, and Title 24, Section 3105.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2108	Standard Criteria		In facilities where system employees have access (e.g., non-public portions of stations, the Yards and Shops, and the ROC), accessibility of controls and operating mechanism shall be as defined in ADAAG Section 308, Reach Range.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Hazards													
2109	Standard Criteria		Hazards due to abrupt changes in floor level, ground and floor surfaces, and gratings shall be mitigated in accordance with ADAAG Chapter 4: Accessible Routes, and Title 24, Section 3105.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2110	Standard Criteria		Objects protruding from walls or ceilings shall be located so as to provide the dimensional clearances cited in ADAAG Chapter 4: Accessible Routes, and Title 24, Section 3105.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Doors													
2111	Standard Criteria		Doors in stations required to be accessible to the public or system employees shall be as specified in ADAAG Section 404, Doors, Doorways, and Gates.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.16.4	STATIONS													
		A	Access													
2112	Standard Criteria		All entrances to buildings and facilities shall be made accessible to individuals with disabilities, as specified in ADAAG Chapter 4: Accessible Routes, and Title 24, Section 3103(b)3.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2113	Standard Criteria		Site development and grading shall be designed to provide access to entrances and normal paths of travel, as specified in ADAAG Chapter 4: Accessible Routes, and Title 24, Section 3106.1. Where necessary, pedestrian ramps, curb ramps, and/or elevators shall be incorporated in such paths.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2114	Standard Criteria		Specific requirements for elements of vertical circulation (ramps, stairs, and elevators) are discussed in Vertical Circulation section of these Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2115	Standard Criteria		Floors and levels within a station/stop shall conform to ADAAG Chapter 4: Accessible Routes. In or at multilevel stations/stops, direct access shall be provided for individuals with disabilities between levels, as specified in ADAAG Section 405, Ramps. Walks and sidewalks at the station/stop site shall conform with ADAAG Section 403, Walking Surfaces, and Title 24, Section 3326.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2116	Performance Criteria		Tactile Guidance provides a pathway for visually impaired patrons that starts at each rail station entrance and leads to the directional bars on the station platform that identify safe waiting areas. The pathway has side branches that lead to fare machines and at least one emergency intercom. The pathway leads to both stairways and elevator call buttons but not escalators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2117	Performance Criteria		The installation of the tactile guidance in conjunction with the installation of the tactile directional bars on the station platforms will direct persons with visual impairments from the property line to the location on the platform where they can safely wait and board a Metro vehicle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Platform													
2118	Standard Criteria		The platform edge strip shall conform to ADAAG, Section 810.5.2 and Title 24, Section 3326 and be at least 24 inches wide, and shall run the full length of the platform and meet the Sound on Cane Contact requirements. Per Title 24, Section 3326(d) pedestrian access aligning with vehicle doors where passengers shall embark shall require detectable directional texture.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2119	Standard Criteria		All light rail platforms shall be 39 inches and heavy rail platforms shall be 44 inches above top of rail, within the same vertical alignment plane as the vehicle floor, within plus or minus 5/8 inch. For further restrictions on the horizontal and vertical gap between the platform and the vehicle, refer to System Safety, section and ADAAG.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2120	Standard Criteria		In all assembly places where seating is provided, there shall be spaces provided for wheelchair users. Accessible seating shall be provided in accordance with Title 24, Section 3103(a). In addition to the spaces provided for wheelchair users, seating suitable for individuals with ambulatory impairments shall be provided, in accordance with Title 24, Section 3103(a).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Communications													
2121	Performance Criteria		In addition, normal and emergency communications equipment usable by the public shall conform to Section 708, Two-way Communication System. A means of conveying equivalent information announced through the PA shall be provided for persons with hearing loss or who are deaf.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Track Crossings													
2122	Standard Criteria		Where it is necessary to cross tracks to reach or exit boarding platforms, provisions are to be made as required by ADAAG section 810.10 and in compliance with ADAAG, Section 404, Doors, Doorways, and Gates.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.16.5	ELEMENTS OF VERTICAL CIRCULATION													
2123	Performance Criteria		Ramps, stairs, and elevators shall be used to provide access to all station/stop facilities and between levels of multistory stations/stops. They shall also be provided in the O&M buildings and other facilities to which only system employees have access as necessary, given the job requirements. Any O&M facilities open to the public shall comply with the ADAAG and California Title 24 CCR requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A	Ramps													
2124	Standard Criteria		A path of travel with a slope greater than 1:20 (5%) shall be considered a ramp. Ramps shall meet the requirements of ADAAG Section 405. Ramps, if needed, shall be provided at each at-grade station, not in subway or aerial structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2125	Standard Criteria		Pedestrian ramps shall have a minimum of 48 inches in clear width, except that pedestrian ramps serving primary entrances to buildings having an occupant load of 300 or more shall have a minimum clear width of 60 inches. The maximum slope shall be 1 foot rise in 12 feet of horizontal run with a cross slope no greater than 1:50, although more gradual slopes are desirable. Ramp landings shall be provided at the top and bottom of each ramp at intervals not exceeding 30 inches of vertical rise, and at each change of direction. Other constraints are given in Title 24, Section 3307 and ADAAG. Warning strips (truncated domes) shall be installed for ramps or hazard zone as required below.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2126	Standard Criteria		Handrails shall be provided on each side of any ramp whose slope exceeds 1:20 or whose rise is greater than 6 inches. The handrails shall be continuous, placed 34 to 38 inches above the ramp surface, and shall extend at least 12 inches beyond the top and bottom of the ramp, with returned ends. Refer to ADAAG and Title 24, Section 3307(e.1).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2127	Standard Criteria		The surface of ramps shall be slip-resistant, and wheel guides or curbs shall be provided on ramps longer than 10 feet. See ADAAG, Sections 4.5 and A4.5.1, Ground and Floor Surfaces and Title 24, Section 3307 for wheel guide requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Stairs													
2128	Standard Criteria		Stairs shall comply with the ADAAG Section 504, Stairways. The upper approach and the lower tread of each stair shall be marked by a strip of clearly contrasting color at least 2 inches wide, placed parallel to and not more than 1 inch from the nose of the step or landing. The strip shall be of material that is slip-resistant. Where stairways occur outside a building, the upper approach and all treads shall be marked by the strips described above; a painted strip shall be acceptable Title 24, Section 3306(r).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2129	Standard Criteria		Open risers are not permitted according to ADAAG Section 504, Stairways and Title 24, Section 3306(s)3. Treads shall not have abrupt edges at the nosing, and shall not project more than 1-1/2 inch past the face of the riser ADAAG, Section 504, Stairways.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Elevators													
2130	Standard Criteria		Minimum of two elevators shall be provided at aboveground and underground stations and in all accessible buildings having more than one floor level, including parking structures. They shall conform to the requirements in Section 408, Elevators of the ADAAG and the ANSI/ASME A17.1 and Title 24, Section 3105(c) and Chapter 51.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2131	Standard Criteria		The minimum inside clear dimensions of the car shall be 82 inches by 64 inches, for center opening doors. The clear opening width of the door shall be 42 inches (ADAAG, Section 407.4.1). The elevator shall have an automatic leveling feature with a tolerance of ± ½ inch (with respect to the adjacent floor landing), which shall be maintained under normal loading and zero loading conditions (ADAAG, Section).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2132	Performance Criteria		Passenger elevators shall be provided with at least one handrail at a nominal height of 32 inches above the car platform, preferably on the rear wall (Title 24, Section 5103).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2133	Standard Criteria		Elevator floor and emergency calls ADA push plate shall be located at the base of wall. Elevator floor buttons shall be no higher than 48 inches from the car floor. Emergency controls shall be grouped at the bottom of the elevator control panel and shall be no lower than 35 inches to center line from the car floor. The emergency telephone handset shall be positioned no higher than 48 inches above the floor, and the cord shall be at least 29 inches long. Hall call buttons shall be within 42 inches of the floor. Other factors that shall comply with ADA Section 407, Elevators and Title 24 are minimum button dimensions, tactile, braille and other identification for the visually impaired, visual and audible car call signals, non-voice emergency communication, hall lantern location and dimensions, and floor designations at each hoistway entrance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2134	Performance Criteria		Station elevator communication and control systems shall be designed to allow either unconstrained access by passengers or access controlled by system operating personnel (either remotely or locally), so as to allow the future system operator to establish its own operating procedures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Pedestrian Grade Separations													
2135	Standard Criteria		Pedestrian grade separations shall be designed as specified in Title 24, Sections 3106.1 through 3108.1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.16.6	NOT USED													
		6.16.7	FARE COLLECTION													

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2136	Standard Criteria		The control and operating mechanism of all TVMs and SAVs shall be no higher than 48 inches above the finished floor in compliance with ADAAG Section 308, Reach Ranges. Clear floor space and maneuvering clearance requirements shall comply with ADAAG Section 403, Walking Surfaces.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2137	Performance Criteria		At stations/stops providing direct physical interchange with other transit modes, means shall be provided for wheelchair occupants to make the transfer independently, i.e., with no more assistance required from the operating staff than is required by other passengers. If a future line or other transit mode system implements a fare gate system concept, a door or gate accessible to individuals with disabilities shall be provided within 30 feet from the bank of Metro Rail turnstile/gate entrances, in accordance with ADAAG Section 404, Doors, Doorways, and Gates.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.16.8	EMERGENCY EGRESS PROVISIONS													
2138	Standard Criteria		The design of Metro Rail System Facilities shall include provisions to enable the safe, timely, and unsupervised evacuation of passengers and employees from all fixed structures and facilities. As a policy, vehicle evacuation is to be accomplished only under the direct supervision of trained emergency forces or system employees. (See Metro Fire/Life Safety Criteria.) In particular, the design shall include provisions and procedures for supervising the safe, timely, and orderly evacuation of passengers with disabilities from vehicles located anywhere in the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		6.16.9	OPERATIONS AND MAINTENANCE (O&M) FACILITIES													
2139	Standard Criteria		The O&M facilities include the ROC, the Yard and Shop Facilities, and portions of stations/stops open to system employees but not to the public. During the design phases of Metro Rail Facilities employee job descriptions shall be analyzed to determine those disabilities that would, by their nature, preclude a disabled person from performing a job satisfactorily. The design of the O&M facilities and system equipment shall accommodate, as necessary, those disabilities that are not precluded; the design shall be in accordance with Title 24 (CCR). In particular, Title 24 requirements for Group B occupancies shall apply, Group B occupancies being defined as "... those that are used by the public as customers, clients, visitors, or which are potentially places of employment..." [California Title 24, Section 3103 (a) 3.B.1]	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7	**ELECTRICAL**													
		7.4	**CLASSIFICATION OF ELECTRICAL LOADS**													
		7.4.1	CRITICAL LOADS													
		7.4.2	ESSENTIAL LOADS													
		7.4.3	NON-ESSENTIAL LOADS													
		7.5	**ELECTRICAL SYSTEMS RELIABILITY**													
		7.5.1	UNDERGROUND STATIONS													
2140	Performance Criteria		Electrical system reliability shall be described in MRDC Section 9, MRDC Section 12, and Metro Fire/Life Safety Criteria. Power supplied to emergency ventilation system shall be in accordance with Metro Fire/Life Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.5.2	AT-GRADE AND ELEVATED STATIONS													
2141	Performance Criteria		Electrical system reliability shall have a single power source and provisions for a full load capacity portable generator calculated for the full load of the Station based on the connected load.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.5.3	OTHER FACILITIES													
		A	Yards and Shops and Maintenance of Way (MOW)													
2142	Performance Criteria		Yard shall be provided with two power sources from the Traction Power Substation (TPSS) on site as described in MRDC Section 9. Stationary standby generator sized to accommodate critical and essential loads in the yard shall also be provided. Refer to MRDC Section 11 Yard and Shops. The generator shall be sized based on the connected load.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Rail Operatoins Control (ROC) Facility													
2143	Performance Criteria		Electrical system design shall comply with NEC requirements for Critical Operations Power System (COPS). ROC shall have power sources from (2) independent utility substations. It shall be provided with a full load stationary emergency standby generator and quick connect provisions for a full load portable generator sized to accomodate critical and essential loads. Provide redundant UPS equipment for critical loads.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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		C	Open Trench Guideway													
2144	Performance Criteria		Electrical system shall have two utility power sources and stationary standby generator at each end of the guideway. Refer to MRDC Fire/Life Safety Criteria. The generator shall be sized based on the connected load.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.6	**POWER SOURCES**													
		7.6.1	UNDERGROUND STATIONS													
2145	Performance Criteria	A	Electrical service for stations shall be provided as described on 7.5.1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2146	Performance Criteria	B	The transfer between the two power sources shall be on the low voltage side via bus tie breakers. The tie breakers and main breakers shall be provided with failsafe interlocking to prevent paralleling of the two power sources.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2147	Performance Criteria	C	The design of electrical power to emergency ventilation system shall comply with NFPA-140, Standard for Fixed Guideway Transit and Passenger Rail Systems. Overcurrent protection devices for this equipment shall not trip due to overload or short circuit of other normal loads.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2148	Performance Criteria	D	The design for fire pumps shall comply with NFPA-20.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2149	Performance Criteria	E	All critical loads shall be supplied by an UPS source. The UPS shall be supplied from two separate essential power source.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.6.2	AT-GRADE AND ELEVATED STATIONS													
2150	Performance Criteria	A	Electrical service shall be provided as described on 7.5.2.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2151	Performance Criteria	B	All critical loads shall be supplied by an UPS power soure. The UPS shall be supplied from two separate essential power sources.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.6.3	YARDS AND SHOPS, AND MAINTENANCE OF WAY (MOW), RAIL OPERATIONS CONTROL (ROC) FACILITY AND OTHER AT-GRADE NON-PASSENGER STRUCTURES AND PARKING STRUCTURES													
2152	Performance Criteria	A	Electrical services for Yard and Shops and Maintenance of Way (MOW), shall be described under 7.7.3A.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2153	Performance Criteria	B	Electrical services for the Rail Operations Control (ROC) Facilitiy shall be provided as described under 7.7.3D.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.7	**POWER DISTRIBUTION SYSTEM**													
2154	Performance Criteria		Power distribution system design shall include drawings with legends, symbol list, electrical site plan, single line diagrams, equipment layout, control and wiring diagrams, load calculations, panel board schedules, conduit and cable schedules.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2155	Performance Criteria		Design of large projects shall be supported by Electrical Transient Analyzer Program (ETAP) electrical network modeling and simulation software tools.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2156	Performance Criteria		Design shall also be guided by Metro Electrical Directive Drawings modified to suit project requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2157	Performance Criteria		Pathways shall be adequately sized and equipped with permanent lifting mechanisms strategically located and supported by steel beams to safely move heavy equipment in and out of the structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.7.1	UNDERGROUND STATIONS													
2158	Prescriptive Spec	A	Each station shall have two Auxiliary Power Rooms, one at each end of the station, and located nera the large motor loads. Each Auxiliary Power Room shall have a unit substation with two medium voltage step-down auxiliary transformers on each side of the unit substation feeding a dual bus type 480V, 3-phase, 3-wire Main Switchgear. The dual buses shall be considered as the two essential buses that are separated by a bus tie-breaker.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2159	Performance Criteria	B	Each Auxiliary Power Room shall have both power sources from medium voltage traction power switchgear located in the Traction Power Substation (TPSS) Room as described in MRDC Section 9 Systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2160	Performance Criteria	C	Switchgear shall have dual buses, equipped with electronically interlocked Main Feeder Breakers and automatic open transition type bus tie-breaker. Switchgear shall be equipped with redundant Programmable Logic Controllers (PLC), wired, and programmed to close to tie-breaker upon loss of one primary power and open prior to return of the primary power source to prevent unsafe paralleling of power sources. PLC system shall be equipped with input/output (I/Os) dry contacts to communicate with ROC SCADA via CIA for control and monitoring of selected equipment including protective, sensing, and alarm devices. Switchgear shall be equipped with built-in Uninterruptible Power Supply (UPS) to provide control power for PLC and associated control devices.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2161	Performance Criteria	D	Each auxiliary power transformer shall be designed and sized based on total connected loads and motor starting analysis inclusive of, but not limited to, emergency ventilation systems fan motors, Tunnel Jet Fans, HVAC and mechanical motors to accommodate all electrical loads of the station, tunnel, and cross passages.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2162	Performance Criteria	E	The Main Switchgear's essential buses shall each supply a minimum of one MCC that is considered an extension of the Main Switchgear's essential buses.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2163	Performance Criteria	F	Each Auxiliary Power Room shall have at least one non-essential bus sub-feed from one of the MCC's essential buses. All non-essential loads shall be load shed during abnormal situation or when the auxiliary transformer is overloaded.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2164	Performance Criteria	G	All ventilation system fans used during both normal operation and during an emergency fire duration, shall be fed from each essential buses of the Main Switchgear. Design of the electric power system shall comply with NFPA 130.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2165	Performance Criteria	H	Power to the emergency ventilation system fans shall be provided by two separate incoming power sources. The incoming power sources shall be physically separated from each other and shall originate from separate power sources. Automatic transfer between the two incoming power sources shall be provided in the event one of them fails. THe auxiliary power distribution system Main Switchgear shall provide a single individual feeder to each emergency ventilation fan.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2166	Performance Criteria	I	Non-gas purging fans may be load shed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2167	Performance Criteria	J	Communications Rooms and Traction Power Substation Rooms shall be provided with critical power from separate independent UPS equipment units.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2168	Performance Criteria	K	Electric power supply for fire pumps shall comply with NFPA 20.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.7.2	AT-GRADE AND ELEVATED STATIONS													
2169	Prescriptive Spec	A	At-grade and elevated passenger stations shall be equipped with a minimum of one Electrical Power Room. The power distribution system for the station shall be 480/277V, 3-phase, 4-wire and the electrical service shall be supplied from either and adjacent TPSS, or if available, directly from a utility power surce. The electrical service shall be a single feeder at low voltage or medium voltage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2170	Performance Criteria	B	There shall be a quick connect plug-in power receptacle at street level suitable for wet locations for connection to an alternate power source in the form of a portable generator. Accessible dedicated space for portable generator shall be provided adjacent to the point of connection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2171	Performance Criteria	C	Transfer of power source from normal to an alternate source shall be by a manual transfer switch sized at full capacity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2172	Performance Criteria	D	Electrical power to emergency lights, exit lights, signs, and other life safety system shall be transferred to an Uninterruptible Power Supply (UPS) upon loss of normal power.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2173	Performance Criteria	E	UPS equipment units for communication and signaling systems shall be provided and shall be independent and separate from the UPS that serves emergency lighting, exit lights, sign, and Fire/Life Safety signange.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.7.3	OTHER METRO FACILITIES AND PROPERTIES													
		A	Yards and Shops, and Maintenance of Way (MOW)													
2174	Performance Criteria		Provide power distribution system that consists of 2 Unit Substations equipped with Main-Tie-Main (MTM) system interlocked to prevent paralleling of power sources. System shall also include Automatic Transfer Switches (ATS), switchboards, panelboards, Uninterruptible Power Sources (UPS) to provide power to main and support buildings such as Paint Body Shops, Car Wash and Cleaning Platforms. Refer to MRDC Section 11 Yard and Shops for power, lighting, and communications infrastructure (conduits) requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Open Trench Guideways													
2175	Performance Criteria		Provide dual bus switchboard equipped with electrically interlocked Main Feeder Breakers and automatic open transition Type Bus Tie Breaker. Switchboard shall be equipped with Programmable Logic Controller (PLC), wired and programmed to close the Tie-breaker upon loss of one primary power and open prior to return of the primary power source to prevent unsafe paralleling of power sources.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Parking Structures and Parking Lots													
2176	Performance Criteria		Shall be provided with LED lighting system and power for Electrical Vehicle Supply Equipment (EVSE) and other equipment. Refer to Section 2 "Environmental Considerations" for electrical energy conservation and 'green' technology requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Rail Operations Control (ROC)													
2177	Performance Criteria		Shall be supplied by two separate utility power sources and a full load capacity stationary standby generator including an Uninterruptible Power Supply (UPS) for critical loads.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Remote Train Grade Crossings													
2178	Performance Criteria		Shall be provided with emergency lighting to comply with Metro requirements in the event that street lighting is compromised or lost.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Bus Loading/Unloading Spare Capacity													
2179	Performance Criteria		Shall be provided with normal and emergency lighting and power receptacle outlets.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.7.4	ELECTRICAL POWER DISTRIBUTION SPARE CAPACITY													
2180	Performance Criteria		Power distribution system shall be provisioned with a 20% minimum spare load capacity of the total connected load. Allocate room space for equipment including but not limited to switchgears, switchboards, panelboards, motor control centers, transformers, and electrical metering per CCR, Title 24, Part 6.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.8	GROUNDING, BONDING, AND GROUND FAULT PROTECTION													
2181	Prescriptive Spec		System ground resistance shall not exceed 5 ohms. 25 ohms or less grounding resistance is acceptable for remote ground electrode that is not bonded to the system ground. Ground rods shall be copper clad steel 3/4" diameter X 10'-0" long. Ground connections shall be exothermic weld for direct burial and concrete embedded connections.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.8.1	UNDERGROUND STATIONS													
2182	Prescriptive Spec	A	A grounding system underneath the base slab at the platform area shall be established to serve as the main ground path of any fault current. Cross passages shall be grounded with a minimum of 2 #4/0 bare copper wire, single cable per tunnel bore connected to station's grounding system shown on ED-471.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2183	Performance Criteria	B	Traction Power Substation (TPSS) Room, Train Control and Communication Room (TC&C), Auxiliary Power Rooms, Electrical Rooms, and Communication Rooms shall utilize the station's grounding system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2184	Prescriptive Spec	C	There shall be redundant and separate 500 kcmil conductors from each Traction Power Substation (TPSS) Room, Train Control and Communication Room (TC&C), and Auxiliary Power Rooms to the grounding system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2185	Performance Criteria	D	The non-current carrying parts of all electrical equipment, devices, panelboards, and metallic raceways and other metallic parts shall be grounded and bonded to the copper ground bus to assure electrical continuity and the capacity to safely conduct any fault current likely to be imposed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2186	Prescriptive Spec	E	There shall be no metallic structures less than 5 ft from the edge of platforms.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2187	Prescriptive Spec	F	Grounding inside the Train Control and Communication Room (TC&C) shall be by a continuous copper ground bus around the inside periphery of the room which is connected directly to the grounding system using 500 kcmil bare copper wire at 4 corners of the room, minimum.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2188	Performance Criteria	G	Bonding system wiring requirement shall be provided per EIA/TIA standard requirement. #16 AWG and smaller shall not be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2189	Performance Criteria	H	Equipment grounding conductor shall be insulated copper terminated at the ground bus at each equipment. Metallic conduit shall not be used as equipment grounding conductor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2190	Performance Criteria	I	Electrical equipment including but not limited to standby generators, power transformers, switchgears, switchboards, motor control centers, and equipment of similar function shall be provided with at least 2 ground pads or ground terminals and shall be connected at different locations to the grounding system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2191	Prescriptive Spec	J	Grounding inside the Traction Power Substation Room, and Auxiliary Power Rooms shall be by a continuous copper ground bus around the inside periphery of the room which is connected directly to the grounding system using 500 kcmil bare copper wire at all 4 corners of the room, minimum.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2192	Performance Criteria	K	Grounding shall be provided for above ground metal structures at station entrances and plaza including but not limited to bike lockers/racks, handrails, canopies, digital displays/mapcases, and station identifiers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2193	Performance Criteria	L	Branch circuits shall be provided with green ground wire sized per NFPA 70 requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2194	Performance Criteria	M	Two hole compression type lugs using tin-plated copper shall be provided to all ground bus bar connections.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2195	Performance Criteria	N	Provide copper ground bus of appropriate size in Communication and Electrical Rooms.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2196	Performance Criteria	O	Provide a minimum of 2 concrete ground test stations at opposite ends of the Plaza Level area and connect to station grounding system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.8.2	AT-GRADE AND ELEVATED STATIONS, YARDS AND SHOPS, AND OTHER FACILITIES													
2197	Performance Criteria	A	Grounding of all metal structure projecting above platforms and metallic appurtenances within the station including but not limited to bike lockers/racks, handrails, canopies, map cases/digital displays, station identifiers and fences.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2198	Performance Criteria	B	Provide copper ground plates of appropriate size in Communication Rooms, Auxiliary Power Rooms and Electrical Rooms.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2199	Performance Criteria	C	Bonding system wiring requirement shall be provided per EIA/TIA standard requirement. #16 AWG and smaller shall not be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2200	Performance Criteria	D	Provide grounding in shop buildings in accordance with requirements of NFPA 70.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2201	Prescriptive Spec	E	All grounding electrodes that are present at each structure/building on the station shall be bonded together to form the grounding electrode system. Provide 2 interconnecting cables between platform floors, structures, ground rings, grids and mats back to the main service grounding system using #4/0 bare copper conductor (minimum).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2202	Performance Criteria	F	All metallic objects along the alignment that are within 15 ft of the centerline of near rail shall be grounded.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2203	Prescriptive Spec	G	All metallic objects in a station shall be bonded to the station grounding grid system and the ground resistance for the station grounding system shall not exceed 5 ohms. Bond any metallic object to the station grounding system that are within less than 6 ft outside of the station perimeter.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2204	Prescriptive Spec	H	Manholes/pull boxes and lighting poles shall be provided with a dedicated 10 ft long, minimum, 3/4" diameter steel copper-clad ground rod or equivalent ground electrode based on grounding system design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2205	Prescriptive Spec	I	Bond station ground ring conductor to lateral steel rebar of the station's platform at 4 ft intervals, 24" below grade minimum.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2206	Prescriptive Spec	J	Provide minimum #4/0 continuous bare copper ground ring conductor routed outside Station platform's concrete foundation, 36" below grade minimum.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2207	Prescriptive Spec	K	Provide minimum 2 ground well and test stations to enhance grounding system. Connect ground well to ground ring with #4/0 bare copper conductor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.8.3	GROUND FAULT PROTECTION													
2208	Performance Criteria	A	Ground fault protection shall be provided as required by NEC for service, feeder, and branch circuits serving large loads in excess of 1000A at 480VAC including motor loads and maintenance receptables in wet locations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.9	**SUPPLY VOLTAGE & VOLTAGE DROP**													
		7.9.1	SUPPLY VOLTAGE													
2209	Prescriptive Spec	A	AC power shall be supplied at nominal 480 volts, 3-phase, 3-wire or 4-wire, 60 Hz. Other nominal voltages shall be obtained by use of dry-type transformers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2210	Definition	B	The rated voltages of the equipment shall be as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2211	Prescriptive Spec	B1	Receptable --> 120 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2212	Prescriptive Spec	B2	Motors 1/2 to 250 HP --> 480 V , three phase, 3 wire Under 1/2 HP --> 120V - 208V, single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2213	Prescriptive Spec	B3	Motor Control --> 120 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2214	Prescriptive Spec	B4	Heaters for motors or electrical equipment --> 208V - 480 V , three phases, 3-wire	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2215	Prescriptive Spec	B5	Dry-type Transformers --> 480/277 V , three phase, 4-wire (Secondary) --> 208/120 V , three phase, 4-wire	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2216	Prescriptive Spec	B6	Switchgears and Switchboards --> 480 V , three phase, 4-wire	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2217	Prescriptive Spec	B7	MCC --> 480 V , three-phase , 4-wire	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2218	Prescriptive Spec	B8	Fare collection equipment --> 120/208 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2219	Prescriptive Spec	B9	Train control and signal systems --> 120/208 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2220	Prescriptive Spec	B10	TMV, SAV, and fare gates --> 120 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2221	Prescriptive Spec	B11	Panelboard --> 208/120 V , three phase, 4-wire grounded neutral --> 480/277 V , three phase, 4-wire grounded neutral	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2222	Prescriptive Spec	B12	Electric clocks --> 120 V , single phase (if any)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2223	Prescriptive Spec	B13	Exit signs --> 277 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2224	Prescriptive Spec	B14	Tunnel lighting --> 277 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2225	Prescriptive Spec	B15	Area and parking lot lighting --> 277 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2226	Prescriptive Spec	B16	Power Outlet --> 480 V , three phase --> 120 V, single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2227	Prescriptive Spec	B17	Lighting --> 277 V , single phase --> 120 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2228	Prescriptive Spec	B18	Visual Messaging System (VMS) --> 120 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2229	Prescriptive Spec	B19	Communications Equipment --> 208 V - 120 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2230	Prescriptive Spec	B20	Electrical Vehicle Charging Stations --> 208 V - 120 V , single phase	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.9.2	VOLTAGE DROPS													
2231	Prescriptive Spec	A	Voltage drops from the secondary side of auxiliary power transformer to the farthest device or equipment shall be no greater than 5%, and limited at the following levels: 1. All feeder circuits down to distribution points 2%. 2. All motor branch circuits 3%. 3. All lighting and receptable branch circuits 3%.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2232	Prescriptive Spec	B	For a direct service feeder from the utility company, the total voltage drop, including feeder circuit, to the farthest motor loads shall be limited to 5%.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2233	Prescriptive Spec	C	The voltage drop calculation for motor circuits shall be based on an 80% power factor, lagging. For heating and other induction loads, the voltage drop calculator shall be based on 100% power factor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2234	Performance Criteria	D	For sensitive electronic equipment loads, the voltage drop on any branch circuit shall not exceed 1.5%. The combined voltage drop of feeder and branch circuit conductors shall not exceed 2.5%. Refer to NFPA 70.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10	BASIC ELECTRICAL MATERIAL AND EQUIPMENT													
		7.10.1	ELECTRICAL, COMMUNICATION AND SIGNALING CONDUITS													
2235	Performance Criteria		Refer to MRDC Section 9 for specific communication and signaling conduits requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2236	Performance Criteria	A	Hot dip galvanized rigid steel conduit (GRS) shall be used in all areas unless otherwise noted. GRS shall not be used in areas where compliance to UL 2196 is required by Fire/Life Safety systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2237	Performance Criteria	B	Intermediate Metallic COnduit (IMC) and Electrical Metallic Tube (EMT) conduits shall not be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2238	Performance Criteria	C	Provide pull rope in empty conduit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2239	Performance Criteria	D	Conduit installation shall be sealed to ensure that cables remain in dry condition.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2240	Performance Criteria	E	Rigid non-metallic electrical conduit shall be used in concrete encasements. Rigid non-metallic electrical conduit shall be PVC conduit (minimum schedule 40 type)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2241	Standard Criteria	F	Conduit penetrations through concrete floors, walls, ceilings, pole foundations, concrete housekeeping pads, and any other location shall be GRS wrapped with non-toxic and environmentally friendly anti-corrosive tape, meeting AWWA C217 standards with temperature variances of -40 degrees Celsius to +84 degrees Celsius.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2242	Performance Criteria	G	Underground duct banks shall be encased in concrete. Duct bank shall consist of more than one conduit installed underground.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2243	Performance Criteria	H	Duct banks located under and/or adjacent to roadways, crossing railroad tracks, and structures shall be designed in coordination with Civil/Structural Engineers. The steel reinforcement design for duct banks shall be submitted to Metro for review and approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2244	Performance Criteria	I	The design of underground electrical and communication conduit systems shall be coordinated with other disciplines including underground utilities and infrastructures to resolve potential clashes and conflicts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2245	Performance Criteria	J	Underground conduits shall comply with CPUC GO 128, NFPA 70, EIA/TIA requirements applicable codes and standards, and Metro requirements. The most stringent requirement shall apply.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2246	Prescriptive Spec	K	Where multiple conduits in concrete encased duct bank, provide interlocking high impact plastic spacers every 5' to support and maintain a clear separation of minimum 2" between conduits during the pour of concrete. Improvised temporary conduit spacers are not acceptable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2247	Prescriptive Spec	L	Provide in-ground concrete pull boxes adjacent to light poles, Conduit stub-up shall be GRS with anti-corrosion tape, extended 4" above pole foundation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2248	Performance Criteria	M	See MRDC Section 9 and Fire/Life Safety Criteria for Fire Alarm system conduits and in-ground pull boxes requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2249	Performance Criteria	N	Rigid nonmetallic conduit shall not be used for the support of luminaries.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2250	Prescriptive Spec	O	Flexible liquid-tight metal conduit shall be used for final connections to all motors, using a minimum 18" length except for Fire/Life Safety motors on which a UL 2196 fire rated cable assemblies shall be used.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2251	Prescriptive Spec	P	The minimum size conduit used throughout the electrical system shall be 3/4" for exposed, and 1" for all concrete encased installation. Direct bury electrical system conduits shall not be allowed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2252	Performance Criteria	Q	Underground ductbanks and electrical substructures including manholes and in-ground pullboxes shall be designed to withstand railroad or traffic loading where applicable and prevent water infiltration and flooding the interior space.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2253	Prescriptive Spec	R	Minimum 30% spare conduits shall be provided for power and 50% for communuication/signaling systems. Spare conduits shall be sized to match the larger conduit size and quantity of spare conduit(s) rounded off to the next higher whole number.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2254	Performance Criteria	S	For underground station and tunnel, conduits, feeders, and branch circuit conduits shall be in compliance with NFPA 130 and Metro Fire Life Safety Criteria and shall comply with UL 2196 listing standard.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2255	Prescriptive Spec	T	All underground ductbanks shall be installed with a high frequency tracer wire system. Connections shall be located in accessble in-ground pull boxes such as manholes and handholes. Install access box with locking mechanism from end to end of ductbank and at every 1000 ft maximum. Provide #12AWG (min.), high strength copper clad steel conductor, insulated with a 30 mil (min), high density, high molecular weight polyethylene (HDPE) insulation listed for direct burial use at 30 volts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2256	Performance Criteria	U	EMT conduit may be used inside drywall or furred wall space in yard and shops buildings not subject to potential physical damage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2257	Prescriptive Spec	V	Conduit system shall be incorporated in the canopy design. Exposed conduit is not allowed. Minimum size shall be 3/4" diameter.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2258	Performance Criteria	W	Provide seismic U-joint expansion deflection conduit fittings in all bridge expansion joints to accommodate between bridge/abutment, cross passages and station/tunnel interfaces.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2259	Standard Criteria	X	All conduits for under platform crawlspace and at-grade stations shall be rigid galvanized steel (GRS), wrapped with non-toxic and environmentally friendly anti-corrosive tape, meeting AWWA C217 standards with temperature variances of -40 degrees Celsius to +84 degrees Celsius.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2260	Performance Criteria	Y	Exposed conduits in public areas/spaces are not permitted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2261	Performance Criteria	Z	For both construction and alterations to existing stations, all conduit for electrical and/or data in station public areas shall be concealed from public view, and shall be either embedded in concrete walls, or concealed above drop ceiling panels or furred wall enclosures that match the adjacent architectural wall or ceiling finishes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2262	Performance Criteria	AA	Sharing of electrical manholes and pull boxes with other systems including but not limited to communications systems, Fire/Life Safety systems, and train control is not permitted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2263	Performance Criteria	BB	Expansion fittings shall be used where raceways pass through structure expansion joints.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2264	Performance Criteria	CC	All conduits shall be identified and labeled per origin and destination.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2265	Performance Criteria	DD	All exposed connections to equipment and devices in underground stations and tunnels shall be provided for a UL 2196 fire rated cable assemblies.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2266	Performance Criteria	EE	Provide warning tape above the full length of the duct bank.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2267	Performance Criteria	FF	Conduits, boxes and fittings installed in damp or wet locations shall be listed for use in wet locations. Conduit installation shall be sealed to ensure that cables remain in dry conditions. For Galvanized Rigid Steel (RGS) conduit, use threaded couplings, fittings, and connectors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2268	Performance Criteria	GG	Avoid the installation of manholes and handholes in landscaped areas. If manholes and handholes are installed in landscaped areas, coordinate the installation with landscaping designer to avoid sprinkler water intrusion.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.2	CABLE TRAYS													
2269	Performance Criteria	A	Cable trays shall be aluminum, ladder type unless galvanized steel cable trays is required in Auxiliary power rooms. The use of cable trays is limited to Auxiliary Power Rooms, TC&C Rooms, and Communications/Signaling Rooms.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2270	Performance Criteria	B	Cable tray assemblies and supports shall be designed to provide adequate strength to support the weight of the tray, cables, and future cables and meet the seismic requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2271	Performance Criteria	C	Where vertically stacked, cable trays shall be separated and located to comply with the requirements of NFPA 70.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2272	Performance Criteria	D	Cable tray assemblies shall be configured to meet the requirements of cable types relevant to separation and labeling requirements of NFPA 70.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2273	Prescriptive Spec	E	Cable tray assemblies shall be sized to provide for 30% spare for future power and 50% for future communications cable additions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.3	RECEPTABLES													
		A	Receptacle Outlets													
		A1	Public Areas													
2274	Prescriptive Spec		There shall be no more than 8 receptacle outlets per 120 volt branch circuit in public areas. The public area receptacle outlets shall be spaced sp that no more than 50 ft of cord will be required to reach any point from the revecptacle outlets. At each receptacle outlet location provide 2 NEMA L5-20R, single twist-lock, 20 amperes, 125 bolts, 2-poles, 3-wire grounding type receptacles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A2	Service and Ancillary Areas													
2275	Prescriptive Spec		There shall be no more than 6 receptable outlets on each 120-volt branch circuit in service and ancillary areas. There shall be a minimum of one duplex receptacle otlet for each 30 ft of wall inside the service and ancillary areas, except where closer by special operational requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A3	Vents, Access Shafts and Plenum Areas													
2276	Prescriptive Spec		These locations shall be equipped with receptacles outlets so that any point can be reached with a 25 ft power cord.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A4	Receptable Outlets in Non-public Areas													
2277	Prescriptive Spec	A4a	Provide receptacle outlet within 10' of an emergency exit hatch protected by listed GFCI receptacle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2278	Prescriptive Spec	A4b	Provide duplex receptacle within 25' of any mechanical unit protected by listed GFCI receptacle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2279	Performance Criteria	A4c	Provide duplex receptacle outlet in fire hose cabinet protected by listed GFCI receptacle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2280	Performance Criteria	A4d	All janitor closet, maintenance areas, employee kitchen, bathroom shall be protected by GFCI receptacle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2281	Performance Criteria	A4e	All exterior locations shall be protected by listed GFCI receptacles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2282		A5	Cover and Cover Plates													
2283	Performance Criteria	A5a	Stainless steel in outdoor areas, yards and shops, service , and ancillary areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2284	Performance Criteria	A5b	Stainless steel in areas considered corrosive such as tunnels and cross passages.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2285	Performance Criteria	A5c	Provide permanent label with panelboard and circuit identification.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.4	WALL SWITCHES													
2286	Prescriptive Spec		Wall switches shall be specification-grade and installed inside each room for controlling general lighting and for conserving energy in accordance with California Title 24. Switches shall be "T" rated, 20 ampheres at 277 volts, silent type unless otherwise noted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.5	CONTROL STATIONS													
2287	Performance Criteria		In general, control stations shall have watertight enclosures. The number and arrangement of control switches shall be as required for their service.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.6	WIRING METHODS AND MATERIALS													
		A	Wiring Materials for Power Distribution System													
		A1	General													
2288	Performance Criteria	A1a	Power conductors shall be copper, single, or multi-conductor cables, UL Listed and suitable to field conditions. Conductors shall be temperature rated at 90 degrees Celsius for both wet and dry conditions, 600V, unless otherwise required by Metro Fire Life Safety and special conditions. Power conductors shall not be smaller than No. 12 AWG. Refer to NFPA 70 requirements relevent to conductor temperature limitations in selecting conductor ampacity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2289	Performance Criteria	A1b	Control wiring shall be copper single or multi-conductor cable with color coding per IECA standard. Control cable shall not be smaller than No. 14 AWG and shall be rated for 90 degrees Celsius, 600V.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2290	Performance Criteria	A1c	Luminaire wiring shall be copper type SF-2 with temperature rating of 150 degrees Celsius, 600V and No. 16 AWG minimum, unless otherwise noted in other sections.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2291	Standard Criteria	A1d	All conductors shall be insulated using minimum XHHW-2 jacketing that is listed for wet and dry locations. Insulation shall be moisture-resistant and flame-retardant type wiring and conform to NFLA 130 requirements unless otherwise noted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2292	Performance Criteria	A1e	All conductors and wiring materials shall be UL listed in accordance with application.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2293	Performance Criteria	A1f	Conductors shall be listed UL 2885 in areas including but not limited to underground stations, tunnels, and other locations where low smoke and halogen-free cables are required to reduce the amount of toxic and corrosive gases emitted during a fire. Conductors shall be listed per FT4/IEEE 1202 and UL 1685 for flame and smoke release requirement.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2294	Prescriptive Spec	A1g	All power feeders and branch circuits shall be copper, single or multiple conductor cables, and suitable for installation in cable tray with thermosetting outer jacket. Power wiring shall be temperature rated at 90 degrees Celsius and not smaller than No. 12 AWG. Control wiring shall be multiple conductor cable with color coding per ICEA standard. Control cable shall not be smaller than No. 14 AWG and shall be rated for 90 degrees Celsius. Fixture wiring shall be type SF-2 or BF with temperature rating of 150 degrees Celsius and No. 16 AWG minimum. Aluminum conductors are not permitted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2295	Performance Criteria	A2	Fire/Life Safety Feeder and Branch Circuit Wiring Materials	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2296	Performance Criteria	A2a	Comply with general wiring materials requirements listed above.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2297	Performance Criteria	A2b	Above ground fire/life safety system branch circuit wiring materials shall comply with NFPA 70 requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2298	Performance Criteria	A2c	Metal clad cables: UL 2196 listed cable assembly.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2299	Performance Criteria	A2d	Mineral Insulated Cables: UL 2196 listed cable assembly.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2300	Performance Criteria	A2e	Reinforced Thermosetting Resin Conduit (RTRC) or approved UL 2196 listed fiberglass phenolic conduit and cable assembly.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2301	Prescriptive Spec	A2f	Stainless steel NEMA 4X boxes and support hardware.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Wiring Methods													
2302	Performance Criteria	B1	Feeder and branch circuit rating and listing requirements shall be based on the location and type of loads supported. In general, life safety system equipment loads, and associated feeder and branch circuiting are those supporting the operation of systems that provide for the safe egress of passengers from stations and tunnels during a fire or other life safety related event. These include, but are not limited to the support of the operation of the following system:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2303	Performance Criteria	B1a	Emergency egress lighting, exit lights and signs.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2304	Performance Criteria	B1b	Emergency ventilation	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2305	Performance Criteria	B1c	Fire detection and fire alarm	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2306	Performance Criteria	B1d	Gas detection systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2307	Performance Criteria	B1e	Emergency communications/signaling systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2308	Performance Criteria	B1f	Emergency control systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2309	Performance Criteria	B1g	Fire pumps	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2310	Performance Criteria	B2	Wiring within Metro's facilities shall be in conduits or ductbanks. Cable trays may be used in non-public areas. Refer to Article 7.10.2 for additional requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B3	Tunnel Lighting Branch Circuiting													
2311	Performance Criteria	B3a	All station and tunnel emergency egress lighting branch circuiting shall be in compliance with UL 2196 listing requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2312	Performance Criteria	B3b	Tunnel lighting shall comply with Article 7.13.7. requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2313	Performance Criteria	B3c	Tunnel lighting redundant UPS power source branch circuiting shall be kept entirely separate and run in separate UL 2196 rated raceways, junction boxes, and cable assembly from sources at both ends of the tunnel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B4	Tunnel Power Circuiting													
2314	Performance Criteria	B4a	Feeders serving emergency in-line type Tunnel Jet Fans in tunnels shall be supplied from an essential power source.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2315	Performance Criteria	B4b	For underground tunnels, fire/life safety system feeder and branch circuit wiring shall conform to NFPA 130 and Metro Fire Life Safety Criteria requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2316	Performance Criteria	B4c	All power distribution system equipment and associated component including but not limited to conductors, conduits, pullboxes and materials shall be properly identified, tagged and labeled.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.7	POWER TRANSFORMERS													
2317	Performance Criteria	A	Auxiliary power transformers shall be dry type, self-cooled (AA) and force-air (FA) type, as required. Provide separate conduits for power and control between the auxiliary transformer and medium voltage switchgear in the TPSS Room for auxiliary transformer thermal overload protection. Conduit and wiring terminations shall be coordinated with equipment vendor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2318	Performance Criteria	B	Construction shall be in accordance with applicable sections of ANSI and NEMA standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2319	Prescriptive Spec	C	Primary and secondary coils of transformers having a primary voltage above 16kV shall be type. Low voltage connection from transformer to switchboard shall be solid copper bus bar.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2320	Performance Criteria	D	Transformer windings shall be copper three-phase, delta-wye connected.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2321	Performance Criteria	E	Low voltage transformers be K-rated type for non-linear loads. Transformer shall have copper windings. Minimum K-factor rating is K-13.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2322	Performance Criteria	F	Transformer sound ratings shall not exceed ANSI C57.12.57 requirements. Quiet-type transformer designs shall be used in office and other areas sensitive to noise.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2323	Performance Criteria	G	Transformer shall be dry type with standard taps on the high voltage (primary) winding. Three phase transformers shall be connected Delta primary and Wye secondary. Copper winding shall be used, aluminum winding is not acceptable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2324	Performance Criteria	H	Transformers shall comply with the requirements of the Department of Energy (DOE).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.8	480 Switchgears and Switchboards													
2325	Standard Criteria	A	Switchboards shall conform to NEMA Standard PB-2 and UL 891.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2326	Standard Criteria	B	Switchgear shall comply with UL 1558 and NASI C37.51.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2327	Performance Criteria	C	Provision for anticipated future loads shall be as indicated per 7.7.4 and a combination of spare circuit breakers and spaces.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2328	Performance Criteria	D	Main protective devices shall consist of power circuit breakers, electrically operated with control arranged to prevent paralleling of two sources. The transfer of power shall be accomplished by a breaker.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2329	Performance Criteria	E	480V switchgears and switchboards shall have copper buses.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2330	Prescriptive Spec	F	Interrupting capacity shall equal or exceed prevailing short circuit current but shall not be less than 65,000 amperes rms symmetrical at 480 volts. Higher interrupting capacity shall be furnished based on short circuit calculations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2331	Performance Criteria	G	Provisions shall be made for mounting instrument transformers and metering equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2332	Performance Criteria	H	Surge Protective Devices (SPD) shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2333	Performance Criteria	I	Switchgear and switchboards shall be equipped with local and remote, and manual and auto control functions. See 7.14.2 for SCADA I/O point requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2334	Prescriptive Spec	J	Provide terminal blocks and accessories with 30% spare as required to enable remote control and monitoring of selected protective devices and other components.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.9	Motor Control Centers (MCC) and Local Starters													
2335	Prescriptive Spec	A	All motor control centers shall conform to NEMA Class II Type B Construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2336	Prescriptive Spec	A1	Circuit breaker combination starters shall be used in motor control centers for 460-volt motors. Individually mounted circuit breaker combination starters shall be used where required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2337	Performance Criteria	A2	All starters shall be NEMA type magnetic, full-voltage start, non-reversing type, except for emergency fans and other driven equipment where requirements call for other types such as reversing or 2-speed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2338	Performance Criteria	A3	Where lock-out type stop buttons and a local start button or 'on-off-auto' switch are required, such control station shall be provided within sight of each motor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2339	Prescriptive Spec	A4	Enclosures shall be NEMA Type 12 except where outdoor or tunnel installation is necessary.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2340	Performance Criteria	A5	Wiring for motors shall be sized in accordance with the data shown in NFPA 70, unless voltage drops require larger sizes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2341	Performance Criteria	A6	Surge Protective Devices (SPD) shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2342	Performance Criteria	A7	MCC shall have copper buses.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2343	Performance Criteria	A8	MCC shall be equipped with local and remote and manual and auto control functions. See 7.14.2 for SCADA I/O point requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2344	Prescriptive Spec	A9	Provide terminal blocks and accessories with 30% spare as required to enable remote control and monitoring of selected protective devices and other components.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.10	Panelboards													
		A	General													
2345	Prescriptive Spec	A1	Separate panelboards shall be provided as necessary for nonessential, essentail, critical circuits, and DC distribution. Panelboards shall be NEMA 12 surface-mounted in all non-public areas. In public areas and offices indoors, panelboards shall be NEMA 12 flush-mounted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2346	Performance Criteria	A2	A listed Surge Protective Device (SPD) shall be installed on all panelboards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2347	Performance Criteria	A3	Panelboards shall include spare breakers for future loads, and shall be equipped with buswork and terminations to accept additional breakers. Each circuit breaker numbering shall be in conformance with NEMA standards, from top closest to the line side to bottom, odd numbers on the left side (1,3,5) and even numbers (2,4,6) on the right when looking in front of the panelboard.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2348	Performance Criteria	A4	Panelboards shall have door-in-door construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2349	Performance Criteria	A5	Panelboards shall have copper phase and neutral bases.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2350	Prescriptive Spec	A6	The following guide selection of panelboard sizes shall be used: <u>Active Single Pole Breakers</u> --> <u>Spare Single Pole 20 A Breakers</u> --> <u>Panel Size Single Poles</u> Up to 6 --> 2 --> 12 6 to 12 --> 2 --> 18 12 to 18 --> 4 --> 24 18 to 24 --> 6 --> 30 24 and up --> 6 --> 42	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Circuit Breakers													

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2351	Prescriptive Spec	B1	The 280V panelboards shall be equipped with branch beakers rated at a minimum of 10,000 amperes symmetrical interrupting capacity or in accordance with short circuit study.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2352	Prescriptive Spec	B2	The 480/277V panelboards shall be equipped with branch breakers rated at 14,000 amperes minimum symmetrical interrupting capacity or in accordance with short circuit study.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2353	Performance Criteria	B3	All circuit breakers shall be the bolt-on type, unless otherwise noted in other sections.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	See 7.7.4 for space capacity.													
		7.10.11	DISCONNECT SWITCHES													
2354	Performance Criteria		All motor circuits shall have a separately mounted non-fusible disconnect switch only where required by the NFPA 70 and shall be within sight of the motor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2355	Performance Criteria	A	Switches shall be heavy duty type with visible quick-made, quick-break blades.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2356	Performance Criteria	B	Fusible switches shall have rejection type fuse holders.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2357	Performance Criteria	C	Terminal lugs shall be rated for 75 degrees centigrade.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2358	Prescriptive Spec	D	Enclosures, unless otherwise noted, shall be NEMA 12 for indoor locations, and NEMA 4X, stainless steel for outdoor locations as a minimum.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2359	Performance Criteria	E	The enclosure shall be interlocked with the switch handle such that the enclosure door or cover cannot be opened with the switch in the "ON" position. The switch handle shall be capable of being padlocked in the "OFF" position but not in the "ON" position.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2360	Performance Criteria	F	Disconnected switches installed between any variable speed drive type of unit (VFD, AFD, USD, ect.) and its respective motor(s), shall have auxiliary break before break (open) interlock control contact.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2361	Performance Criteria	G	Elevator or escalator disconnect switches shall be fused in accordance with local codes and APTA design guidelines.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2362	Prescriptive Spec	H	The size, number of poles, and fusing for each switch shall be as denoted on the drawings. As a minimum, no less than one pole for each undergrounded conductor shall be provided. Switches shall be rated 250 VAC or 600 VAC as required by the circuit to which it is connected.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2363	Performance Criteria	I	Switches serving motors with more than one set of windings shall have the number of poles necessary to disconnect all conductors to all windings in a single switch.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.12	LIGHTING TRANSFORMERS													
2364	Performance Criteria	A	Lighting transformers shall be dry type with copper windings and standard taps on the high voltage winding. Transformer shall be 3-phase or single-phase as required. They shall be wall-mounted or floor-mounted with sound isolation mounting pads.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2365	Standard Criteria	B	Noise levels shall not exceed the following values when measured in accordance with ANSI standard C.89.2: 1 - 9kVA --> 40 dBA 10 - 50kVA --> 45dBA 51-150kVA --> 50dBA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2366	Performance Criteria	C	Transformers shall comply with the requirements of the Department of Energy (DOE).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.13	UNINTERRUPTIBLE POWER SUPPY (UPS) SYSTEM													
2367	Performance Criteria		Design criteria are for separate, dedicated UPS equipment for Emergency Lighting and Communications systems critical loads. For Traction Power Substations (TPSS) UPS equipment design criteria, refer to MRDC Section 9.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A	General Requirements													
2368	Performance Criteria		The UPS system shall be supplied with 2 power sources. Power sources shall be from separate essential buses.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2369	Performance Criteria		The UPS shall be on-line double conversion system that includes a solid state rectifier/battery charger, sealed type batteries, inverter, solid state transfer switch and external manual by-pass switch.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2370	Prescriptive Spec		The sizing of the UPS shall be based on a 100% duty cycle for all connected loads including 100% spare capacity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2371	Performance Criteria		UPS equipment serving emergency lighting shall be UL 924 listed as an assembly unit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2372	Performance Criteria		A separate UPS equipment serving Communication Systems shall be UL 1778 listed as an assembly unit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2373	Performance Criteria		UPS system shall have local/remote control functions and local/remote indications. See subsection 7.14.2 of this document for UPS SCADA I/O point requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Rectifier/Battery Charger													
2374	Performance Criteria		The Rectifier shall be high frequency solid state type and shall have adequate capacity to simultaneously supply power to the inverter at full rated output and charge the batteries. Battery charger re-charge rate from a completely discharged condition to fully charged shall be 8 times the discharge period for communications' UPS and 8 times the discharge time for emergency lighting UPS equipment. The battery charger shall have an adjustable charge rate for equilization and shall provide a "no charge" indication to SCADA supervisory control system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Battery													
2375	Prescriptive Spec		Batteries shall be sealed type and have sufficient capacity to carry the following UPS load continuously for the times indicated, with a final terminal voltage of not less than 1.75 volts per cell.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Prescriptive Spec		Architectural and MRDC Section 8 Mechanical for battery room requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2376	Performance Criteria		Provide Battery monitoring and management system, that allows for remote monitoring at the ROC SCADA supervisory control system. See 7.14.2 for UPS SCADA I/O point requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C1	Underground Stations													

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2377	Prescriptive Spec	C1a	4 Hour battery. See MRDC Section 9 for all communication systems back up power requirements including but not limited to:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2378	Definition		- PA System - Fire Protection and Fire Alarm Systems - Security System/CCTV - USF Station Network Equipment - Radio - Gas Monitoring - Metro Call Points (Metro public telephones) - Maintenance Telephones (MTEL) - Emergency Telephone (ETEL) - Load shed panel - Emergeny Exit Door Operation	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2379	Prescriptive Spec	C1b	1-1/2 Hour Battery, Emergency Lighting	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2380	Definition		- Emergency lights - Exit lights and signs - Tunnel and cross passage lighting	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C2	At-Grade and Elevated Stations													
2381	Prescriptive Spec	C2a	4 Hour battery. See MRDC Section 9 for all communication systems back up power requirements including but not limited to:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2382	Definition		- PA System - Fire Protection and Fire Alarm Systems - Security System/CCTV - USF Station Network Equipment - Radio - Gas Monitoring - Metro Call Points (Metro public telephones) - Maintenance Telephones (MTEL) - Emergency Telephone (ETEL)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C3	Yard, Shops and other Metro Facilities													
2383	Prescriptive Spec	C3a	4 hour battery. See MRDC Section 11 Yard and Shops for all communications systems back up power requirements including but not limited to:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2384	Definition		- communication and signaling equipment - all related safety functions as defined in MRDC Section 11 Yards and Shops	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2385	Prescriptive Spec	C3b	1-1/2 Hour Battery, Emergency Lighting	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2386	Definition		- emergency lights - exit lights and signs	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Inverter													
2387	Performance Criteria		The inverter shall be soild state type, Pulse Width Modulated (PWM) design and utilizing Insulated Gate Bi-polar Transistor (IGBT) technology. Inverter input voltage and output voltage shall be based and provided per the single line diagram.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Static Transfer Switch													
2388	Prescriptive Spec	E1	A high speed Silicone Controlled Rectifier (SRC) static transfer switch shall automatically transfer the critical panel load to the by-pass feeder AC source in the event a fault occurs in the inverter. This transfer shall occur in less than 1/4 cycle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2389	Performance Criteria	E2	Operation of the transfer switch shall be indicated on the SCADA supervisory control system and alarm panels. See 7.14.2 for UPS SCADA I/O point requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2390	Performance Criteria	E3	Any attemped re-transfer from the bypass essential bus to the inverter shall be limited to two unsuccessful attempts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Manual By-Pass Switch													
2391	Performance Criteria		An external manual by-pass switch shall be provided for maintenance and to allow removal of the UPS. It shall transfer the load to the alternate AC power source without any interruption to the loads. By-pass feeder shall be connected to a separate essential bus.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.14	AUTOMATIC TRANSFER SWITCH (ATS)													
2392	Performance Criteria		An automatic transfer switch shall be used where there is more than one power source feeding the same load. It shall be designed such that only one power source can supply power to a switchboard without the possibility of paralleling the two sources. Automatic transfer switch and by-pass isolating switch shall be an integral unit and shall be installed in the same line-up switchboard enclosure arrangement for convenience of operation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.15	STANDBY GENERATORS													
2393	Prescriptive Spec		Portable and stationary standby generators shall be used as a backup power source to the normal utility power source. Output voltage shall be 480/277V, 3-phase, 4-wire.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2394	Performance Criteria		Portable generator connection to the station distribution system shall be by a power receptable or quick connect assembly in conjunction with a manual transfer switch. The power receptacle or quick connect assembly shall be fully coordinated with Metro Operations termination requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2395	Prescriptive Spec		All necessary accessories for the stationary standby generator shall include double wall containemnt fuel day tank, and underground storage tank, generator main circuit breaker, battery, battery charger, remote annunciator panel for monitoring and control, and automatic transfer switch shall be compatible with the generator sized for 72 hours of continuous service.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.16	ENCLOSURES													

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2396	Prescriptive Spec		All electrical equipment enclosures and pullboxes shall be NEMA rated to suit environment and field conditions unless more stringent rating is required. Enclosures and pullboxes located within the boundaries of the station that are publicly accessible or visible shall be flush with, and recessed in, the adjacent wall system, and shall be stainless steel, NEMA 4X.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2397	Prescriptive Spec		Semi-recessed and surface mounted cabinets are not allowed. In underground tunnels, cross passages, and other sreas where there is potential for corrosion, enclosures shall be stainless steel, NEMA 4X.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.10.17	HOUSEKEEPING PAD													
2398	Prescriptive Spec		All floor mounted equipment shall be provided with 4 high AFF (minimum) concrete reinforced housekeeping pad and shall extend 4" all around the equipment base dimensions. Housekeeping pad shall be approved by Metro Electrical and Structural Engineers. Required spacing and protective bollards and metal fencing shall be provided per Architectural Standards and Metro Requirements. The 4" edge of the housekeeping pad shall be painted yellow.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.11	**POWER SUPPLY TO MECHANICAL AND ARCHITECTURAL EQUIPMENT**													
		7.11.1	EMERGENCY VENTILATION SYSTEM FOR UNDERGROUND STATION AND TUNNELS													
2399	Performance Criteria		Overcurrent devices designed to protect conductors shall operate on magentic principles and not depend upon thermal properties. Fans designed for emergency ventilation shall have the thermal overload relays by-passed and shall not trip due to overload unless excess current is sensed simultaneously with a no-air-flow signal. Cables used for emergency ventilation fans and associated dampers shall pass the flame propagation criteria per NFPA 130. All other electrical requirements associated with emergency ventilation system shall comply with NFPA 130, MRDC applicable codes and standards. Each emergency ventilation fan feeder circuit and its associated control cables, shall be kept separate/isolated from other emergency ventilation fan circuits via dedicated conduit(s) and manhole(s)/pullbox(es).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.11.2	VENTILATION SYSTEM FOR ANCILLARY ROOMS													
2400	Performance Criteria		Power supply for ventilation fans and mechanical equipment shall be from essential buses located in the Auxiliary Power or Electrical Room. All underground installations are classified as gassy and requires sufficient ventilation to prevent accumulation of gases to an explosive elvel. Ventilation fans shall be designed for continuous operation per NFPA 70.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.11.3	SUMP PUMPS													
2401	Performance Criteria		Each pump station shall be equipped with dual pumps. Pumps shall be fed from two independent essential power sources and independent feeders nearest to the pump station. Only one pump at a time may be out of service except during an area-wide power outage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.11.4	VENTILATION SYSTEM FOR AT-GRADE AND ELEVATED STATIONS													
2402	Performance Criteria		Where locations of at-grade and elevated stations are not classified as "gassy", all ventilation systems shall be fed from non-essential buses.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.11.5	ELEVATORS													
2403	Prescriptive Spec		This equipment shall be fed from the essential bus. The electrical power supply to the equipment shall consist of a nominal 480-volt, 3-phase, 60 Hz supply terminated in a fused disconnect switch in the machine room.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.11.6	ESCALATORS													
2404	Performance Criteria		This item is considered a non-essential load. Power shall be supplied from non-essential bus.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.11.7	SEWEGE EJECTOR PUMPS													
2405	Performance Criteria		Each pump station shall be equipped with dual pumps. Pumps shall be fed from two independent essential power sources and independent feeders nearest to the pump station. Only one pump at a time may be out of service except during an area-wide power outage	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.12	**POWER REQUIREMENTS FOR SYSTEMWIDE SUBSTATIONS AND MISCELLANEOUS YARD FACILITIES**													
		7.12.1	TRAIN CONTROL AND COMMUNICATION (TC&C) ROOM													
2406	Prescriptive Spec	A	208/120V, 3-phase, 4-wire power panel fed from the uninterruptible power supply shall be provided for all critical loads.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2407	Prescriptive Spec	B	2 208/120V, 3-phase, 4-wire power sources from the essential buses shall be provided in the TC&C Room for the ATC Panel, transformer and DC distribution system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.12.2	FARE COLLECTION SYSTEM													
2408	Performance Criteria		Provide dedicated essential power circuit with dedicated neutral and communication conduits. Refer to MRDC Section 9.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.12.3	TICKET VENDING MACHINES (TVMs)/ STAND ALONE VALIDATORS (SAVs), AND FARE GATES													
2409	Performance Criteria		Provide non-essential dedicated power circuit with dedicated neutral and provide 1" communication conduits.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.12.4	MAP CASES/DIGITAL DISPLAYS													
2410	Performance Criteria		Provide non-essential dedicated power circuit with dedicated neutral and provide 1" communication conduits.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.12.5	VISUAL MESSAGING SYSTEM (VMS)													
2411	Performance Criteria		Provide non-essential dedicated power circuit with dedicated neutral and provide 1" communication conduits. Refer to MRDC Section 9.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.12.6	COMMUNICATION EQUIPMENT AND FACILITIES													
2412	Performance Criteria		Provide power and service receptables (conduit and wiring) for communication systems as required. Refer to MRDC Section 9 for communication conduit requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.13	**LIGHTING**													
		7.13.1	GENERAL													

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2413	Performance Criteria		Lighting plays an important role in creating a safe and comfortable space for all passengers. Application of the luminaire and the efficacy of the luminaire (a measure of how well a light source produces visible light) contributes to improving the overall passenger experience of both interior and exterior station environments. It is essential that lighting be considered as an integrated element when establishing holistic station design solutions. Design of lighting is to be effective, aesthetically pleasing, and easy to maintain.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2414	Definition		Included in this subsection are the requirements for normal and emergency lighting systems. For lighting terms, definitions, goals, and application overview, see Appendix A.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2415	Standard Criteria		All interior and exterior lighting design and lighting control shall comply with MRDC Section 2 Environmental Considerations, California Building Energy Efficiency Standards, CCR Title 24, Part 6, California Green Building Standards Code, CCR, Title 24, Part 11, CALGreen.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2416	Performance Criteria		Provide dedicated powered circuit with dedicated neutral for each lighting branch circuit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A	The lighting system shall:													
2417	Performance Criteria	1	Be functional, yet complementary to those other aesthetic features in the public spaces that which provide an atmosphere of relative comfort, pleasantness and cleanliness of surroundings, and a sense of personal safety and security. Lighting for passenger stations should be bright, consistent, pleasant, and calming, cheerful. rather than harsh, stark, or dim	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2418	Performance Criteria	2	Provide adequate lighting levels rated for continuous operation, contrast ratios and other visibility attributes necessary to stimulate productivity, facilitate the use of facilities by passengers patrons or the successful completion of tasks in a timely yet safe manner, and maintain appropriate surveillance levels under all ambient light conditions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2419	Performance Criteria	3	Be relatively simple and economical to construct and maintain. Serviceability of the bulb replacement as well as driver access shall be capable from below the ceiling. The lighting design shall avoid the placement of luminaires in inaccessible locations (at height), or above equipment and other dangerous or fragile items.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2420	Performance Criteria	4	Be energy-efficient using LED luminaires, except as approved by Metro for specialized applications using luminaires for proper illumination of special station features, such as artwork or difficult to light areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2421	Performance Criteria	5	Be vandal-resistant / tamper-proof (in spaces accessible to passengers patrons or to the general public).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2422	Performance Criteria	6	Effectively control glare or other extraneous reflections in the visual field.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2423	Prescriptive Spec	7	Lighting shall be easy and safe to maintain. Luminaires with internal driver shall be easy to remove and replace. For luminaires mounted in high ceilings where there is no other option to provide adequate and appropriate lighting to a space, temporary scaffolding may be required for access and maintenance of the luminaire(s). Scaffolding must not completely block or unduly impede the flow of the traffic in the station. Luminaires that are not easily accessible shall have a long life with a life expectancy of 50,000 hours minimum, to avoid frequent replacement	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2424	Performance Criteria	8	LED strip ceiling luminaires in station concourse and platform interiors shall be flush mounted within perforated metal drop ceiling panels to avoid dust collection on luminaire surfaces. Lighting luminaires shall be easily accessible for ease of replacement. Layout of ceiling light luminaires shall be in regular staggered format as shown in standard drawings to ensure even lighting levels across platforms and concourses.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2425	Performance Criteria	9	Lighting design and photometric calculations in accordance to Tables 7.1, 7.2 and 7.3 shall take into consideration actual equipment layout, placement and location of appurtenances, machineries, catwalks, hoists, parked rail vehicles etc. which will impact illuminance or foot-candleat ground level. Illuminance level shall be maintained in the entire lighting area regardless of equipment size, location, etc. Illuminance level in between parked rail vehicles and buses shall also be maintained. Contractors shall provide a photometric study with lighting summary (including minimum, maximum, average foot-candles, uniformity ratio and other industry accepted values) for Metro to review, during the earliest feasible design phase.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2426	Performance Criteria	10	All artwork shall be illuminated. Lighting for artwork shall be coordinated with Metro Arts & Design and integrated in a manner that is consistent and compatible with the architectural, materials, features, language, and overall aesthetic. All artwork lighting shall be dimmable. Each artwork display location shall have a dedicated control panel to facilitate independent lighting levels and dimming appropriate to the specific artwork.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Lighting system efficiency shall be achieved by:													
2427	Performance Criteria	1	Selecting high efficiency light sources, LED drivers, and appropriate LED luminaires	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2428	Performance Criteria	2	Minimizing light spillage and light pollution	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2429	Standard Criteria	3	Exterior lighting shall conform to the backlight, uplight, and glare (BUG) requirements per California Building Energy Efficiency Standards, CCR Title 24, Part 6, and California Green Building Standards Code, CCR Title 24, Part 11, CALGreen.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2430	Prescriptive Spec	4	Exterior lighting shall not exceed the uplight value of BUG U0; full cutoff.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2431	Performance Criteria	5	Employing supplementary luminaires to achieve high task-illumination levels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2432	Performance Criteria	C	Consideration should be given to the location and arrangement of lighting circuits and panel configuration to accommodate retrofitted automated energy control devices. All electrical connections and cabinets shall be concealed from public view and accessible only to authorized Metro personnel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2433	Prescriptive Spec	D	Yard lighting shall provide sufficient illumination to permit operations and maintenance activities to be performed safely on a 24-hour basis. A minimum illumination of average-maintained 2 foot-candles, as measured at ground level, shall be provided. Light poles shall be grounded and bonded to the grounding system	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2434	Performance Criteria	D	Yard lights, towers, poles or stanchions shall be designed and located for easy and safe maintenance accessibility, minimize shadows, reduce light pollution per CALGreen and Los Angeles County Dark Sky compliance requirements, and avoid interference with operations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2435	Prescriptive Spec	D	Yard high mast poles shall be tapered tubular aluminum, used for area illumination and shall be accessible and limited to 70 feet in height. Poles with luminaire-lowering mechanisms shall not be used. Where practical, poles shall be located in the aisles used for OCS supports.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2436	Performance Criteria	E	Luminaires shall be provided with integral drivers LED board, fuse and power supply with 20kV/KA surge protector that meet and exceeds FCC 47 CFR 15 and MIL-STD 461F requirements and fuses. Remote LED drivers and power supplies are acceptable where accessibility and ease of maintenance is required and where an integrated driver or power supply is not able to achieve the optimal overall station lighting level and temperature	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2437	Performance Criteria	F	Stairwell illuminated handrails for underground, elevated, and at-grade stations shall be equipped with LED pod lighting that meets local codes and all applicable standards including American with Disabilities Act (ADA) regulation. LED pods that illuminate stairs both asymmetrically and symmetrically, allow for a low-glare and energy efficient approach to meeting egress and life-safety code required light levels. Lighting shall be asymmetric optic luminaire with a clear lens, mounted at rail nadir for low glare. Handrail and lighting assembly shall be integral to the handrail, vandal-resistant, NEMA 4/IP65 listed and UL listed as complete assembly, shall be from same manufacturer and conform to all applicable codes and standards. Handrail lighting power circuit(s) shall be supplied from emergency circuits and shall be designed to emphasize illumination on the top and bottom steps and landings. Luminaire assembly and driver shall be easy to access and replace.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2438	Performance Criteria	F	Provide sufficient lighting suitable for wet location complete with switching control system located in accessible spaces to crawl/under platform spaces for maintenance personnel access	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2439		G	For other locations where illuminated handrails are required, 7.13.1.F requirement shall apply	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2440	Performance Criteria	H	Portal canopy lighting for underground stations shall be accessible for ease of maintenance. LED luminaires shall have visible diodes and be recessed into the canopy outriggers, so the lens of the luminaire is flush with the bottom of the outrigger for optimal light output levels. All supporting electrical conduit shall be hidden within outrigger and central beam.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2441	Performance Criteria	I	Other lighting elements/luminaires/types shall not be attached to station canopy structures, including columns, beams, and outriggers. Exceptions may be made at the direction of Metro to address optimal lighting for portal artwork as required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2442	Performance Criteria	J	Lighting within underground stations at the mid-landing, concourse, and platform level shall generally be linear LED slot light laid out within a grid ceiling, recessed into the ceiling panel system. A staggered layout of recessed LED luminaires allows for general ambient light across station platforms. Luminaires must be independently suspended from the ceiling structure. Visible luminaire housing shall match surrounding surface materials and be flush with the ceiling. No lighting or lighting luminaires shall encroach on or obscure station artwork or signage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2443	Prescriptive Spec	K	For high ceiling areas in stair/escalator wells and entrance portals, supplemental lighting shall be provided by escalator skirt/balustrade lighting and handrail lighting. Ceiling luminaires requiring scaffolding for maintenance and wall-mounted light luminaires in these areas shall only be used as a last resort to meet minimum lighting requirements, shall not obscure station art, and shall only be used with Metro’s approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2444	Performance Criteria	L	Platform edge lighting shall be provided from a multi-purpose continuous linear LED downlight pendant assembly suspended above the platform edge and integrated within the platform edge signage. The integrated linear LED installed along the bottom of the signage panel houses a specular louver, which directs and concentrates the light on the platform edge, for decreased glare and narrow flood distribution, for increased concentrated light levels at the platform edge. The platform edge pendant assembly shall consolidate all equipment required at the platform level, including CCTV cameras and speakers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2445	Prescriptive Spec	M	Light poles within the boundaries of the station that are publicly accessible or visible shall be cylindrical and metallic, with a brushed silver (natural) aluminum finish. Nonmetallic including fiberglass poles are not permitted. Light Poles shall be free standing and employ a pole-top luminaire. An indirect asymmetric reflector with a clear glass lens shall be used to ensure low glare indirect lighting at exterior station public areas. Poles shall accommodate LED lighting, with the ability to internally house conduit for other technology such as speakers, cameras, and digital display information screens. Side of pole shall have an adequate number of secure and flush mounted access panels, matching pole finish to accommodate for installation of future equipment and related conduit infrastructure. Refer to Architectural Standard and Directive drawings for general location of light poles. Pedestrian-scale light poles shall place the luminaire at 12 feet above the finished surface.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2446	Performance Criteria	N	Lighting for underpasses shall be located on the underside of elevated stations or bridge/overpass structures, shall be a ceiling mounted linear wall-wash luminaire that illuminates vertical surfaces with RGBA color changing illumination. Additionally, LED linear slot lights at the ceiling shall be provided to provide uniform illumination for safety and security throughout the space.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2447	Prescriptive Spec	O	All luminaires should consider R9 color performance. The standard deviation color matching (SDCM) MacAdam ellipse for all LED sources shall not exceed 2 for interior or 3 for exterior applications.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2448	Prescriptive Spec	P	LED drivers shall exhibit a rated lifetime of 50,000 hours or more for their rated application and shall be dimmable to 1% flicker free. The luminaires should exhibit a minimum efficacy of 60 Lm/W for interior applications and 55 Lm/W for exterior applications.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2449	Prescriptive Spec	Q	Flexible conduit can be used for recessed mounted ceiling luminaires for 6 feet long maximum.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		7.13.2	NORMAL ILLUMINANCE VALUES													
2450	Prescriptive Spec	A	The design illuminances shall be target, average maintained values as listed in Table 7.1 and 7.2. However, illumination levels for tasks requiring sustained visibility shall be a minimum of 20 foot-candles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2451	Prescriptive Spec	B	Illuminance values not listed in Table 7.1 and 7.2 shall be those recommended by the IES and APTA for the particular (or sufficiently similar) activity, using a zero weighing factor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2452	Performance Criteria	C	The illumination on all entrance and exit roadways shall be graduated up or down to the illumination level of the public street or highway, as much as practical.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2453	Standard Criteria	D	Illumination for access roadways shall be in accordance with IES RP-8 recommended. level	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2454	Performance Criteria	E	Art work illumination shall be approved by the architect in coordination with Metro Art Program Department.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.13.3	LIGHT CONTRAST													
2455	Performance Criteria	A	Outdoor luminaires shall be so positioned that they do not result in glare or otherwise hinder nighttime train movements. Care must be taken to minimize glare on adjacent properties or to motorists. This is particularly important in residential areas. Exterior lighting shall conform to the backlight, uplight, and glare (BUG) requirements per California Building Energy Efficiency Standards, CCR Title 24, Part 6, and California Green Building Standards Code, CCR, Title 24, Part 11, CALGreen.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2456	Performance Criteria	B	Small areas for accent artworks, design interest, or message purposes, such as for station identification, destination sign, map case/digital display, safety or guidance, will be allowed to have brightness ratios in excess of the preceding criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2457	Performance Criteria	C	Luminaires in staffed control rooms should be so positioned that no reflected glare from meter faces or cathode ray tube monitoring screens meets the operator's eyes while in front of at his workstation	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.13.4	EMERGENCY ILLUMINANCE VALUES													
2458	Prescriptive Spec	A	Emergency levels shall be target, average maintained values as listed in Table 7.3	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2459	Performance Criteria	B	Emergency and exit lights in underground areas shall be located so as to minimize the possibility of being obscured by stratified smoke from a fire.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.13.5	EMERGENCY AND NORMAL LIGHTING													
		A	Emergency Lighting:													
2460	Performance Criteria		All public and non-public areas within passenger stations shall be equipped with emergency lights. For tunnel lighting, see 7.13.7. All emergency lighting branch circuits shall be carried in separate conduits running from the emergency lighting power supply unit to the emergency luminaire lighting fixture. All other requirements shall conform to NFPA 70National Electric Code Article 700. Canopy emergency lighting shall be connected to lighting control panel with automatic overrides to remain 'on' during power outage on emergency condition. Provide separate and dedicated emergency lighting circuits (4 minimum) each circuit with dedicated neutral for U/G station platform edge lighting systems. Dedicated circuits shall be supplied separately from each station's Auxiliary Power Rooms emergency lighting power supply source by way of UPS critical panels.both sides of the station auxiliary power rooms (APR) UPS vital panels, emergency lighting APR vital panels. Platform emergency edge lighting shall be separated in quadrants northeast and northwest, southeast and southwest for circuiting. U/GUnderground station platforms emergency lighting circuits shall have independent and separate circuits from and mezzanine concourse levels. All rooms shall have emergency lighting	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Normal Lighting:													
2461	Performance Criteria		All public and non-public areas within passenger stations shall be equipped with normal lighting. Underground station platforms normal lighting circuits shall have independent and separate circuits from the mezzanine and concourse levels	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.13.6	LIGHTING CONTROL PANEL													
2462	Standard Criteria	A	Lighting control shall comply with California Building Energy Efficiency Standards, CCR Title 24, Part 6, and California Green Building Standards Code, CCR, Title 24, Part 11, CALGreen. including but not limited to the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		1	Interior													
2463	Standard Criteria	a	Multi-Level Lighting Controls	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2464	Standard Criteria	b	Shut-Off Controls	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2465	Standard Criteria	c	Automatic Daylighting Controls	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2466	Standard Criteria	d	Demand Responsive Controls	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		2	Exterior													
2467	Standard Criteria	a	Outdoor Lighting Controls and Equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2468	Standard Criteria	b	Sign Lighting Controls	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Emergency Lighting Control													
2469	Performance Criteria		Luminaires that are designated for emergency lighting, and are intended to function in emergency mode only when normal power is absent is not required to be automatically controlled in accordance with CCR Title 24, Part 6.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2470	Performance Criteria		Emergency lighting in underground structure shall only be switched at the breaker panel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2471	Performance Criteria		For exterior emergency lighting and in transition areas between exterior and interior, a photocell and/or astronomic time-clock shall be from the Lighting Control Panel and shall be used to turn off the lighting during daytime.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2472	Performance Criteria		The photocell unit shall be located where no artificial light such as street lighting, building wall-packs, and other lights causing the lighting system to shutoff and interferes with its function. Photocell shielding shall be approved by Metro. Landscape shall not obstruct/interfere with the ability to provide control sensing. Photocell shall be listed and rated for the environmental temperature it serves.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Normal Lighting Control													
2473	Performance Criteria		Normal lighting at ancillary and services areas shall be controlled by the Lighting Control Panel with wall switches and occupancy sensors utilizing dual technology of PIR and Microphonics to turn off the lights when the spaces are unoccupied. Provide daylighting as applicable	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Exterior Lighting Control													
2474	Performance Criteria		Exterior lighting shall be controlled by the Lighting Control Panel with the minimum of photocells, motion sensing controls, and astronomic time-clock control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		E	Auxiliary Power Room and Other Electrical Rooms													
2475	Performance Criteria		Auxiliary Power Rooms and other electrical rooms subject to NFPA 70 are not to be controlled by automatic means in accordance with CCR Title 24, Part 6 Building Energy Efficiency Standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		F	Rail Operation Control (ROC)													
2476	Performance Criteria		Lighting shall have “state of the art” lighting control system complete with features including but not limited to dimming, daylighting, individual and/or zone control in compliance with CCR Title 24, Part 6, Building Energy Efficiency Standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		G	Public Areas													
2477	Performance Criteria		Lighting control at public areas shall be coordinated with Metro. Normal and emergency lighting at street levels shall be controlled by the Lighting Control Panel. These lights shall also be controlled at the rooms accessible to the transit police and maintenance crews.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		H	Lighting Control Equipment													
2478	Performance Criteria		A UL listed, factory-assembled digital Lighting Control Panel with 365-day astronomic time clock, networked lighting control devices and equipment including but not limited to exterior mounted photoelectric cell(s), occupancy and motion sensors, light switches, dimming control switches, daylighting controls, and demand response controls shall be supplied. The photocell unit shall be located where no artificial light such as street lighting, building wall packs, and other lights causing the lighting system to shutoff and interferes with its function. Photocell shielding shall be approved by Metro. Landscape shall not obstruct/interfere with the ability to provide control sensing. Photocell shall be listed and rated for the environmental temperature it serves. Lighting control panel shall be installed in the electrical room accessible to designated transit police and maintenance personnel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.13.7	TUNNEL LIGHTING													
2479	Prescriptive Spec		Lighting shall be provided for tunnel walkways per Table 7.3 and track level per Table 7.1. Refer to Electrical Standard Drawing ES-106.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2480	Prescriptive Spec		Each tunnel shall be illuminated by Light Emitting Diode (LED) Luminaire spaced evenly throughout the tunnel. Luminaire shall be a type to eliminate glare to train operator. Luminaire shall be FCC 47 CFR 15 listed and certified. Each tunnel luminaire shall be equipped with two independent LED (board and driver) assemblies and each LED assembly shall be supplied board fed from two different UPS power sources. Two separate UPS powersources to tunnel lights on each side of the tunnel shall be provided from two stations adjacent to each side of tunnel. If a tunnel is not in close proximity to the stations and makes it impractical to provide tunnel lighting power from the stations, two independent at-grade utility power sources shall be provided, one at each end of the tunnel portal. The two UPS sources shall be provided for back-up in-cases of utility power sources outages. Spacing of fixtures shall be 25 feet on center, with two high lumen output lamps. Use 1-pole, 20A circuit breaker on each dedicated circuit with dedicated neutral. Tunnel lighting installation shall include last section of guideway tunnel next to underground portal. Underground wiring and conduit shall be provided for redundant feeders in separate conduits to power tunnel lights from opposite direction. Refer to 7.10.13 for UPS requirement.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.13.8	EGRESS													
2481	Prescriptive Spec		Egress shall have an Illuminance/Exitance requirement as per Table 7.2, with an emergency lighting minimum as per Table 7.3.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.13.9	GUIDEWAY LIGHTING													
2482	Performance Criteria		Egress for passengers shall be in conformance with Metro Fire/Life Safety Design Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.13.10	CALCULATIONS													
2483	Performance Criteria	A	Calculations shall conform to IESNA procedures and recommendations. Calculated values shall be presented on calculated illuminance/exitance summary form 7-A.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2484	Performance Criteria	B	Computer software photometric calculations must be performed for all areas including but not limited to station public areas and egress routes,train crossing, etc. to assure competent and thorough lighting design. Photometric drawings with lighting summary and calculations for both normal and emergency lighting shall be provided based on lighting software AGi32 or approved equivalent.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2485	Prescriptive Spec	C	Illumination levels for work areas shall be calculated at the working plane, generally a horizontal plane set at 2'-6" above the finished floor level, except that for task lighting the actual working height shall be used whenever this information is available.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2486	Performance Criteria	D	Illumination levels for walking surfaces, egress paths and security lighting shall be calculated at the surface being illuminated, except as otherwise required by codes or regulations or as specified herein.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2487	Prescriptive Spec	E	Lighting calculations shall be based on Light Loss Factor (LLF) of no higher than 70% in all areas except in conditioned spaces.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2488	Performance Criteria	F	Reflectance values shall be based, whenever possible, on the actual reflectances of the proposed materials. Generally, material used shall meet the reflectance values tabulated in Tables 7.2, and 7.4. Where specific reflectances are not available, use appropriate value from IES Standard.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.14	CONTROLS, METERING AND INSTRUMENTATION													
		7.14.1	GENERAL													
2489	Performance Criteria		Under normal conditions, supervision of the local auxiliary electrical equipment, including control and monitoring of the essential functions shall be performed remotely at Rail Operations Control (ROC)central control. This supervision shall be accomplished by integration of SCADA system, the cable transmission system (CTS), and the fire and Emergency Management (F&EM) system. Local controls and annunciation (alarm indication) shall also be provided at each facility to permit standby supervision and control of the equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.14.2	FUNCTIONS													
2490	Performance Criteria		Auxiliary power and UPS equipment that require remote and local control and monitoring including but not limited to auxiliary power transformers, main breakers, tie-breaker, and feeder breakers in main switchgears/switchboards, MCCs, UPS, and Local Control Stations shall be fully equipped with devices and terminal blocks to accommodate wiring and termination of input and output (I/O) from ROC SCADA I/O points and Local Control and monitoring stations. The auxiliary power and UPS equipment shall provide for the accommodation of auxiliary contacts with at least one spare for all local and remote functions of the ROC SCADA system to provide a complete operational system. Refer to Section 9 Appendix B for complete I/O SCADA points and Electrical Directives Drawings applicable to remote control and monitoring of auxiliary power and UPS equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.14.3	LOCAL ANNUCIATION													
2491	Performance Criteria		Local annunciation and control shall be provided per equipment manufacturer standards, applicable codes, and Metro requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		7.15	ENVIRONMENTAL AND SUSTAINABILITY INITIATIVES (ESI)													
2492	Performance Criteria		Electrical design shall be based on specific project requirements. Electrical design shall be coordinated with MRDC Section 2 Environmental Considerations, MRDC Section 3 Civil, MRDC Section 5 Structural and MRDC Section 6 Architectural.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2493	Performance Criteria	A	Electrical service equipment shall provide Photo-Voltaic (PV) system feeder interconnection, protection and raceways.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2494	Performance Criteria	B	Electrical and PV equipment, Battery Energy Storage System (BESS) space and raceway requirements shall be coordinated with related MRDCs.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2495	Performance Criteria	C	Electrical energy metering equipment and associated raceways shall be provided for the monitoring of the separation/disaggregated electrical loads and system integration.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2496	Performance Criteria	D	Electric Vehicle Service Equipment (EVSE) shall be provided with power and associated communication raceways.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2497	Performance Criteria		Design of PV system and BESS shall be coordinated with MRDC Section 2.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8	MECHANICAL													
		8.1	MECHANICAL													
		8.1.1	GENERAL													
2498	Performance Criteria	A	Introduction This document describes criteria for the design of Heating, Ventilating and Air Conditioning (HVAC) Systems for the Metro Rail projects. The systems covered in these criteria are for the fixed facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2499	Performance Criteria	B	HVAC System Components – Heavy Rail	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2500	Performance Criteria	B1	Underground Stations & Tunnels The HVAC includes the following (Figures 8-1 & 8-2):	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2501	Performance Criteria	B1a	Underplatform Exhaust (UPE) System 1) Captures heat released by trains in the station. 2) May supplement tunnel emergency ventilation system in the event of a train fire in tunnel. 3) May be used for gas mitigation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2502	Performance Criteria	B1b	Overplatform Exhaust (OPE) System 1) Extracts fire heat and smoke from a train fire in a station. 2) May be used for gas mitigation. 3) OPE System shall be determined by emergency station ventilation modeling using computational fluid dynamics (CFD) software program.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2503	Performance Criteria	B1c	Concourse Exhaust System (CES) 1) Exhaust smoke from station concourse. 2) Exhaust gases from station concourse 3) CES System shall be determined by emergency station ventilation modeling using computational fluid dynamics (CFD) software program.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2504	Performance Criteria	B1d	Emergency Ventilation System (EVS) Multi-purpose, two speed, 100 percent reversible fans located at both ends of subway stations shall serve the emergency ventilation system and the gas mitigation system. 1) Fan rooms located at both ends of each subway station. 2) Ventilates stations and tunnels. 3) Provides air passage to and from surface. 4) Used for station and tunnel fire emergencies. 5) May be used for station ventilation with outside air on extremely hot days. 6) Used for gas mitigation. 7) Located as required in mid-tunnel vent shafts. 8) EVS shall not be used for dust mitigation purpose.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2505	Performance Criteria	B1e	Ancillary Space HVAC Systems Provide ventilation and air-conditioning for ancillary rooms and equipment rooms, and described in Paragraph 8.1.6, Underground Station Non-Public Area Ventilation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2506	Performance Criteria	B2	Above ground Stations – Heavy Rail	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2507	Performance Criteria	B2a	Enclosed Stations- To Be Determined (TBD) if required	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2508	Performance Criteria	B2b	Ancillary Space HVAC Systems – Provide HVAC for ancillary rooms and equipment rooms, as described in Paragraph 8.1.6 Underground Station Non-Public Area Ventilation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2509	Performance Criteria	C	HVAC System Components – Light Rail	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2510	Performance Criteria	C1	Underground Stations and Tunnels The HVAC includes the following (Figures 8-3 & 8-4):	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2511	Performance Criteria	C1a	Station Over Trackway Exhaust (OTE) System 1) Captures heat released by the trains in the stations. 2) Supplements the emergency ventilation system (EVS) for station and tunnel fires. 3) Removes smoke from station platform public area generated by fire. 4) May be used for gas mitigation. 5) OTE System shall be determined by emergency station ventilation modeling using computational fluid dynamics (CFD) software program.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2512	Performance Criteria	C1b	Emergency Ventilation System (EVS) Multi-purpose, two speed, reversible fans located at both ends of subway stations shall serve the emergency ventilation system and the gas mitigation system. 1) Fan rooms located at both ends of each subway station. 2) Ventilates stations and tunnels. 3) Located as required in mid-tunnel vent shafts. 4) Provides air passage to and from surface. 5) Used for station and tunnel fire emergencies. 6) Used for station ventilation with outside air. 7) Used for gas mitigation. 8) EVS shall not be used for dust mitigation purpose.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2513	Performance Criteria	C1c	Concourse Exhaust System (CES) 1) Provided to expel smoke from station concourse public. 2) May be used as part of the gas mitigation system. 3) CES System shall be determined by emergency station ventilation modeling using computational fluid dynamics (CFD) software program.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2514	Performance Criteria	C1d	Underplatform Exhaust (UPE) System 1) Used for Dust Control to capture dust released by trains in the stations. Shall be included in dust study. Alternate method of dust control shall require prior Metro approval. 2) May supplement tunnel emergency ventilation system in the event of a train fire in tunnel. 3) May be used for gas mitigation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2515	Performance Criteria	C2	Above Ground Stations – Light Rail a. Enclosed stations – TBD if required b. Ancillary Space HVAC Systems – Provide HVAC as described in Paragraph 8.1.6, Underground Station Non-Public Area Ventilation. c. Transit operations booth - TBD if required. Provide heating and cooling and employee toilet exhaust ventilation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2516	Performance Criteria	D	Yards and Shops HVAC Systems Provide heating, ventilation, and air conditioning for offices, equipment rooms, and maintenance shops as per local codes and CAL OSHA.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2517	Performance Criteria	E	Control and Monitoring	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2518	Performance Criteria	E1	Local Control Panels a. Located in stations and motor control centers. Overrides remote control from the Rail Operations Control (ROC) and Emergency Management Panel (EMP). b. Used by maintenance personnel to operate equipment for testing and maintenance, and in event of failure of central control system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2519	Performance Criteria	E2	Central Control and Monitoring a. Located in the ROC. b. Controls and monitors mechanical and electrical equipment throughout system. c. Overrides manual or automatic HVAC Controls during normal operation as required, except controls from a local control panel. d. Activates emergency ventilation system manually in case of fire for preprogrammed sequence, Emergency Ventilation Operating Procedures (EVOP), after selection of evacuation route by Supervisor of Operations (ROC). e. UPE is thermostatically controlled once the ROC enables it.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2520	Performance Criteria	E3	Control at the EMP a. Located near the station entrance. Overrides remote control from the ROC. EMP must control ventilation with or without ROC and without any single point failure when ROC connection is lost. b. Used by emergency response personnel in the event of failure of the Central Control System.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.2	APPLICABLE DOCUMENTS													
2521	Standard Criteria		Unless otherwise required herein, the air-conditioning and ventilation system design shall conform to the latest editions and applicable standards, codes, and recommended guidelines of the following organizations: Air Movement and Control Association, Inc. (AMCA) American National Standards Institute (ANSI) American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) American Society for Testing and Materials (ASTM) California Building Code (CBC) California Code of Regulations (CCR), Title 24 California Occupational Safety and Health Administration (CAL/OSHA) Los Angeles City and County Building Codes Los Angeles City and County Mechanical Codes Los Angeles City and County Plumbing Codes Los Angeles City and County Fire Codes National Electric Code (NEC) National Fire Protection Association (NFPA) Sheet Metal and Air-Conditioning Contractor's National Association (SMACNA) Subway Environmental Design Handbook Vol. 1, 2nd Edition, 1976	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.3	FUNCTIONAL REQUIREMENTS													
2522	Standard Criteria	A	Underground Station and Tunnel This section applies to the HVAC Systems for the station public areas and subway tunnels. Control of environmental conditions (temperature, air velocity, air pressure, smoke removal, noise, etc.), in the stations and tunnels is necessary to meet the diverse needs of normal operations, congestion, and emergencies, including a fire within the system. In areas classified as "Potentially Gassy" or "Gassy" by CAL/OSHA, all ventilation systems may be used for gas mitigation. The accumulation of dust in the tunnels and stations shall be considered in the ventilation studies in order to assure the creation of an environment that provides reasonable cleanliness in accordance with the general practice in rail systems. Dust criteria based on US EPA National Ambient Air Quality Standard criteria of PM 10 = 150 microgram per cubic meter of air (24-hr time weighted average) and PM 2.5 = 35 microgram per cubic meter of air (24-hr time weighted average).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2523	Standard Criteria	A1	Emergency and Smoke Exhaust Systems **a.** During a fire emergency within the subway system, an emergency ventilation system shall provide outside air to assist passenger evacuation and purge smoke from the subway systems. Computer simulations shall be used to establish emergency fan system modes. **b.** A smoke exhaust system shall be provided at the mezzanine or concourse ceiling of the station to purge pockets of cold smoke that lingers after a fire. The smoke exhaust system is part of the emergency ventilation system. Option to provide a separate independent smoke exhaust system with Metro approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2524	Standard Criteria	A2	Heavy Rail **a.** Station public area ventilation is achieved by a combination of UPE plus piston effect ventilation through the station entrances and the ventilation shafts at the ends of the stations. An UPE system captures much of the heat released and dust from trains in the station, before it can enter the public area. **b.** Limited tunnel ventilation is achieved through the piston action of moving trains. Tunnel air is expelled from the system as a train approaches tunnel ventilation shaft, outside air is drawn into the system in the wake of a train. **c.** The station air velocities are limited by tunnel-to-tunnel venting and the bypass airflow path to and from the outdoors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2525	Standard Criteria	A3	Light Rail **a.** Station ventilation will be achieved by the piston action of the moving trains, supplemented by mechanical ventilation. **b.** Station public-area ventilation is achieved through an air exhaust system provided by the two speed 100 percent reversible emergency/station ventilation fans. These fans are used in either exhaust or supply mode for tunnel emergency ventilation. **c.** Over Trackway Exhaust System shall capture much of the heat released from trains in the station, before it can enter the public area. **d.** Option to use a UPE system to captures heat released and dust from underside of trains in the station, before it can enter the public area.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2526	Standard Criteria	B	Ancillary Space HVAC HVAC systems shall be provided in ancillary spaces to maintain an acceptable environment for the operating and maintenance personnel, to prolong the life of equipment by proper control of temperature, pressure, and humidity, and to mitigate possible gas accumulation. Refer to Table 8-1 for design conditions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2527	Standard Criteria	C	Yards and Shops HVAC HVAC systems shall be provided in these facilities to maintain an acceptable environment for the operating and maintenance personnel and to prolong the life of equipment by proper control of temperature, pressure, and humidity. Refer to Table 8-2 for design conditions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2528	Standard Criteria	D	ROC HVAC HVAC systems shall be provided in the ROC to maintain an acceptable environmental for operating and maintenance personnel and to prolong the life of equipment by proper control of temperature, pressure, humidity and dust. Refer to Table 8-1 for design conditions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.4	DESIGN PARAMETERS													
2529	Standard Criteria	A	Ambient Conditions	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2530	Standard Criteria	A1	Subway HVAC Design (Public Area Platform and Concourse) a. Summer Outside Peak Design Conditions 1) Dry Bulb Temperature 84°F Based on ASHRAE 1989 5% frequency of occurrence adjusted to 5:00 PM 2) Wet Bulb Temperature 70°F 3) Mean Daily Temperature Range (Dry Bulb) 20°F Based on ASHRAE 1989 4) Extreme Dry Bulb 105.5°F Based on ASHRAE 2009 for LAX, 50 year occurrence. This value is not a comfort value but an extreme condition which the subway must safely operate at. 5) Winter Minimum Dry Bulb Temperature 36°F	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2531	Standard Criteria	A2	Ancillary Spaces and Yards and Shops Design a. Summer Outside Peak Design Conditions 1) Dry Bulb Temperature 90°F Apply temperature data specific to location of Yard and Shops, which is higher than 90 °F. Yards that are located outside of Los Angeles City shall use peak temperature based on ASHRAE 2.5% frequency of occurrence. 2) Wet Bulb Temperature 70°F b. Winter Outside Minimum Dry Bulb Temperature 36°F	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2532	Standard Criteria	B	Design Conditions for Normal Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2533	Standard Criteria	B1a, b	Station Design Conditions - Ventilated Station a. Ideal Dry Bulb Temperature 84°F Acceptable Dry Bulb Temperature 89°F b. Humidity No Control	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2534	Standard Criteria	B1c	Peak Air Velocity - The average of the highest measurable air velocity rates, occurring for longer than a five to eight second period which includes the maximum air velocity, resulting from the fluctuations caused by the piston action of moving trains. The Subway Environment Simulation (SES) shall be used to confirm the resistance of the tunnel-to-tunnel venting is sufficiently small to maintain air velocities at or below criteria. Peak Air Velocities generated on the Horizontal Surfaces (Platform, Concourse, Entranceways) where most of the passengers are expected to be (at the middle segment of the station, between the station centerline and the platform safety stripe) while awaiting train service.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2535	Standard Criteria	B1d	The "average" station velocity shall not exceed 600 fpm. (Note: Average Air Velocity – Any reference to an "average" value shall be interpreted to mean an "average absolute velocity over train headway". These airflows occur during normal operations. Absolute values are used to calculate velocities so that both negative and positive values of velocity contribute to the average.)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2536	Standard Criteria	B1e	Air Pressure Transients for Patrons The criterion for rapid pressure changes, applicable when the total change in pressure is greater than 0.10 psi (2.8 in. wg), is that no person, patron or employee, shall be subjected to a rate of pressure change greater than 0.06 psi per sec (1.7 in. wg per sec).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2537	Standard Criteria	B1f	Station Outdoor Air Requirements Following the ANSI/ASHRAE Standard 62.1, the outdoor air rate for the station shall be 7.5 cfm per person plus 0.06 cfm/ft2 for transportation waiting areas. If occupancy data cannot be obtained from the link load analysis or other means, the outdoor air requirement shall use the standard recommended design occupancy recommended in the standard of 100 people per 1,000 ft2. If necessary, the station outdoor air requirement can be adjusted based on the procedures in Standard 62.1, Section 6.2.6 "Design for Varying Operating Conditions." This is possible because peak occupancy may only occur for a short duration.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2538	Standard Criteria	B2	Tunnel Design Conditions	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2539	Standard Criteria	B2a, b, c	**a.** Dry Bulb Temperature Expected Average Maximum - 104ºF **b.** Humidity - No Control **c.** Air Velocity Unoccupied Tunnels - No Control Occupied (maintenance workers, etc.) - minimum air velocity 150 fpm or as per Paragraph 8.1.4.F, whichever is greater Occupied (maintenance workers, etc.) - maximum air velocity 2200 fpm (note this may restrict train speeds)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2540	Standard Criteria	B2d	Air Pressure Transients - Stations and Tunnels Air pressure transient effect on personnel shall comply with 8.1.4 B.1.e. As per Paragraph 8.1.4.H, on-board and in-station pressure transients shall be calculated in accordance with the methodology described in the Subway Environmental Design Handbook (SEDH) or by using the Subway Environment Simulation Computer Program (SES), whichever is more appropriate. Ducts and other mechanical equipment and support systems exposed to air pressure caused by train movement, in the station public areas and within the tunnel trainway shall be designed to withstand the pressure transient loading and pressure reversals. The SES computer program shall be used to calculate wayside pressure change criteria as per Paragraph 8.1.4.H.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2541	Standard Criteria	B2e	Ancillary Space Design Conditions Ancillary space design conditions for stations, and design conditions for spaces in yards and shops facilities shall be in accordance with the requirements listed in Section 8.1.6.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2542	Standard Criteria	B2f	Trains in Ventilation Zone	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2543	Standard Criteria	B2g	A ventilation zone is defined as a tunnel segment bounded on its ends by either a ventilation shaft or a portal. Refer to Fire Life Safety Criteria Section 2.3.9.2 for number of trains in ventilation zone. Tunnel Air Temperatures – Average The average tunnel air temperature shall not exceed 104�F. The peak tunnel air temperature shall not exceed the criterion for Congested Operations as shown in Section 8.1.4.E.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2544	Standard Criteria	B2h	Bypass Dampers - All underground rail station (heavy rail and light rail) ventilation shafts shall include by-pass dampers. Provide direct bypass into exhaust shaft. Do not bypass through Emergency Fan Room.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2545	Standard Criteria	C	Design Conditions for Transit Vehicle Air-Conditioners The design air temperature at the intake to the vehicle air-conditioner condensers shall not exceed 113°F.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2546	Standard Criteria	C1	Station Design Conditions If the air conditioning condensers are located below the floor of the train (heavy rail vehicle), then this applies to the bulk (fully mixed in a vertical plane) temperature of the air beneath the floor. If the condensers are located on the train rooftops (light rail vehicle), then this applies to the stratified temperature of the air above the train.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2547	Standard Criteria	C2	Tunnel Design Conditions If the condensers are located below the train, (heavy rail vehicles), this temperature shall be the bulk (fully mixed in a vertical plane) tunnel air temperature. If the condensers are located on the train rooftops, (light rail vehicle), this temperature shall be the temperature of the stratified layer of air above the train.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2548	Standard Criteria	D	Design Conditions for Emergency Operations-Underground The most critical fan shall be assumed to be out of service during the tunnel and station SES and Computational Fluid Dynamics (CFD) analyses. Stations: one fan out with one car burning and no fans out with two cars burning. Tunnels: one fan out with two cars burning. The temperatures in this paragraph are based on the emergency scenario of a serious fire involving a single three-car train: (Light rail), single six-car train (Heavy Rail).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2549	Standard Criteria	D1	Station Design Conditions The following design condition is applicable to platform areas and entrances, including the evacuation route of passengers in an emergency. Maximum Temperature in Evacuation Route (Tenable environment): 120°F	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2550	Standard Criteria	D1a-e	**a.** HEAVY RAIL: Fully Developed Train Fire Heat Release Rate (FHRR) for 2 cars burning shall be 86,528,000 Btu/hr. Also refer to Fire Life-Safety Criteria for complete data on Fire Growth rates, Smoke Release rates and Fire Properties. **b.** LIGHT RAIL: Fully Developed Train Fire Heat Release Rate for 2 cars burning shall be 67,712,000 Btu/hr. Also refer to Fire-Life Safety Criteria for complete data on Fire Growth rates, Smoke Release rates and Fire Properties. **c.** Heavy Rail/Light Rail Visibility Criteria per NFPA 130 (2010) B.2.1.3 Smoke Obscuration Levels. Also refer to Fire Life Safety Criteria. **d.** Station time of tenability Criteria per NFPA 130 (2010). Also refer to Fire Life Safety Criteria. For a station, the ventilation system must maintain a certain time-of-tenability during a large fire for the platform. **e.** Station Air Velocities During emergency situations, the ventilation system shall operate to maintain a tenable environment. Velocities do not have to be maintained at a comfortable level but they shall not impede people from evacuating safely. The SEDH and NFPA 130 recommend a limit of 2,200 fpm opposing the direction of intended travel (egress).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2551	Standard Criteria	D2a-e	**a.** For emergency ventilation design purposes, the path of evacuation is to include both the open tunnel and the annulus between the train and the tunnel walls as required. (The path of evacuation for evacuation time, etc. is defined in other Design Criteria.) **b.** Appropriate ventilation shall be maintained for at least one path of evacuation from the fire site to a point of safety. **c.** The maximum temperature in the path of evacuation shall not exceed 120ºF, ignoring radiant heating effects. **d.** The air velocity in the path of evacuation shall not exceed 2,200 fpm opposing egress. Above 2,200 fpm people may experience difficulty in walking. The minimum airflow required during an emergency shall be at least 150 fpm in the full tunnel area in the path of egress. **e.** The emergency ventilation operating modes must account for the adjacent tunnel acting as a path of egress. The capacity of the equipment must account for the adjacent tunnel acting as a path of egress.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2552	Standard Criteria	D2f-j	**f.** With one critical fan out of service, the annular critical air velocity (the velocity in the train-tunnel annulus) in the path of evacuation shall not be less than that required to control the direction of spread of smoke and hot gases from a fire having with the full heat release. Critical velocity requirement applies in tunnels and in crossovers. Critical air velocity is defined below. Annular Critical Velocity The Metro Project shall adhere to critical air velocity calculations, which are based on the annular cross sectional area. This procedure is detailed in the SES 4.1 Users Manual. The annular cross sectional area is calculated by subtracting the cross section area of the train from the full cross sectional area of the tunnel. (See Figure 8-6.) **g.** Trains in Ventilation Zone A ventilation zone is defined as the area between two adjacent ventilation shaft inlets and/or portals. For A pictorial representation refer to Metro Fire Life Safety Criteria (Section 2.3.9.2 Figure 2-2) Figure 8-7 Not Used **h.** Cross-passages open- One cross-passage open **i.** Bypass Dampers - All underground stations (heavy rail and light rail) station ventilation shaft shall include by-pass dampers. **j.** Tunnel time of tenability Criteria per NFPA 130 (2010). Also refer to Fire-Life Safety Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2553	Standard Criteria	E	Congested Operations Criteria	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2554	Standard Criteria	E1	Air Velocities "Peak" velocity experienced in the station during congested operations shall not exceed 1,000 fpm. The average velocity in the station shall not exceed 600 fpm. This excludes the airflow within two feet of the train perimeter.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2555	Standard Criteria	E2	Tunnel Air Temperature – Peak The temperature shall not exceed 113ºF. If air conditioning condenser intakes are located on the top of the train, the maximum bulk temperature will need to be reduced based on a two- or three-dimensional analysis of the tunnel area and air conditioning units.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2556	Standard Criteria	F	Maintenance Operation Criteria In addition to meeting the emergency requirements, the emergency ventilation system must be able to meet the maintenance ventilation requirements. The tracks and tunnels will be maintained with diesel equipment. Diesel fumes in enclosed environments can cause an unhealthy environment for workers when not properly ventilated. For the underground portion of the project, dilution of these fumes to acceptable concentrations shall be achieved using the emergency ventilation system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2557	Standard Criteria	F	Ventilation Requirements Operations of diesel vehicles inside a tunnel are subject to the California Code of Regulations, Title 8, Subchapter 20, Tunnel Safety Orders, Article 17, Section 8470. The regulation currently requires a minimum of 60 lineal feet per minute, 100 cubic feet per minute (cfm) per diesel brake horsepower plus 200 cfm per person underground. Based on these airflow requirements, the maximum volume rate of air needed during maintenance will be determined. The estimated required volume flow rate is 87,000cfm per tunnel bore with one rail track. The emergency ventilation system shall be able to supply this volume of air to each ventilation zone with the maintenance vehicle present (not intended to have maintenance underway in two parallel tunnels simultaneously).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2558	Standard Criteria	F	The aerodynamic properties of the maintenance vehicle will be adequately modeled to show the ventilation system can overcome the maintenance train aerodynamic resistance when supplying the volume of air needed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2559	Standard Criteria	G	Ventilating for Methane and Hydrogen Sulfide - The required design air velocity in underground facilities and tunnels to control methane and hydrogen-sulfide is 150 fpm. This airflow velocity shall be required continuously during non-operating conditions, and also during the operation of the Emergency Back-up Power System (EBPS). Coordinate with section 9 Systems, par. 9.19 Traction Power, for the design of the Emergency Back-up Power System (EBPS).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2560	Standard Criteria	H	Analysis for Tunnel and Station Public Area Ventilation Design Basis LA Metro shall be modeled using the Subway Environment Simulation Computer Program Version 4.1 (SES) (or later) for design of the emergency ventilation system. The procedures used to model the system shall follow the SES Version 4.1 user's manual (or later). The SES simulates train movement, airflow, humidity, air and wall temperatures, and emergency fire situations. Simulations shall be performed to assure the system meets the design requirements. For emergency station ventilation, the station shall be modeled using a three dimensional computation fluid dynamics (CFD) created in a commercially available program such as Fluent, FDS or another package with prior Metro approval. Transient simulation of the large fire will show that the ventilation system can maintain a tenable environment for the specified time of tenability. Compliance with criteria must be confirmed or demonstrated using these software packages. This section gives an overall summary of the SES simulations that need to be performed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2561	Standard Criteria	H1	Normal Operations Normal operation simulations shall be performed to study how the system behaves on a normal day. The first normal operations performed shall focus on train movement. Train Movement The moving train simulations shall be performed to: Confirm the train movements predicted by the SES and the traction power and signaling simulations are the same. Provide portal entry and exit train speeds for the pressure transient analysis of on-board passengers and station patrons. Determine maximum pressure transients for wayside equipment by performing a 'rogue' train simulation Confirm train model can be used for full normal operation simulations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2562	Standard Criteria	H2	Full Normal Operations The full normal operations simulations shall be performed to analyze the environment inside the underground transit system. These environmental variables need to meet the design requirements. There shall be a series of runs to analyze the environment under different circumstances. The airflows during normal operation are affected by the operating schedule. Simulations need to be performed with trains moving at different locations within the system and therefore at least two simulations shall be performed. The first simulation will be performed with each direction in the system starting at the same time. The second simulation will be performed with one direction shifted half a headway. The results of these two runs will be analyzed to determine if the system meets temperature and air velocity criteria. Other simulations that effectively shift the headways will be acceptable. In addition to the rush-hour simulations, the air velocity criteria shall be checked during off-peak hours. This simulation shall assume only one train is moving through the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2563	Standard Criteria	H3	Congested Operations- To be done in Preliminary Engineering Congested SES simulations shall use the tunnel air and wall temperatures determined in the normal analysis and the ambient air temperature. A train shall be simulated stopped in the middle of the longest ventilation zone for 30 minutes or until the air temperatures reach quasi-steady state, whichever time is shorter. During that time, the bulk temperature surrounding the train should never exceed the congested peak temperature. If this temperature is exceeded, mechanical ventilation will need to be considered during congested operations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2564	Standard Criteria	H4	Emergency Simulations The SES emergency simulations shall be performed to determine the capacity required to meet the emergency requirements and to assure the tunnel lining designer that the tunnel lining design uses the appropriate temperature-time curve. The design of the system must account for different combinations of the following: Maximum number of trains in the incident tunnel One open cross passage Fan failure with Fire Heat Release Rate The worse case fire location for each ventilation zone for one track shall be modeled. The locations that require the highest fan capacities shall be noted and used for cold flow field tests. Per NFPA 130, the Final SES report must provide cold air velocities for as-built validation (commissioning). With the fan capacities determined, the maintenance simulations can be performed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2565	Standard Criteria	H5	Maintenance Simulations- To be done in Preliminary Engineering Using the fan capacities determined from the emergency runs, the ventilation system shall be modeled for maintenance operations. The simulation shall assure that the system can achieve maintenance criteria when the diesel maintenance equipment is operating. The adjacent upstream and downstream shafts can be used to ventilate the tunnels (not intended to have maintenance underway in two parallel tunnels simultaneously).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2566	Standard Criteria	I	Ventilation Equipment Design Criteria Electronic components shall have a design life of 15 years. All other tunnel ventilation equipment shall have a design life of 40 years. Calculations supporting that equipment meets these requirements shall be submitted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2567	Standard Criteria	J	Design Velocities for Air Distribution Systems Design velocities shall be selected for the required system performance and to minimize airborne noise generation, draft, and intake of dust particles. Following are general maximum velocities in air distribution systems: (velocities may be increased up to 25 percent above these values with specific approval.)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2568	Standard Criteria	J1	Sheet Metal Ducts Main Supply Duct: 2000 fpm Branch Supply Duct: 1500 fpm Outside Air Intake Duct: 1500 fpm Main Exhaust and Return Ducts: 1800 fpm Branch Exhaust and Return Ducts: 1200 fpm Transfer Duct: 350 fpm	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2569	Standard Criteria	J2	Concrete Ducts, Plenums, and Shafts UPE/Platform level: 1500 fpm Outside Air Intake: 1500 fpm All Others: 1800 fpm	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2570	Standard Criteria	J3	Air Outlets and Intakes Supply Registers and Diffusers: To be selected for throw and noise criteria Exhaust and Return Grilles: 500 fpm over gross area Transfer Grilles: 250 fpm over gross area Transfer Louvers: 250 fpm over gross area	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2571	Standard Criteria	K	Noise Criteria See Metro Rail Design Criteria Section 2- Environmental Considerations, Noise and Vibration.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2572	Standard Criteria	L	Factory Testing Fans, dampers and devices used for emergency ventilation shall be factory tested with the results being provided to Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2573	Standard Criteria	L1	Ventilation equipment shall be factory-tested using accepted standards such as those published by the Air Moving and Control Association, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, the International Standards Organization, and the Underwriters Laboratory. If an appropriate standard does not exist then a test procedure shall be submitted for approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2574	Standard Criteria	L2	Factory tests shall consist of prototype testing and production testing. Prototype testing shall include those tests necessary to assure the design of the equipment is acceptable. Typically one prototype is thoroughly tested. Production testing shall include those tests necessary to assure the equipment as produced meets specification. Typically all equipment produced is production tested.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2575	Standard Criteria	M	Site Testing A Test Plan shall be prepared and submitted to Metro and the FLSC for review and approval prior to the site tests. The Test Plan shall describe the method of testing and identify pass-fail criteria. As a minimum, the Test Plan shall identify the following items:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2576	Standard Criteria	M1-4	**1.** The tests shall include individual fan and damper tests (2 and 3) and systemwide performance tests (4-13). **2.** The individual fans and dampers shall be operated to confirm their functionality. As a minimum, their operation shall be initiated locally from the motor control center. **3.** The individual fan and ventilation plant airflows shall be measured to confirm the intended airflows are being delivered. At least one test shall be made to measure the time required for the fan plant airflows to reach steady-state from a zero-flow start and at least one test shall be made to measure the time required for the fan plan airflows to reverse from full forward to full-reverse operation. Subsequent tests shall be conducted from Rail Operations Control to verify remote fan and damper operation. **4.** The no-fire (or cold) station and tunnel airflows provided by the as-built mechanical ventilation system shall be measured to confirm that the airflows meet the requirements determined by the analysis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2577	Standard Criteria	M5-9	**5.** The Test Plan shall include provisions for the witnessing of the systemwide tests by Metro and the FLSC. The designer or the engineer of record shall be present to support the test and evaluate performance. The contractor and the ventilation equipment suppliers shall be present on an as-needed basis. **6.** The systemwide testing shall be done by a qualified airflow measurement specialist or contractor having previous experience in measuring airflows. **7.** Calibrated instruments providing an air velocity measurement accuracy of +/- 2.5% shall be used. The number of points to be measured to convert air velocities to airflows shall be determined by standards such as those published by the American Society of Heating Refrigerating and Air-Conditioning Engineers, the Air Moving and Control Association or a CFD analysis. The test data shall be electronically recorded for future use. **8.** The Test Plan shall identify the fan(s) that are assumed to be operated and not operated by the analysis for each scenario being tested. **9.** The Test Plan shall include at least one test to measure the time required for all the fans used in a fire scenario to reach full operating mode.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.5	UNDERGROUND STATION PUBLIC AREA VENTILATION													
2578	Standard Criteria	A1-4	General **1.** The purpose of these systems is to provide ventilation during normal, emergency, congested and maintenance operations. **2.** The heavy rail public area ventilation systems include underplatform exhaust (UPE), overplatform exhaust (OPE) determined through CFD, concourse exhaust (CES) determined through CFD, and Emergency Ventilation (EVS). **3.** The light rail public area ventilation systems include EVS and OTE determined through CFD, and CES determined through CFD, and UPE. **4.** Calculation of Pressure Losses **a.** Pressure loss calculations shall be performed in accordance with the American Society of Heating, Refrigerating and Air-Conditioning Engineers Handbook of Fundamentals, latest edition. **b.** The static pressure differential across any register shall not be less than 0.25 in. wg. when the system is operating at full exhaust capacity. **c.** Use the Subway Environmental Design Handbook, Volume I Principles and Applications and latest edition of Handbook of Hydraulic Resistance (Idelchik) for pressure loss calculation data. Pressure loss calculation data used shall include 15 percent margin and corrected to 36 degrees Fahrenheit. **d.** For reversible fans, pressure losses shall be calculated for both directions (supply and exhaust) of airflow with the greatest pressure selected.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2579	Standard Criteria	A5-9	**5.** Sound attenuating duct elements shall be selected such that the noise levels generated by the fan systems do not exceed the limits indicated in Section 2, Environmental Considerations, Noise and Vibration. **6.** Each fan-motor unit shall be of the axial-flow type, with internally mounted, direct drive motor construction. Fans shall have manually adjustable pitch blades to permit a change in pressure and/or airflow capacity for either system balancing or future system modification. **7.** Fan equipment shall include inlet and outlet transition pieces, flexible connectors, inlet and outlet sound attenuators, and a shutoff damper. **8.** Dampers shall be parallel-blade, industrial, heavy-duty type, weatherproof design. Two limit switches shall be provided in each damper actuator for remote monitoring of damper position, one for open and the other for closed position. Damper leakage at shutoff shall be less than or equal to UL555Class1 Extended (14 CFM/ sq ft at 12 in. wg). **9.** A computerized evaluation of the fan performance for steady-state (no trains moving in subway) and unsteady-state (trains moving in subway) conditions shall be undertaken with the Subway Environment Simulation (SES) program.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2580	Performance Criteria	B1	Underplatform Exhaust (UPE) Ventilation System System Description For a typical station, two fans at each end of the station shall be provided with ducted connection to the plenums below the platform. Each fan will be 35,000 cfm. The exhaust distribution shall have uniformity of ±10 percent over the length of the platform. The UPE system may be used during emergencies to supplement the airflow of the emergency fans. UPE shall not have redundant fans or be high-temperature rated since credit will not be taken for its capacity when selecting ventilation equipment capacities for an emergency. The plenums below the platform shall be constructed of fireproof materials and shall not be used to house electrical cables, pneumatic lines, or other critical items. Fire, protection piping serving escalators, elevators, hoistways of fire hose cabinets at platform level may cross UPE plenum, in the transverse direction only. The UPE system may also be used to purge gas from the system. The UPE system on the Light Rail may also be used for dust control to capture dust brought along by trains into the station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2581	Performance Criteria	B2	Equipment and Accessories Fan-motor units shall be selected to have a total efficiency of not less than 75 percent. The operating speed of fan-motor units shall not exceed 1200 rpm.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2582	Performance Criteria	C	Emergency Ventilation Systems Tunnel sections between stations, pocket tracks, and tail tracks in a fire emergency shall be ventilated by fans located in station or mid-tunnel ventilation structures. Fans shall run in a supply or exhaust mode, determined by preprogrammed emergency ventilation scenarios. Booster (or jet) fans may be used to supplement the emergency fans. Fan operation, including forward or reverse mode and tunnel damper position shall be supported by ventilation analyses.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2583	Performance Criteria	C1	Emergency Ventilation Equipment shall comply with the following requirements: **a.** Fan-motor units shall be 100 percent reversible. **b.** All emergency ventilation system components, including fan-motor units, flexible connections, screens, fan dampers, and tunnel dampers located in the air stream shall be capable of operating in an ambient temperature of 482°F for a minimum of 90 minutes. (See Metro Fire-Life Safety Criteria, Section 2.3.3). **c.** For a typical station, two fans, TBD cfm, shall be provided at each end of the station with connections to each tunnel and to a ventilation shaft to the surface. The fan airflows, total pressures, fan motor powers and sound attenuation shall be calculated for two fans operating at full capacity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2584	Performance Criteria	C2	Emergency Ventilation Equipment shall comply with the following requirements: **a.** Fan-motor units shall be 100 percent reversible. **b.** All emergency ventilation system components, including fan-motor units, flexible connections, screens, fan dampers, and tunnel dampers located in the air stream shall be capable of operating in an ambient temperature of 482°F for a minimum of 90 minutes. (See Metro Fire-Life Safety Criteria, Section 2.3.3). **c.** For a typical station, two fans, TBD cfm, shall be provided at each end of the station with connections to each tunnel and to a ventilation shaft to the surface. The fan airflows, total pressures, fan motor powers and sound attenuation shall be calculated for two fans operating at full capacity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2585	Performance Criteria	C3	Fan Selection The fan-motor units shall be selected to operate in the stable range of the fan curve through the entire operating pressure range.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2586	Performance Criteria	C4	The EVS fan-motor units shall have two speed drives.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2587	Performance Criteria	D	Over Platform Exhaust (OPE)- Heavy Rail/ Over Trackway Exhaust (OTE)- Light Rail **1.** System Description The OPE/OTE shall use the emergency ventilation system described in 8.1.5.A. It shall be used for normal operations cooling, control of smoke from a fire and gas purging. The exhaust distribution shall have uniformity of ±10 percent over the length of the platform. The plenums shall be constructed of fireproof materials and shall not be used to house electrical cables, pneumatic lines, or other critical items. Fire, protection piping serving escalators, elevators, hoistways of fire hose cabinets at platform level may cross UPE plenum, in the transverse direction only. **2.** All system components including fan motor units located in the air stream shall be capable of operating in an ambient temperature of 482°F for a minimum of 90 minutes, as the ventilation system may be used in a fire emergency.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2588	Performance Criteria	E	Concourse Exhaust System (CES) The concourse shalll have separate exhaust ducts. CES capacities will initially be based on 5 cfm per square ft. of projected concourse public space ceiling area (roof area less non-public area). The design CES capacities shall be supported by ventilation analysis. Outside air shall be drawn primarily through the entrances and exhausted through the EVS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.6	UNDERGROUND STATION NON-PUBLIC AREA VENTILATION													
2589	Performance Criteria	A1-4	General **1.** The concepts described in these criteria are applicable to the HVAC systems, equipment, operation, and controls in the indicated areas. **2.** Outside and indoor summer and winter peak design conditions shall conform to the requirements covered in Paragraph 8.1.4, Design Parameters. **3.** Duct type smoke detectors located in the discharge duct of supply fans downstream of air filters and upstream of any auxiliary connection with a capacity more than 2,000 cfm shall shut down supply fans, and exhaust fans via interlock with supply fan, where interlock is provided. **4.** Fan total pressures shall be calculated as per 8.1.5.A.4.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2590	Performance Criteria	A5-8	**5.** Fire dampers or combination fire/smoke dampers shall be provided at duct penetrations in rated walls, including concrete fresh air intake and exhaust shafts. Exception: Fire dampers shall not be provided in wall penetrations for the emergency fire ventilation system, including the under platform exhaust system. All dampers shall be tested and rated as required by UL 555S. All dampers shall be Underwriters Laboratories Inc. label. **6.** Backdraft dampers shall be used on exhaust fan discharge ducts where more than a single fan discharges into a common exhaust plenum, unless motorized damper is provided. Barometric relief dampers shall be used in exhaust ducts and openings where positive pressure is required to be maintained by forced air supply and gravity exhaust. **7.** Medium efficiency, disposable type air filters complete with dirty filter indicator shall be provided for all ancillary fans excluding emergency fans. Air filter materials shall be Underwriters' Laboratories Inc. listed as Class 1. Filter efficiency rating shall be in accordance with ASHRAE Test Standard 52-76. Filters face velocity shall not exceed 250 FPM. Filters shall be standardized sizes and readily available for ease of maintenance. All filter holding frames and flat or v-bank side access filter housings shall be factory-made by the filter manufacturer, and shall be complete with inside flange gaskets, and access door edge and filter track gaskets. **8.** Outdoor Air Louvers Outdoor air louvers shall be certified with AMCA licensed performance test results. The beginning point of water penetration, 0.02 ounces of water per square foot of louver free area shall be greater than 1000 fpm louver free area velocity. Water penetration at 1250 fpm louver free area velocity shall be less than 0.04 ounces of water per square foot of louver free area. Louvers shall have a minimum free area ratio of 50%. Louvers shall be selected at a maximum gross area velocity of 400 fpm for air intakes and 500 fpm for air exhausts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2591	Performance Criteria	B1	Train Control and Communications (TC&C) Equipment Rooms System Concepts Air-conditioning system shall be designed so the air-handling unit can switch over from minimum outside air required for ventilation to 100 percent outside air, in case of refrigeration system malfunction, or need to purge TC & C Room from gas. During normal operation approximately 90 percent of the supply air shall be recirculated, and 10 percent of the supply air shall be exhausted by exfiltration to maintain a positive pressure within the space. Supply air shall be filtered.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2592	Performance Criteria	B2	Cooling Load Cooling load shall be based on a summation of the following heat gains: **a.** Heat gain from equipment **b.** Lighting load of 3 watts per square foot **c.** Minimum ventilation 10 percent outside air **d.** Solar and transmission gains, where applicable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2593	Performance Criteria	B3	Equipment and Accessories **a.** Air-Conditioning Unit Equipment shall be of the direct-expansion, split-system type, with the air conditioning unit located in a fan room adjacent to Train Control Room, with an air-cooled condenser. Condenser may be a part of the air conditioning unit, or may be remote from it. **b.** Exhaust Fan A centrifugal exhaust fan shall be provided in the fan room adjacent to Train Control Room, with ductwork to exhaust air from the Train Control Room to the outside for gas purge, or for cold smoke purge after fire, and shall be used with the air handling unit in the 100 percent outside air (OSA) mode. In case of refrigeration system malfunction, provide 100 percent outside air for cooling.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2594	Performance Criteria	B4	Operation and Control **a.** A room thermostat, set point 75°F shall be provided to cycle the compressor(s) to maintain the room temperature at the thermostat setting. The fan shall operate continuously. An automatic economizer control shall not be used for the Train Control Room system. **b.** Another room thermostat, set point 100°F shall be provided to transmit an indication of high temperature to the ROC. **c.** The air-conditioning system shall be automatically shut down in case of fire or smoke detection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2595	Performance Criteria	B5	Reliability All air-conditioning equipment serving the Train Control Room shall be wired to the essential bus located in the Auxiliary Power Room.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2596	Performance Criteria	C1	Traction Power Substation (TPSS) System Concepts A ventilation system is required in all enclosed traction power substations to remove heat generated by the transformers and rectifiers and to ensure that the operating temperatures within substations do not exceed the design operating conditions. A central ventilation system shall be provided to supply filtered, 100 percent outdoor air to traction power substations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2597	Performance Criteria	C2	Ventilation Capacity The ventilation requirement shall be based on a summation of the following internal heat gains: **a.** Lighting load of two watts per square foot **b.** Solar and transmission gains, where applicable **c.** The heat gain produced by equipment in the TPSS for heavy rail shall be calculated based on the following: Heat Gain from Equipment: 35 kW Stations with traction Power: 65 kW Station with Traction and Auxiliary Power In the same room: 80 kW TPSS in Mid-Vent Structure: As required **d.** The heat gain provided from equipment in the TPSS for light rail shall be calculated based on actual loads. **e.** TPSS above ground shall be air conditioned as required to maintain required temperature or per manufacturer's recommendation. Provide backup AC unit to assure reliability.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2598	Performance Criteria	C3a-d	System Arrangement and Associated Equipment **a.** The system designed to remove heat gain from equipment shall consist of not less than two supply fans with motorized dampers, filters, air distribution system, and automatic temperature controls. **b.** One supply fan shall be capable of providing 100 percent of the ventilation requirement. The other (redundant) supply fan shall serve as a standby unit and shall operate, should the inside air temperature exceed 94°F. **c.** Air shall be exhausted from room to the outside through relief opening connected to a relief shaft. Motor operated damper and three-hour fire damper shall be installed in the relief opening. If site conditions permit, relief opening, shaft and grating shall be located as near to TPSS as possible, and shall be large enough to prevent an excessive positive pressure build-up in substation. Depending on the proximity of the shaft terminus at grade level, mechanical exhaust may be required. Room pressure shall not exceed 0.25 inch water gauge. **d.** Ventilating air shall not be taken from the subway or exhausted into the subway without approval from the Fire-Life Safety Committee.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2599	Performance Criteria	C3e-h	**e.** A separate third fan, running continuously shall supply a minimum of 5000 cfm into the Traction Power Substation to maintain a slight positive space pressure and to prevent gas buildup when both supply fans are off. **f.** Instead of a third fan, the incoming Electrical Service Room supply fan may be used with additional ductwork and capacity as required to pressurize the substation and to mitigate gas accumulation. **g.** Fans shall be selected with sound power levels such that, with one supply fan in operation, the noise level in the substation does not exceed 85 dBA. **h.** Fans shall be powered from the essential bus.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2600	Performance Criteria	C4	Operation and Control **a.** The operation of the large supply fans shall be controlled by a thermostat located within the substation. Fan operation shall alternate duty cycle to equalize wear. When the space temperature rises to 86ºF, the first supply fans shall start. On a continued rise to 94°F, the second fan shall start. On a fall in the temperature to 90°F, the second fan shall stop. On a continued fall in temperature to 80°F, the first fan shall stop. The third small supply fan shall run continuously. Local manual control shall be provided for fan operation of the ventilation system during human occupancy of the substation. Remote control shall be provided from the ROC. **b.** The ventilation system shall be automatically shut down in case of fire or smoke detection within the traction power substation. **c.** A high-temperature thermostat and the dirty filter indicator shall each transmit a system fault indication to the ROC. Thermostat shall be set at 110°F.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2601	Performance Criteria	D1	Auxiliary Power Rooms System Concepts A supply and exhaust ventilation system shall be provided to remove heat produced by equipment and lights within the space and discharge this heat at grade. Outside air shall be obtained from a supply air shaft, or directly from the outside. Air filtration shall be provided and a positive pressure shall be maintained in the room by the supply fan.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2602	Performance Criteria	D2	Ventilation Requirement The ventilation requirement shall be based on summation of the following internal heat gains: **a.** One percent of the installed power transformer capacity **b.** Lighting load of 2 watts per square foot **c.** The heat produced by the electrical equipment **d.** Solar and transmission gains, where applicable	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2603	Performance Criteria	D3	Equipment and Accessories The system shall consist of two supply, two exhaust fans, air distribution ductwork and devices, filters, and automatic temperature controls.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2604	Performance Criteria	D4	Operation and Control **a.** One supply and one exhaust fan shall run continuously. The second pair shall be thermostatically controlled to start at 84 degrees F (adjustable) and stop on fall in temperature to 80 degrees F (adjustable). Operation of the two set of supply and exhaust fan shall alternate duty cycle to equalize wear. Local manual control and remote control from the ROC shall be provided. Provide any fan failure alarm to ROC. **b.** A high temperature thermostat shall transmit a system fault indication to the ROC. Thermostat shall be set at 110°F. **c.** The supply fan(s) shall be automatically shut down in case of smoke detection by a duct type detector, if provided. Space smoke detector shall activate the preaction sprinkler system. **d.** A positive pressure within the room shall be maintained by the supply fan.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2605	Performance Criteria	E1	Battery Rooms (For Above and Under Ground Stations) System Concepts Exhaust ventilation shall be provided to limit the concentration of hydrogen gas within the space to one percent by volume. Exhaust air shall be drawn from a high level within the space and shall be discharged to grade level. Outside air, tempered cooled and filtered supply air shall be provided at the air intake to the battery room. Transfer air from adjacent conditioned space, if available and sufficient can be used instead of tempered supply air from additional A/C fan coil unit. Ventilation system shall comply with NFPA 130. Refer to Electrical Design Criteria for room requirement for housing batteries.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2606	Performance Criteria	E2	Equipment and Accessories The system shall consist of an exhaust fan air distribution ductwork and devices, air outlet damper, and manual controls. Additionally fan coil (cooling) with air filter shall be provided for supply air to battery rooms. All Battery rooms shall have two, redundant exhaust fans. If one fan fails, the other shall take over. Fan operation shall alternate duty cycle to equalize wear. Exhaust fans shall be spark resistant AMCA Type A with explosion proof fan motors. Miscellaneous electrical devices located inside battery rooms shall also be explosion proof. Ductwork located inside battery rooms shall be constructed of stainless steel. The complete battery exhaust ductwork, including dampers and air distribution devices located in the airstream shall also be constructed of stainless steel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2607	Performance Criteria	E3	Operation and Control **a.** Ventilation systems for battery rooms shall run continuously. Operation shall be monitored by an airflow switch located in the discharge duct of the fan. Indication of malfunction of the ventilation system shall be transmitted to the ROC. **b.** Battery chargers in battery rooms adjacent to the Auxiliary Power Room shall be interlocked with the exhaust fan and shall shut off upon failure of the exhaust fan. In TC&C Room Battery Rooms, if both fans fail, battery charger shall shut off after an 8-hour delay. In DWP Battery Rooms battery charger shall not be interlocked with battery room exhaust fan. **c.** Temperature sensor at the supply air side of fan coil (A/C) unit shall provide control of room temperature. Set point temperature shall be adjustable. A/C fan or cooling failure alarm shall be transmitted to ROC. **d.** Motorized dampers in or near battery room wall openings shall be leak tight with sealed blades.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2608	Performance Criteria	F1	Other Ancillary Rooms **1.** System Concepts **a.** Exhaust ventilation shall be provided for each ancillary room. Air shall be discharged to grade. Ventilation air shall be provided, as required, and shall be taken from adjacent areas or outside, as applicable. Ventilation systems with a supply fan capacity of 2000 cfm or above shall be shut down automatically in case of detection of smoke by duct type detector in the supply duct. **b.** In underground stations make-up air for mechanical exhaust systems shall be provided by a mechanical supply system if possible. If not possible or feasible, make-up air for the exhaust system(s) may be provided through a transfer grille from the adjacent public area with a fire/smoke damper in the opening for the transfer grille, linked to a smoke detector located in the ancillary area near the transfer grille, subject to approval by the Fire-life Safety Committee.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2609	Performance Criteria	F2	Operation and Controls Ventilation shall be as follows: **a.** Toilets – Continuous operation **b.** Custodial Room – Continuous operation **c.** Trash rooms - Continuous operation **d.** Sewage Ejector Rooms and Sump Pump Rooms - Continuous operation **e.** Elevator Machine Rooms – Continuous operation. The ventilation requirement shall be based on internal heat gain from the elevator power units with room temperature not to exceed 95°F, or as per manufacturers' recommendations. Air conditioned as required. Fans, dampers and air conditioning equipment that service elevator machine rooms shall be accessible from outside the room. **f.** Mechanical or Electrical Equipment Rooms – Continuous operation. The ventilation requirement shall be based on internal heat gain from heat generating equipment. **g.** Storage Rooms - Continuous operation	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2610	Performance Criteria	G1	Incoming Electrical Service (DWP) Room **1.** System Concepts DWP rooms shall be ventilated by a supply and exhaust system. Exhaust air shall be discharged through a relief shaft dedicated to DWP room, extending up to grade. Wall opening into relief shaft shall be equipped with security bars to prevent entry into DWP Room from shaft. Relief shaft may be adjacent to the TPSS relief shaft. Depending on the proximity of the shaft terminus at grade level, mechanical exhaust may be required. Install gravity (backdraft) damper and 3HR fire damper in relief wall opening into shaft. Fire Damper(s) must be accessible from outside of DWP Room. Equip relief wall opening with ½ inch square, 18 gauge galvanized screen, and with security bars six inches on centers to prevent entry into DWP Room from shaft. Systems and equipment shall comply with DWP requirements. Outside air shall be drawn from an outside air intake shaft, or directly from the outside. Air filtration shall be provided and positive pressure shall be maintained in the room by the supply fan. Room pressure shall be 0.25 inch water gauge or less.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2611	Performance Criteria	G2	Ventilation Requirements Ventilation shall be provided at the rate of 10 air changes per hour. Ventilation air shall not be taken from the subway or exhausted into the subway.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2612	Performance Criteria	G3	Equipment and Accessories The ventilation system shall consist of a supply fan running continuously, filter, ductwork, dampers, and double deflection registers equipped with screen. The supply fan may be used also to serve and pressurize the Traction Power Substation with additional capacity. Install gravity damper in the supply branch-duct serving DWP room, to isolate DWP room from TPSS, if fan stops.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2613	Performance Criteria	G4	Operation and Control The fan shall run continuously and shall be interlocked with its outlet damper. Local manual control shall be provided inside the Incoming Service Room. Remote control shall be provided from the ROC. The ventilation system shall be automatically shut down in case of smoke or fire within the Incoming Service Room, but manual override shall be provided to purge the smoke as required. A dirty filter indicator shall transmit a system fault indication to the ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2614	Performance Criteria	H1	Emergency Exit Enclosure To alleviate possible gas accumulation, emergency exit stairs direct to surface shall be naturally ventilated through a screened opening at the topmost portion of the enclosure, leading into an airway with grating at street level.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2615	Performance Criteria	H2	Enclosed emergency exit corridors equipped with mechanical ventilation to prevent gas build-up shall be kept smoke free. Supply and exhaust ducts serving corridor shall run above rated corridor ceiling, with fire/smoke dampers at each corridor wall penetration, linked to a smoke detector. The use of transfer grilles for air intake from adjacent spaces is not allowed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2616	Performance Criteria	I	Service Corridors Provide mechanical ventilation in service corridors as described above, under Paragraph 8.1.6.H.2, except transfer grilles to provide make-up air to adjacent ancillary rooms may be used with a fire/smoke damper (FSD) in the opening for the transfer grille, linked to a smoke detector in the corridor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2617	Performance Criteria	J	All FSDs shall be controlled directly from the fire alarm system (smoke detectors). In certain cases such as having a dedicated ventilation system for a particular corridor, FSD shall close and the associated fan shall shut down via the same signal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2618	Performance Criteria	K	Cross Passage in Tunnels All Cross passages located in gassy or potentially gassy areas shall be mechanically ventilated with a minimum of continuous circulation rate of 10 air changes per hour. Cross passage ventilation fan shall take air in from one tunnel and discharge air into the other tunnel. When communications equipment or electrical equipment are placed in cross passages, comply with Section 8.1.4 Table 8-1 and Section 8.1.6 space design requirements. Ventilation openings into tunnels shall be provided with fire/smoke dampers linked to a smoke detector located in cross passages, to prevent smoke traveling from one tunnel to another in case of a tunnel fire emergency. If mechanical ventilation is used, fan shall be shut down via fire/smoke damper interlock.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.7	TERMINALS FOR VENTILATION SHAFT AT GRADE, AND SHAFT DESIGN													

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2619	Standard Criteria	A	General **1.** All air intake and exhaust vent terminations at grade and shaft design shall comply with guidelines from Transit Security Design Consideration Report by FTA dated November 2004. **2.** The maximum air velocity through a grating or louver shall be computed using the gross face area of the grating or louver, exclusive of any supports.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2620	Performance Criteria	B	Velocities through Terminals (Gratings) at or above Grade All ventilation shafts and terminals at or above grade shall be sized, designed, and spaced in accordance with the following criteria: **1.** Normal Operation **a.** Outside air intakes at sidewalk level - Size grating for a maximum face velocity of 1,000 fpm. This grating area shall be face area minus any supporting beams. **b.** Outside air intakes ten feet or more above grade or away from public areas - size face area of grating for a maximum air velocity of 1,200 fpm. **c.** Exhaust air at sidewalk level - size face area of grating for a peak outflow air velocity of 500 fpm. **d.** Exhaust air 10 feet or more above sidewalk level, or away from public areas - the peak discharge velocity should be limited by noise criteria but face velocity shall not exceed 1,200 fpm. **2.** Emergency Operations - Exhaust air gross area of grating 3 feet or more above sidewalk - the maximum face area velocity shall not exceed 1,500 fpm.(The noise criteria are waived.) Grating located on public sidewalk- the maximum face area velocity shall not exceed 1,000 fpm. **3.** Sizing Terminals for EVS **a.** Gratings shall be sized using EVS fan capacity air volumes with velocities quoted under Paragraph 8.1.7.B.2 for emergency operation. **b.** Where grating may serve dual purposes, exhaust or supply for both normal station ventilation and emergency ventilation, the greater area requirement shall apply.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2621	Performance Criteria	C1	Grating Locations **1.** Ventilation shaft terminals (gratings) at street level shall be located to avoid pedestrian and vehicle crossings and to minimize the danger of flooding from the sidewalk or street. When located in sidewalks, they shall occupy not more than 40 percent of the sidewalk width. Where possible, they shall be located in median strips or off-street locations and shall be suitably screened with plants or other decorative treatment. Openings at grade for EVS shafts shall be separated from openings for underplatform, smoke or any exhaust shaft by a minimum horizontal distance of 40 feet, edge to edge. EVS underplatform shafts and smoke exhaust shafts shall also be separated from the closest station entrance, surface emergency stair doorways, elevator shaft openings and outside air intake openings unless protected by fire/smoke dampers, by a minimum horizontal distance of 40 feet, edge to edge. Where this distance is not practical, the horizontal distance may be reduced to 15 feet if the closest emergency/station ventilation or underplatform and smoke exhaust shaft terminal is raised a minimum of 10 feet above the station entrance, emergency stair doorway and unprotected outside air intake opening, of the underplatform and smoke exhaust shaft terminal is raised a minimum of 10 feet above the EVS relief shaft terminal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2622	Performance Criteria	C2, 3	**2.** At-grade, surfaces shall be sloped away from gratings of shafts terminating at-grade to minimize the flow of water into the shafts. **3.** Exhaust air shafts may be combined into a common shaft. Outside air intake shafts may be combined into a common shaft. Under no circumstances shall exhaust and intake shafts be combined into a common shaft. Emergency/Station Ventilation shafts shall not be combined with any other shaft.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2623	Performance Criteria	D	Shaft Design **1.** In the design of fan shafts, sudden expansion and contraction in the shaft cross section shall be avoided to the greatest extent possible. The minimum number of turns and elbows shall be used. Turning vanes may be used to reduce pressure losses. Streamlining of obstructions in fan shaft passages shall be undertaken where economically warranted. Air passages shall be constructed of smooth concrete or heavy metal ductwork.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.8	STATION AND TUNNEL HVAC CONTROLS													
2624	Standard Criteria	A	Local Control **1.** Local control panels shall provide control and indication for HVAC equipment. They shall be located either at each motor control center or close to the controlled equipment. Local control panels shall be used primarily for equipment maintenance, and can also be used to operate the equipment in event of a failure of the Supervisory Control and Data Acquisition system (SCADA). **2.** Manual remote control shall be provided in an Emergency Management Panel (EMP) located in a strategic point of the station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2625	Standard Criteria	B	ROC Public Area Ventilation Systems The SCADA system is provided in ROC to operate and supervise the HVAC and other equipment. Certain equipment can be remotely monitored and operated. Equipment operation shall be supervised through feedback of equipment status and alarms. The ROC will coordinate transit operations, operation of HVAC equipment, electrical equipment, and other equipment. During emergencies, the ROC shall coordinate rescue and evacuation activities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2626	Standard Criteria	C	Station-Environmental Air System Control Operation of the UPE systems shall be controlled from the ROC with local control at the station as required for maintenance, and backup in case of failure of the central control system. Control devices and control panels for the UPE and emergency ventilation system shall be located outside the UPE fan rooms or Emergency Fan Rooms. An automatic mode can be activated at the ROC that shall switch control to a local automatic thermostatically controlled system. An emergency mode is also provided to override certain local protective devices and local control loops to provide appropriate equipment operation in case of fire, or gas detection in the tunnel. During emergencies the tunnel and station equipment is activated from the ROC in a predetermined pattern that depends upon the nature and location of the emergency, choice of evacuation route and other factors. In addition there shall be provisions for remote or local manual override as described above under "Local Control."	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2627	Standard Criteria	D	OPE/OTE Control Operation of the over platform exhaust/ over trackway exhaust for underground stations shall be controlled and supervised from a ROC however, in the event of a train fire at the platform, OPE/OTE operation may also be initiated by the OPE/OTE heat detectors. Local controls shall be provided at the station as required for maintenance, and backup in case of failure of ROC control system. If provided, with local control at the station as required for maintenance, and backup in case of failure of the central control system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2628	Standard Criteria	E	CES Control The Concourse Smoke Exhaust System shall be controlled from the ROC to exhaust residual smoke from the concourse level public areas after the station fire emergency. An emergency mode is also provided to operate the appropriate smoke exhaust fans in case of gas detection in the tunnel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2629	Standard Criteria	F	Local control shall override control from ROC and EMP. EMP Control shall override control from the ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.9	YARD AND SHOP AND MAINTENANCE OF WAY SHOP HVAC SYSTEMS													
2630	Standard Criteria	A	General The concepts described in these criteria are applicable to the HVAC systems, equipment, operation, and controls in the indicated areas. Outside and indoors summer and winter design conditions shall conform to the requirements covered in Paragraph 8.1.4, Design Parameters. HVAC system and equipment shall comply with California Code of Regulations (CCR), Title 24.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2631	Performance Criteria	B1, 2	General Office Areas **1.** System Concepts An HVAC system shall be provided consisting of a split package air-conditioner or single packaged air-conditioner, air distribution system, controls, drives and accessories. All air-conditioning systems, except where noted otherwise, shall be designed so that air-conditioning units can modulate from minimum outside air required for ventilation to 100 percent outside air as required by codes. **2.** Cooling Load Cooling load shall be based on a summation of the following heat gains: **a.** (To accommodate future additions and changes in equipment load, provide an additional 15% to the sensible heat load and an additional 5% to the latent heat load.) **b.** Occupancy **c.** Lighting, computers and office equipment loads **d.** Ventilation make-up air **e.** Solar and transmission gains, where applicable	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2632	Performance Criteria	B3, 4	**3.** Heating Load Heating load shall be based on a summation of the following: **a.** Transmission Load **b.** Ventilation Air Load **4.** Operation and Control Individual room temperature controls shall be provided by means of room thermostats controlling the supply air temperature or varying the air volume as the space load changes. Economizer control shall be provided by means of an exhaust fan and outside air and return air dampers in the unit. Control sequences shall be provided as standard with the unit manufacturer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2633	Performance Criteria	C	Open Shop Areas These include areas for service and inspection, heavy repair, truck shop and wheel shop. A summer ventilating system shall be provided consisting of roof-mounted exhaust fans with backdraft or motor-operated dampers, screened wall louvers with filters, motor operated dampers, and automatic temperature controls. Equipment shall be located to provide uniform air flows through all areas to the extent practical. A room thermostat shall be provided for each set of wall louver and exhaust fan. Ventilation requirements shall be based on the first 15 feet of building height and as required by local codes. Gravity ventilation could be used in some areas of facilities, if adequate. Heating shall be provided by high intensity gas fired radiant heaters and controlled by room thermostats. The heaters shall be sized and located to provide uniform temperatures. Units shall be mounted as high as practicable above the floor to preclude obstruction of work spaces.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2634	Performance Criteria	D	Enclosed Shop Areas **1.** Main Shop Building: **a.** Air-conditioned areas: Air Brake Shop, Air-Conditioning Shop, Electrical Repair Shop, Electronics Shop, Electronic Parts Storage Room, Control Tower and its Equipment Rooms **b.** Not air-conditioned areas: Welding Shop, Sheet Metal Shop, Machine Shop, Upholstery Shop, Paint Shop and Parts Cleaning	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2635	Performance Criteria	E	Paint Spray Area The ventilation system shall be sized for the supply air to be less than the air exhausted by the paint spray booth exhaust, and according to code requirements. Filtration of air shall be provided as recommended by the spray paint equipment supplier and as required by applicable codes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2636	Performance Criteria	F	Car Wash Area Ventilation shall be similar to Open Shop Areas described above. Roof mounted exhaust fan shall be minimum 2 units. Heating (for occupied cleaning platform area only) shall be provided by high intensity gas fired radiant heaters controlled with a wall thermostat and spring timer (2 hours).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2637	Performance Criteria	G	Degrease Room The ventilation shall consist of a roof-mounted exhaust fan with air drawn from the shop areas through transfer grilles. The fan shall have continuous operation with manual override switch. Heating shall be provided in the make-up air unit, controlled by room thermostats.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2638	Performance Criteria	H	Mechanical Equipment Rooms Mechanical exhaust ventilation shall be provided as required by applicable codes. Make up air may be taken from shop areas or outdoors. The exhaust fan shall be controlled by a room thermostat. Where required, mechanical equipment room shall be heated by natural gas heat.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2639	Performance Criteria	I	Electrical Equipment Rooms Electrical equipment rooms shall be ventilated or air-conditioned as required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2640	Performance Criteria	J	Locker Rooms/Shower Rooms The locker rooms shall have exhaust ventilation and receive heat and air-conditioned air for make-up from the general office unit described in Paragraph 8.1. 9B, General Office Areas. Where there is no adjoining general office, a make-up air unit with gas heat shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2641	Performance Criteria	K	Toilets **1.** In the maintenance shop, toilet rooms shall be heated with secondary air transferred from adjacent locker rooms. The toilet room exhaust fan ventilation shall operate continuously. **2.** In the general office area, toilet rooms receive heat and air-conditioned air from the general office unit described in Paragraph 8.1.9.B, General Office Areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2642	Performance Criteria	L1, 2	Blow-Down Facility **1.** System Concepts A supply and exhaust ventilation system shall be provided to remove air borne dust. **2.** Ventilation Requirements Exhaust ventilation in the pit, at the rate of 4 cfm per square foot of pit area, shall be provided. Make-up air, or supply air shall be equal to the exhaust air. General exhaust ventilation at the rate of 10 air changes per hour should be provided in the remainder of the facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2643	Performance Criteria	L3, 4	**3.** Equipment and Accessories One or more wet scrubbers shall be provided for exhaust air system to remove dust particles before exhausting the air to the outdoors. The scrubber shall be dynamic precipitator type with an exhauster and water spray. The water/dust slurry shall be discharged to the sanitary sewer after clarification. Clean air shall be discharged to atmosphere. One or more make-up air units with filters shall be provided. Roof-mounted exhaust fans shall be used for general ventilation. Exhaust air intake grilles shall be located near the pit floor with minimum face velocity of 175 fpm. Make-up air supply shall be introduced at the roof and near the walk platform. Appropriate distribution ductwork and devices, filters, and automatic temperature controls and interlocks shall be provided. **4.** Operation and Control **a.** General exhaust fans shall be thermostatically controlled (electric type) to run when temperature exceeds 85°F and off when temperature falls below 70°F. **b.** Scrubbers shall be interlocked with make-up air systems and water supply system pressure switch. Scrubbers shall be manually started and stopped.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2644	Performance Criteria	M1	Parts Storage Areas System Concept Part storage areas shall be heated and ventilated by means of a rooftop, direct gas-fired heating and ventilating unit. During cooling mode, 100 percent outside air shall be provided to space. During heating mode, 25 percent outside air shall be provided to the space and 75 percent air shall be circulated. Exhaust fan for 100 percent and 25 percent capacity shall be provided to relieve pressure in the space. Air distribution-ductwork shall be designed to provide adequate air circulation around tall part storage shelves.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2645	Performance Criteria	M2	Equipment and Accessories Heating and ventilating unit shall be suitable for outdoor installation complete with direct gas-fired burner, centrifugal fan with belt-driven motor, motorized outside air and return air dampers, filters, roof curb, factory-installed safety and gas modulation controls with remote panel. Exhaust fans shall be roof mounted with roof curb and motorized damper.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2646	Performance Criteria	M3	Operation and Control The heating and ventilation unit shall be started with a 24-hour, 7-day time clock. The heating and ventilating unit shall be controlled by a heating and cooling thermostat. Exhaust fan shall be interlocked with heating and ventilating unit. Outside air damper shall be normally closed and return damper shall be normally open (i.e., when power is off). Room thermostat shall be set at 80ºF for cooling and 65ºF for heating. During cooling mode, the heating and ventilating unit and the exhaust fan sized for 100 percent capacity shall start, with the outside air damper fully open and return air damper fully closed. During heating mode, the heating and ventilating unit and the exhaust fan sized for 25 percent capacity shall start, with the outside air damper at the minimum (25%) position and the return air damper fully open. Gas burner shall be modulated to satisfy heating requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2647	Performance Criteria	N	Open Storage Areas Open storage areas shall be heated and ventilated in accordance with Paragraph 8.1.9.C, Open Shop Areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2648	Performance Criteria	O	Rail Vehicle Paint Spray Building Rail vehicle paint spray buildings shall be single source, manufacturer-engineered downdraft ventilation buildings with a make-up ventilation air system and an exhaust air filtration system. Make-up ventilation air system shall be filtered, and temperature controlled with heating as recommended by the spray paint equipment supplier and required by the types of paint to be used in the facility. Exhaust air shall be filtered as recommended by the spray paint equipment supplier.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2649	Performance Criteria	P	Rail Vehicle Body and Sheet Metal Shop Building Rail vehicle body and sheet metal shop buildings shall be similar to Open Shop Areas described above. Body shop where paint prep process requires car body filler paste application followed by buffing and grinding, shall be provided with downdraft dust collection system and filtered makeup air system with automatic air temperature control. Dust collection system shall be by means of wet scrubber, similar to Blow-down facility. Exhaust rate shall exceed the supply rate by about 10%. Negative pressure system shall be maintained in the shop. The air shall be heated in winter to a temperature of about 65 degree F. Follow the requirements of Cal/OSHA regulation, Title 8, section 5143. The ventilation system shall provide sufficient exhaust and make up air to prevent employees exposures to concentration of air borne contaminants from exceeding those specified in Title 8, section 5155. Exhaust flow shall be adequate to sweep dust and other contaminants so as to prevent accumulation of dust in the shop. Design shall include down draft with air curtain in the work zone and exhaust grille located on the floor and not on the wall side. Body and sheet metal shop shall also include a welding area or manufactured welding booth. Welding area or welding booth shall be provided with fume intake/capture device, filtration and exhaust system for complying with AQMD and CAL OSHA rules and regulatory requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2650	Performance Criteria	Q	All Other Areas HVAC criteria for all other areas shall conform to Paragraph 8.1.6, Underground Station Non-Public Area Ventilation, unless otherwise required herein.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.10	ROC HVAC SYSTEMS													
2651	Performance Criteria		Outdoor and indoor summer and winter design conditions shall conform to the requirement covered in Paragraph 8.1.4, Design Parameters. The concepts described in Paragraph 8.1.9 are applicable to the heating, ventilating, and air-conditioning systems, equipment, operation, and controls in identical areas. For Communication & Signaling Room, see Paragraph 8.1.6.B Train Control and Communications Equipment Room.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.11	ELECTRIC HEATING EQUIPMENT													
2652	Performance Criteria		**A.** Electric heating equipment shall include convectors, unit heaters, baseboard heaters, and duct heaters. **B.** All electric heating equipment shall be thermostatically controlled and shall be provided with protective devices as required by the National Electrical Code. **C.** Electric duct and unit heaters shall be controlled by means of 120-volt remote thermostat. Electric baseboard and convector heaters shall be controlled by means of an integral thermostat (120-volt or 277-volt). **D.** All electrical heating equipment shall be Underwriters' Laboratories (UL) listed. **E.** All electric resistance heating equipment shall have high-limit and flow controls.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.12	PRE-PURCHASE OF ECS EQUIPMENT (Not Used)													
		8.1.13	VIBRATION ISOLATION													

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2653	Performance Criteria		All equipment producing vibration shall be isolated from the structure by means of spring or rubber-in-shear vibration isolators. All piping and ducts attached to rotating equipment shall be isolated from such equipment by flexible connections. Inertia blocks shall be provided as required. See Section 2 - Environmental Considerations entitled "Noise and Vibration" for vibration isolation criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.14	EQUIPMENT FOUNDATIONS													
2654	Performance Criteria		All floor-mounted equipment shall be placed on reinforced concrete housekeeping pads. Minimum pad height shall be six inches.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.15	EQUIPMENT ACCESS HATCHES													
2655	Performance Criteria		Provisions shall be made for the installation and removal of each complete factory-built item of equipment. All shafts extending up to grade, openings into shafts, hatches, hatchways, removable gratings, access plates, and doors intended for use in the installation and removal of mechanical equipment shall be sized with adequate clearances, so that such equipment can be moved between grade and its location without the need for special disassembly of the equipment. Preferably, the installations and removal of equipment from underground mechanical equipment rooms shall be accommodated by providing hatches in slabs and/or removable gratings to grade level. Where this is not feasible or economical, and with the prior approval from Metro, installation and removal of equipment may be accommodated by providing openings above or adjacent to the trackway. Hatches in slabs shall be constructed to preserve required fire separation rating between levels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.1.16	EQUIPMENT HANDLING													
2656	Performance Criteria		Provision shall be made in the form of monorail lifting hooks and removable panels for the installation and removal of equipment. Structural openings shall be sized so that each complete factory-built item of equipment can be installed without disassembly or special construction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.2	**PLUMBING**													
		8.2.1	SYSTEM DESCRIPTION													
2657	Performance Criteria		This document describes criteria for the design of plumbing and drainage systems serving the Los Angeles area heavy and light trail transit system passenger stations, tunnels. All piping and plumbing pertaining to the fire protection system is excluded from these criteria, and is described in the Metro Fire-Life Safety Design Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.2.2	APPLICABLE DOCUMENTS													
2658	Standard Criteria	A-G	The plumbing design shall comply with all applicable local codes of the City and County of Los Angeles, and with the following State of California codes: **A.** American National Standards Institute (ANSI) **B.** American Society of Civil Engineers (ASCE) **C.** American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) **D.** American Society of Mechanical Engineers (ASME) **E.** American Society of Plumbing Engineers (ASPE) **F.** American Society for Testing and Materials (ASTM International) **G.** American Welding Society (AWS)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2659	Standard Criteria	H-N	**H.** California Code of Regulations (CCR), Title 8, Health and Safety Act **I.** California Code of Regulations (CCR), Title 19, State Fire Marshall Code **J.** California Code of Regulations (CCR), Title 24, State Building Code **K.** In addition, plumbing design and components shall comply with applicable standards, set forth by the following agencies: **L.** Los Angeles City and County Plumbing Code **M.** National Fire Protection Association (NFPA) **N.** California Plumbing Code	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.2.3	FUNCTIONAL REQUIREMENTS													
2660	Performance Criteria		**A.** Convey fluids from Public Utilities' distribution and/or storage points to Metro stations consumption and/or service points. **B.** Collect and convey drainage and sewage from station service areas to the public sewer system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.2.4	PIPING													
2661	Standard Criteria	A	General Considerations All pressure piping systems shall be designed to meet the requirements of the Code for Pressure Piping, ANSI B.31, all applicable sections. All pipe fittings, flanges, valves, and accessories shall comply with ANSI B.16 for dimensional requirements. All piping systems shall be designed and arranged for neat appearance, properly sloped for drainage and venting, properly arranged, supported, guided, and anchored to provide complete flexibility, and to maintain the integrity of all systems without any damage or leaks during either hot or cold operating conditions. Piping shall be accessible and shall not be embedded in concrete structures unless embedment is unavoidable because of architectural or structural requirements. All valves and accessories shall be arranged in a systematic manner in places accessible for operation without the use of chains or additional operating platforms. Sleeves shall be provided wherever pipes pass through structures. Coordinate and interface the design with the corrosion control discipline through all phases of the project. Comply with the corrosion control requirements specified in Metro Rail Design Criteria Section 3.10 Corrosion Control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2662	Performance Criteria	B	Piping Accessories All required piping accessories shall be of sufficient size and provided to assure trouble free balancing and operation of all piping systems. These accessories shall include, but not be limited to, strainers, vent cocks, dirt and drip legs with drain and flush connections, liquid flow indicators, balancing cocks, relief valves, and pressure and temperature gauges. All piping accessories requiring maintenance or replacement shall be located in accessible places. All dials of gauges and indicators shall be of sufficient size and arranged to be easily seen and read from operating floor levels. Piping expansion joints shall be selected to provide for not less than 150 percent of the calculated traverse.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.2.5	PLUMBING AND DRAINAGE - STATIONS													
2663	Performance Criteria	A	Plumbing Fixtures Plumbing fixtures in all transit station toilet rooms shall be installed to accommodate physically handicapped people in wheelchairs. All wall hung fixtures shall be supported by standard chair supports. All hose bibbs inside buildings and stations shall be installed in walls in stainless steel boxes with flanges flush with wall. All exterior hose bibbs shall be installed in exterior walls in brass boxes with flanges flush with wall. All station lavatory faucets shall be of the spring loaded type.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2664	Performance Criteria	B	Plumbing Fixtures Connections All services and piping connections for plumbing fixtures shall be sized and installed in accordance with Table 8-3.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2665	Performance Criteria	C	Drains All floor drains, area drains, and roof drains shall be of bottom outlet type wherever possible. Where space is not adequate to use bottom outlet drains, drains with side outlets may be substituted. All drains used in membrane waterproof floors and roofs shall be provided with flashing collars securely clamped to the waterproof membranes. Drains shall be provided as follows: **1.** Drainage area drains shall be provided in and at elevator pits, lower pits of escalators, in emergency exits, track damper plenum rooms and other ventilation system and in all ancillary rooms except incoming Electrical Service Rooms, Battery Rooms with lead acid batteries and Elevator Machine rooms for hydraulic elevators. **2.** Storm water drains shall be provided at station and building entrance areas and in vent shafts. Entrance areas and vent shafts so equipped shall slope away from the station, or curbs shall be provided in shafts to prevent drainage into structure. **3.** Track drains inside transit system stations shall consist of concrete drainage slots, concrete catch basins, and concrete manholes with cast iron gratings at 120-foot centers. No traps or vents shall be required for the track drainage system. **4.** Roof drains, where required, shall be connected to the available underground drain systems and overflow drains shall spill on grade.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2666	Performance Criteria	D	Install hose-bibb, wall mounted, in each Trash Room and where indicated.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2667	Performance Criteria	E	Traps All traps shall be of plain pattern having a seal of not less than 2-1/2 inches and not greater than 4 inches. All traps shall be of material specified for the piping system to which they are connected. All exposed traps in toilet rooms shall have chromium finish. All area drains serving track damper plenum rooms and other ventilation system plenum rooms or chambers shall be provided with deep seal traps. Seal depth shall be adequate to maintain the trap seal for the maximum air pressure difference of the plenum being served.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2668	Performance Criteria	F	Cleanouts Cleanouts shall be provided on all soil, waste, and drain lines for each pair of 45 degree bends and for each 90 degree bend, and for each 75 feet of straight run, except track drainage for which maintenance of the drain pipes shall be through the catch basins. All cleanouts brought to finished floors shall terminate with removable clean out brass covers, flush with the floor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2669	Performance Criteria	G	Valves Isolation valves shall be provided on the inlet side of each water heater, on each pressure main at building entrances, on each pressure branch of distribution mains, at each plumbing fixture (except where several units installed in a battery, one isolation valve shall be adequate), on both sides of in-line accessories, and equipment that require removal or isolation from pressure for maintenance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2670	Performance Criteria	H	Plumbing Equipment Due consideration shall be given to performance, noise, durability, standardization, and handling characteristics when selecting equipment for the plumbing systems. All equipment selected for the plumbing systems shall be manufacturer's standard and cataloged product suitable for competitive bidding.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2671	Performance Criteria	H1	Electric Water Heaters All electric water heaters used shall be of storage type, 30 gallons minimum storage, with 100°F recovery capacity sized for plumbing fixture demand.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2672	Performance Criteria	H2	Sewage Ejector Stations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2673	Performance Criteria	H2a	Sewage ejector stations shall be pneumatic type, duplex ejector units. Each ejector unit shall be equipped with a cast iron sewage receiver designed for 50 psi working pressure, an air-cooled air compressor, interconnecting air piping and controls, sewage inlet and discharge piping with corrosion resistant check valves and isolation valves, air exhaust piping and controls, electronicmechanical level controls, electric controls, and interlocks for the air compressor. All interconnecting air piping, control valves, sewage inlet and discharge valves, piping, and accessories shall be supplied by the ejector equipment supplier in subassemblies for field installation. The sizes and capacity shall be based on total head calculated for one ejector operating. The minimum size of any unit shall be 30 gpm capacity with 4 inches minimum sewage discharge and 2 inches minimum air exhaust. Each ejector unit shall operate automatically from local electronic level controls and supervised from Central Control/ ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2674	Performance Criteria	H2b	Abnormally high sewage levels in the receiver shall be annunciated to Central Control. Units shall be installed in a concrete pit. The depth of each shall be selected to allow the upper flanged opening on the sewage receiver (the opening provided for the mechanical level control) to project above the rim of the pit. All automatic control devices, valves, and accessories requiring maintenance or replacement shall be located above the rim of the ejector pit. The bottom of the ejector pit shall be sloped to one corner where a pump and a submersible centrifugal sump pump shall be provided to return any leakage back to the sewage inlet pipe. The sewage return sump pump shall be controlled automatically by an electronic level sensor and through a local "on-off-automatic" switch. An electric probe to detect liquid in the ejector pit shall be located in this sump and wired for annunciation to Central Control/ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2675	Performance Criteria	H2c	Electric toilets may be used in certain instances with Metro prior approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2676	Performance Criteria	H3	Station Drainage Pump Stations Each drainage pump station shall consist of a sump with two submersible non-clog sewage type pumps. Pumps operation shall alternate duty cycle to equalize wear. Water level controls, electric pump "on-off-automatic" switch, high water level indicator to annunciate at the ROC, and connections to street mains shall be provided. Provisions shall be made through piping and valves to direct the effluent in the sump pumps to both street level and track level for disposal. Storage and removal equipment shall not be part of the design. Totalizers shall be provided at the sump pump discharge to measure the quantity of flow discharge. Paddle wheel flow meter totalizers are prohibited. Sampling ports shall be provided to analyze quality of the discharged water. Pump Rating - Each pump shall be sized for 100 percent of drainage volume including infiltration. Minimum pump capacity shall be 500 gpm.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2677	Performance Criteria	I	Plumbing Systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2678	Performance Criteria	I1	Potable Cold Water Systems Each passenger station shall be served with building mains sized for the total plumbing fixture demand. The domestic water service shall be provided with a pressure reducing valve when city pressure at the lowest point of use inside the structure is higher than 70 psig. The pressure reducing valve shall be located on the discharge side of main shutoff valve immediately inside the building wall. Sizing of the domestic water lines shall be based on maintaining uniform pressure at plumbing fixtures located at the same level, to minimize shock and water hammer, and to maintain a minimum of 25 psig pressure at each flush valve. All pipe lines shall be run in a systematic manner, parallel and at right angles with walls, and properly pitched for drainage. Shock absorbers and water hammer arrestors shall be provided for long pipe runs and branches with flush valves. In addition to the station main shutoff valve, isolation valves shall be provided in branch lines and for each station floor level to facilitate maintenance in individual areas without losing service for the entire facility. Pressure reducing valves and backflow preventers shall be provided where the potable water system is connected to automatic makeups.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2679	Performance Criteria	I2	Potable Hot Water Systems Potable hot water systems for each underground passenger station shall include water heaters, expansion tank (if required by Code), circulating hot water pumps, (if required), hot water distribution piping, and pipe accessories. All hot water pipes shall be sized for the simultaneous fixture demand with a minimum pipe size of 3/4 inches when serving more than a single fixture. All pipes shall be arranged in a systematic manner, and provisions made for thermal expansion and drainage. All hot water pipes shall be insulated. Isolation valves shall be provided for all branches to facilitate maintenance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2680	Performance Criteria	I3	Sanitary Soil and Waste System The soil and waste system for each underground passenger station shall include soil and waste piping from all plumbing fixtures and floor drains located in toilets, custodial, and trash rooms, sewage ejector stations, and ejector discharge piping. All soil and waste pipes shall be sized for fixture demand as required by applicable plumbing codes and ordinances.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2681	Performance Criteria	I4	Vent Systems Complete vent systems shall be provided for all soil and waste systems and sized in accordance with applicable plumbing codes and ordinances. All horizontal vent pipes shall be kept as short as possible, pitched at 1/4 inch per foot toward soil and waste pipes, then rise to the outside in the most direct way. Each vent riser shall be properly flashed at roof penetration and terminated by a vandal-proof vent cap.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2682	Performance Criteria	I5	Drainage Systems Drainage systems shall include track area drains in underground passenger stations crossover areas, pocket tracks and drainage for vent shafts. Track drainage pipes inside passenger stations shall be pitched at 1/4 inch per foot whenever possible but not less than 1/8 inch per foot. No vents or traps shall be required for the track drainage system. Area drains from rooms other than toilets, custodial, and trash rooms shall be connected to the track drainage system without traps and vents. Area drains from the cold air plenums of the station air conditioning system shall be connected to the track drainage system through a deep seal trap, vented and automatically primed to maintain a positive seal for the air plenum. No mechanical equipment drain shall be connected directly into any drain system. Indirect drain connectors with air gap shall be used. Area drainage for entrance areas and drainage for vent shafts shall be connected to storm water system by gravity where possible. Oil separators and sand and grease interceptor (clarifier) shall be installed and shall prevent discharging oil, grease and sand into public sewage and storm drain systems. Elevator and escalator pit drain and underground station track drain shall all processed through clarifier to remove oil, grease, and sand	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2683	Performance Criteria	I6	Drainage, Soil, Waste and Vent Pipe Pressurized pipe shall be Schedule 40 black steel pipe when three-inch or smaller, and cement-mortar lined ductile iron pipe when larger than three-inch. Exposed nonpressurized pipe shall be service-weight or extra heavy cast-iron-soil pipe, in accordance with engineering practice for the application. Buried and embedded nonpressurized pipe may be service-weight or extra heavy cast-iron-soil pipe, Schedule 80. Pipe size selection shall be supported by calculation in accordance with standard plumbing engineering practice and the parameters that follow. Nonpressurized drainage pipe size shall be a minimum of three inches nominal diameter, except that track drain pipe shall be a minimum of eight inches nominal diameter. Drainage, soil and waste pipe size shall not be less than the outlet size of the fixture from which it drains. Application of buried polyvinyl chloride (PVC) pipe shall be allowed with Metro approval in the corrosive area only. PVC pipe shall be per by the Los Angeles City Plumbing Code and in accordance with engineering practice for the application.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.2.6	DRAINAGE - TUNNELS													
2684	Performance Criteria	A	General Requirements **1.** Invert elevations and the location of drainage facilities at the interface between contract units shall be coordinated with related Designers. **2.** To the extent practical, drainage shall be by gravity flow. Where collection points are below the elevation of gravity outfalls, pumping stations shall be installed. **3.** Surface drainage, from decks, entrances, ventilation shafts, fan shafts, and similar openings shall not be collected in the underground section drainage system where possible. **4.** No sanitary sewage shall be permitted to enter the track drainage system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2685	Performance Criteria	B	Location of Drains In subway stations and line sections at crossovers and pocket tracks, track drains shall be provided with drain inlets at 120 feet on centers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2686	Prescriptive Spec	C	Drainage Piping Drainage piping for underground sections shall be selected from the following except that embedded piping may be Schedule 80 PVC: **Maximum Diameter: Material: Use** 4": Extra heavy weight cast iron soil pipe: Drain connections in structural walls and floors 6": Extra heavy weight cast iron soil pipe: Drain connection in structural walls and floors 3": PVC: Battery room drain 8": PVC: pipe Main track drain													
2687	Performance Criteria	D	Drainage Volumes The volume of water to be handled by each drainage system shall be calculated as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2688	Performance Criteria	D1	Open areas draining into the subway drainage system Drainage volumes from decks, entrances, ventilation shafts, fan shafts, and similar openings draining into the subway drainage system shall be calculated by means of the formula: Q = Aci where: Q = Volume, in cubic feet per second A = Drainage area, in acres C = Coefficient of runoff i = Rainfall intensity for 50-year frequenc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2689	Performance Criteria	D2	Underground Section in Earth Drainage volume in underground structures in earth, designed to exclude groundwater, shall be based on the formula: q = a + L 30 500 where: q = Volume, in gallons per minute a = Horizontal projected area of all subway openings, in square feet, e.g., station entrances, fan shafts, etc. L = Linear feet of subway structure in the drainage system	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2690	Performance Criteria	D3	Underground Section in Rock Drainage volumes in underground structures in rock, designed to collect groundwater in order to relieve hydrostatic pressure, shall be based on the formula: q = a + L 30 50 where: q, a, and L are as defined above	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2691	Performance Criteria	E	Flow Formula **1.** Flow and velocity in drainage piping shall be calculated using Manning's formula. In the use of this formula, the following factors for "n" shall be used: n = 0.015 for concrete pipe 24 inch diameter and less n = 0.013 for concrete pipe over 24 inch diameter n = 0.013 for PVC, cement and cast iron soil pipe	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2692	Performance Criteria	F	Grades **1.** Drainage piping shall have the following minimum grades where feasible within the structure outlines: Pipe Diameter Minimum Grade 4" 2.0% or 1/4" per foot 6" 1.0% or 1/8" per foot 8" 0.65% **2.** For the design of main drains, the Designer shall consider the economics of increasing the size of the drain line to permit as close a correlation as possible between the drain profile and the T/R (Top of Rail) profile, or for the drain profile to be accommodated within the height available within the base slab designed for structural reasons. **3.** Main drain lines shall be designed so that the grades produce a minimum velocity of 2.5 feet per second with the pipe flowing 50 percent full.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2693	Performance Criteria	G	Tunnel Drainage Pump Sections Refer to Paragraph 8.2.5H.3.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.2.7	COMPRESSED AIR SYSTEM													
2694	Performance Criteria	A	General Compressed air system shall consist of air compressors, operational and safety controls, fluid cooler, air receiver, compressed air dryers, compressed air piping, cooling water piping, and appurtenances required for complete operable system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2695	Performance Criteria	B	Design Parameters Compressed air system shall be designed in accordance with ASPE Databook, latest edition and Table 8-4, Compressed Air System Requirements. An allowance of 25 percent shall be added to calculated capacity, as Table 8-4 represents average usage. An allowance of 10 percent shall also be added for leakage. The compressed air system shall be designed and rated at 125 psig.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2696	Performance Criteria	C	Equipment and Accessories	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2697	Performance Criteria	C1	Compressors Compressors shall be single-stage, oil free rotary screw compressor, belt-driven type with safety controls, inlet filters, vibration isolators, airdryers, aftercooler and flexible connections. Compressors, motor, and air receiver-separator shall be mounted on common baseplate.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2698	Performance Criteria	C2	Controls Compressors shall have dual controls consisting of constant speed control and automatic start and stop control with manual/automatic selector switch. Automatic lead-lag controls shall be provided. Both compressors shall operate if the lead compressor cannot maintain system pressure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2699	Performance Criteria	C3	Fluid Cooler Fluid cooler shall be closed circuit type, tube-and-fin type with frame, coil, dual pumps, closed expansion tank, starters, fuses, transformer, terminal, prepiped and prewired with controls, disconnect and pump switch. One fluid cooler shall serve all compressors. Fluid cooler shall be furnished by the compressor manufacturer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2700	Performance Criteria	C4	Air Receiver Air receiver shall be ASME labeled and shall be rated for working pressure in accordance with ASME boiler and Pressure Vessel Code, Section VIII.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2701	Performance Criteria	C5	Compressed Air Dryer Compressed air dryer shall be mechanical refrigeration type with automatic freeze protection, a regenerative air-to-air exchanger and a main compressed air cooling exchanger. Pressure drop through dryer shall not exceed three psi. Air shall leave dryer at a temperature of 40oF and dew point of 40°F, based on inlet temperature of 100°F. Dryer shall be packaged type, completely wired and piped. Only connections required are air inlet, outlet, condensate drain and refrigerant compressor contractor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2702	Performance Criteria	D	Compressed Air Piping Compressed air piping shall be sized in accordance with ASPE Databook, latest edition. Compressed air piping shall conform to Paragraph 8.2.5, Piping.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2703	Performance Criteria	E	Cooling Water Piping Cooling water piping shall conform to Paragraph 8.2.5, Piping. Cooling water piping shall be sized in accordance with acceptable industry practices. Makeup water fill line shall be provided with backflow preventer, pressure reducing valve and shutoff valves.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9	SYSTEMS													
		9.1	GENERAL REQUIREMENTS FOR SYSTEMS													
		9.1.1	APPLICABLE DOCUMENTS													
2704	Standard Criteria		The codes of Los Angeles City and County and the State of California shall prevail where applicable. Where no City, County, or State codes exist, the standards of the following regulatory and advisory agencies shall be followed: • American National Standards Institute (ANSI) • American Society of Mechanical Engineers (ASME) • American Society of Testing and Materials (ASTM) • Electronic Industries Association (EIA) • Federal Communications Commission (FCC) • Insulated Cable Engineers Association (ICEA) • Institute of Electrical and Electronics Engineers (IEEE) • California Code of Regulations (CCR), Title 19, State Fire Marshal • National Electrical Manufacturers Association (NEMA) • National Fire Protection Association (NFPA) • California Code of Regulations (CCR), Title 8, Health and Safety Act • California Public Utilities Commission (CPUC) • Underwriters Laboratory (UL) • U. S. Department of Transportation (DOT/FTA) • California Building Code, Title 24, Uniform Building Code. • United States "Americans with Disabilities Act (ADA) of 1990. • Telecommunications Industry Associate/Electronic Industries Alliance TIA/EIA 222 • Motorola R56 Standards	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.1.2	LEGAL REQUIREMENTS													
2705	Standard Criteria		The Communications system equipment and apparatus shall comply with legal requirements set forth in the following documents: • Federal Communications Commission, Part 1, "Practices and procedures;" Part 2, "Frequency Allocations and Radio Treaty Matters;" part 15, :Radio Frequency Devices;" Part 17, "Construction, Marking, and Lighting of Antenna Structures;" Part 68, "Connection of Terminal Equipment to Telephone Equipment;" Part 90, "Private Land Mobile Radio Services." • California Public Utilities Commission, General Order No. 95, "Rules for Overhead Electric Line Construction;" General Order No. 128, "Construction of Underground Electric Supply and Communications Systems."	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.1.3	STANDARDS													

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2706	Standard Criteria		In addition to the standards of Paragraph 9.1.1 the Communications system design and equipment shall be specified and constructed in accordance with the criteria herein. American Railway Engineering and Maintenance of Way Association (AREMA) American Public Transit Association (APTA) American Standard Code for Information Interchange (ASCII) Factory Mutual System (FMS) U.S. Government Code of Federal Regulations and Military Standards Metro fall Protection Policy Metro Fire/Life Safety Criteria	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.2	**FARE COLLECTION**													
		9.2.1	DESCRIPTION - CONCEPT OF OPERATIONS													
2707	Performance Criteria		The purpose of these criteria is to describe the Fare Collection System and compatible equipment to be used with Metro Rail Transit facilities. The farecollection system shall utilize a Barrier configuration. The Barrier configuration shall be provided at all stations (elevated, underground, and at grade. The Barrier configuration shall utilize Ticket Vending Machines (TVMs) and fare gates at station entrances plus Transfer SAVs at transfer stations, and require patrons to use a properly encoded POP (Proof of payment) document, “smart card”, to access the paid area of a station through fare gates. Once in the paid area of the station or on the vehicle a patron must have in their possession a POP document (which is defined broadly to include a properly encoded smart card) that can be checked by fare inspectors. If the patron does not have such a POP document, they may be cited under applicable statutes. The fare collection system shall enable patrons to purchase the POP without human intervention. The system elements shall be compliant with the Universal Fare System (UFS) procured by Metro beginning in 2001. In addition to the equipment and apparatus designed to serve and assist the Metro System patrons, the fare collection equipment shall include auditing and monitoring equipment, revenue handling and transporting equipment, and data processing equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.2.2	FUNCTIONAL REQUIREMENTS													
2708	Performance Criteria		The main components of the Fare Collection System shall respond to functional requirements inherent to their respective service functions. The functional requirements of the main components shall be the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2709	Performance Criteria	A	General The following general requirements shall apply to all station-installed equipment of the fare collection System: The Fare Collection system shall be designed to be compatible with Metro Rail station design. The number and types of equipment at each station shall be based on: • Ridership analysis at each Metro Rail station; specifically peak demand. • Fare policy to be utilized. • Metro policy on maximum allowed queue length (passenger waiting plus transaction time; for TVM 2 minutes, for transfer SAV or fare gate 20 seconds) for fare transactions. The average time of a transaction (time between arrival at the fare equipment queue and the completion of transaction) shall not exceed 120 seconds. • Transaction times for fare collection equipment. • The provisions (raceways, power availability, etc.) shall be implemented for Maximum Line Capacity requirements or the maximum ridership that can be carried on new line. • Metro policy on queuing length for fare gates.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2710	Performance Criteria	A	The Fare Collection policy requires a minimum of two ticket vending machines (TVMs) at each fare vending area, with additional numbers to be based on ridership analyses. The provisions (raceways, etc.) shall be implemented for Maximum Line Capacity requirement adjusted per minimum policy. Stations or platforms with multiple entrances in the same direction shall have a minimum of one ticket vending machine at each entrance. Platforms with more than one entrance in the same direction shall be considered individually, and equipment will be allocated to entrances based on ridership projections for that entrance. Provisions (raceways, etc.) shall be implemented for Maximum Line Capacity requirement adjusted per minimum policy. All equipment shall comply with the functional requirements embodied in Metro’s specification for the Universal Fare System.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2711	Performance Criteria	B	Ticket Vending Machines (TVM) Fares shall be sold at Ticket Vending Machines (TVM) utilizing TAP smart cards as fare media. TVMs shall be capable of selling TAP smart cards, and loading single ride and other fare types including passes, and also loading stored-value media onto the smart card. TVMs shall be located at or near the entrance to each “paid” area. A reduced function TVM may be provided in some locations. Such a device may accept only credit/debit card payment (no cash), and may have limited fare types available. Ticket Vending Machines shall comply with the requirements of Metro’s Universal Fare System. Capabilities shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2712	Performance Criteria	B1	General Characteristics: Ergonomic external design similar to existing equipment. Designed to withstand vandalism and prevent minimum entry of liquids while providing maximum ease of use for entry of coins and bills. Exterior light and lighting system Patron display unit that provides input and assistance to the patron during transactions. Expandability, using open ports or circuit card slots for future capability to process other payment media Fully compliant with applicable sections of current ADA Standards for Transportation Facilities issued by the Department of Transportation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2713	Performance Criteria	B2	Security Strengthened stainless steel cabinet Audible intrusion and vibration alarms Maintain and print a record of alarms Alarms reported to the Central Data Collection System (CDCS) and Metro SCADA system in real time High security locking mechanism. Separate secure vaults to contain coins and bills	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2714	Performance Criteria	B3	Customer Interface Menu driven display screen with customer information Comply with requirements of the Code of Federal Regulations, 28 CFR Part 36, “Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities” and Title 24 California Building & Standards Code (Physical Access Regulations). Support multiple languages	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2715	Performance Criteria	B4	Ticketing Ability to handle multiple ridership categories Means of easily changing fare types and generating additional fare types as required, through the Central Data Collection System (CDCS) Receipt printing using the thermal printing Self-unjamming for the coin system and bill note acceptor Payment Processing Accept US coins and currency in common circulation Accept, smart cards, tokens, credit cards and debit cards Recirculation of coins for use as change Continuous monitoring of smart card and receipt stock, coins and bills Multiple bills escrowed pending completion of transactions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2716	Performance Criteria	B5	Credit/ATM (Debit) Bank Card System Capable of processing credit and debit card transactions, in accordance with prevailing banking regulations. System to be provided shall include interface capabilities for regional transaction processing system as defined by Metro. Minimizing fraud by comparing credit and debit card numbers against internal bad-card lists, updated regularly. Checking sales against editable parameters Routing transactions to the clearing house, checking customer personal identification number (PIN) (debit card payments only), obtaining authorization and transmitting the authorization to TVMs. Providing Settlement data to Metro and the clearinghouse. Exterior lighting and lighting system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2717	Performance Criteria	B6	Contactless Smart Card Processor Compliant with UFS standard for contactless smart cards Add value or time, validate (deduct rides or value), and perform all other functions on contactless smart cards, consistent with current contactless smart card functionality adopted by Metro. Capability to provide Metro personnel access authorization via a smart card for revenue servicing and maintenance. Ability to handle multiple ridership categories Means of easily changing ticket product format and generating additional ticket types as required, through the Central Data Collection System (CDCS)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2718	Performance Criteria	B7	Contact Smart Card Reader EMV compliant Read identification and security data from and remove and load to or remove value from "electronic purse" on contact-type smart card. Capability to provide Metro personnel access authorization via a smart card for revenue servicing and maintenance. Track travel behavior Cancel lost or stolen cards Provide ancillary revenue operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2719	Performance Criteria	B8	Reporting Report all transactions in batch mode via Data Transmission System Fully transactional database Alarms and credit/debit card transactions reported in real time All additions must be fully compliant with the existing Universal Fare System in place.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2720	Performance Criteria	C	Stand Alone Validator	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2721	Performance Criteria	C	In a POP system using stored-value or stored-ride fare media, it is necessary for patrons to "validate" their fare media prior to entering the paid area. In doing so, they present to fare inspectors their encoded electronic fare media to indicate that the fare has been properly deducted. This function shall be performed at the station entrance fare gate array, or for patrons already on the system and transferring between trains on intersecting rail lines, at a Transfer Stand Alone Validator (SAV), a small specialized machine designed for this purpose within the paid area of the transfer station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2722	Performance Criteria	C	At transfer stations, SAVs shall be provided within the paid area of the station to facilitate patron transferring between trains without having to exit and re-enter the station through the station entrance fare gates. At least four Transfer SAVs shall be provided, with additional Transfer SAVs provided as necessary to support ridership needs. Where transfer point is between different platforms, Transfer SAVs shall be arranged in a virtual gate configuration analogous to a fare gate barrier across paths of transfer depending on space availability. Where transfer point is a common platform shared by trains of different lines, Transfer SAVs shall be arranged in back to-back pairs, with pairs evenly spaced along length of platform (along centerline of center platform stations, and along back side of side platform stations) to minimize walking distance for patrons exiting any car of train to validate their fare media prior to boarding the train that they are transferring to..	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2723	Performance Criteria	C	Transfer Stand Alone Validators shall provide the following functionality: • Validate smart cards by deducting the designated fare amount and encoding the new value, with appropriate identifying information. • Confirm validation of a contactless smart card electronic purse (programmable function) and transmit date, time, location, and SAV identification number to be stored on the smart card. • Record all validations and transmit all data transactions and event data to the CDCS. • Be stand-alone devices. • Support eventual TAP In/TAP Out fare policy. • Customer interface complying with requirements of Code of Federal Regulations, 28 CFR Part 36, "Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities" and Title 24 California Building & Standards Code (Physical Access Regulations).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2724	Performance Criteria	D	Fare gates shall require patrons to tap a properly encoded smart card to open the fare gate barrier to allow the patron to pass through to access the paid area of a station. Fare gates shall also be required to be able to be tapped for exit to the non paid area, upon function being activated. Fare gates shall be located at or near the entrance to each "paid" area as part of a fare barrier. The fare barrier shall also include emergency swing gates to support emergency egress and fencing to provide complete physical separation between paid and non-paid areas. Fare gates shall include both the turnstile and barrier-leaf (for ADAAG) types, and along with emergency swing gates, comply with the requirements of Metro's Universal Fare System. Capabilities shall include the following: All station designs shall have equipment quantities analysis, queuing analysis/modeling and exit calculations performed to determine quantities of fare gating required to support each station design (Reference Section 9.2.6.B below).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2725	Performance Criteria	E	Passenger Assistance Telephones	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2726	Performance Criteria	E	Passenger assistance telephones shall be provided adjacent to the TVMs (but not on the TVMs) to enable patrons to have voice contact with the Rail Operations Control (ROC) for assistance. These telephones shall be provided within the front field of view of the closed circuit television system of the customer while using this phone. Provisions shall be made to allow the hearing and speech impaired to indicate a request for assistance. Additional provisions are described in Section 9.7 (Telephone Subsystem).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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2727	Performance Criteria	F	Gate Telephones Gate telephones (GTELs) shall be provided on both sides of fare barriers at gated stations to enable patrons to obtain assistance from Metro personnel remotely monitoring station fare gate arrays. As a minimum, two GTELs, one GTEL on each side of the fare gate array (paid and non-paid sides), are required per fare gate array location. GTELs shall be located near fare gates but in such a manner that the GTEL user position does not obstruct the fare gate queuing path or the emergency swing gate egress path, and is clear of the emergency swing gate opening range. The GTEL shall allow for hands free operation and include a CCTV camera to facilitate communication with the patron. The GTEL shall include lights to indicate to the user when the call has been initiated, when the conversation is possible, and if the ADA fare gate has been unlatched remotely from the ROC. The GTEL housing shall include space reserved for future addition of card reader type device.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2728	Performance Criteria	G	CCTV CCTV cameras shall be provided in stations for monitoring of PTELs, TVMs, SAVs, fare barriers and GTELs (both sides of barrier) to Metro personnel at ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2729	Performance Criteria	H	Data Acquisition A Central Data Collection System (CDCS) control shall be capable of integrating all (existing and new) fare collection equipment to obtain and process information such as number and type of transaction, revenue collected, and to diagnose malfunctions. The data processor shall be capable of acquiring, processing and storing transaction information from all fare collection equipment for auditing, collecting statistics, and other purposes, as necessary.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2730	Performance Criteria	I	Revenue Transfer A revenue cart shall be used to replenish change storage units, smart card and receipt stock in TVMs and to transfer cashboxes and bill vaults from TVMs to the Revenue Processing Facility (RPF). Carts shall be transported from stations to the RPF by revenue truck. The cart and TVM shall provide secure currency transfer and preclude the unauthorized access to revenue funds.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2731	Performance Criteria	J	Enforcement/Security	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2732	Performance Criteria	J	The free and paid areas of all stations and interiors of all passenger vehicles shall be identified with the following minimum requirements: Station entry and platform areas shall have signage that indicates the need for possession of a properly validated smart card as Proof of Payment for entry into the paid area. These signs shall be located before and at the point of differentiation, and within the paid areas so as to meet all legislative/legal requirements for effective enforcement. Signs shall be conspicuous and easily understood by patrons and comply with legal requirements for such signage. The location of the free to paid area line shall be clearly delineated by architectural features or signage to permit easy identification. The interior of each vehicle shall have signs that indicate that on-board patrons must possess a properly validated smart card. These signs shall comply with all legislative/legal requirements for effective enforcement and be conspicuous and easily understood. Refer to Metro Signage Standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2733	Performance Criteria	J	Fare Enforcement personnel shall be easily identified, assigned adequate enforcement authority, and meet state/local statutes or requirements. Fare enforcement personnel will carry a mobile phone validator (MPV) that will interface to smart cards and indicate whether the card is carrying an electronic proof of payment and is properly validated. Fare Enforcement personnel may be provided with vehicles – security personnel will normally have vehicles. Parking shall be provided for at least one security/Fare Enforcement vehicle at each station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.2.3	SYSTEM INTERFACES													
2734	Performance Criteria		Fare Collection equipment shall be designed to interface with other elements within Metro Rail Stations and throughout the Metro Rail system, as follows: Communication Systems SCADA System Rail Operations Control Auxiliary Vehicles Revenue Processing Facility Central Data Collection System (CDCS) Fiber Optic System Leased phone lines if necessary Fire System In addition, the Fare Collection System shall interface with other elements outside the Metro System, such as business and commercial institutions for off-site vending of smart cards and loading of passes and stored value, discount and other promotional fare media.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.2.4	REVENUE SERVICING AND EQUIPMENT MAINTENANCE													

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2735	Performance Criteria		Fare collection equipment will require revenue servicing (collection of money and replacement of consumable supplies) and normal maintenance. This will be provided by Metro and/or other personnel using trucks. Station design shall provide parking in reasonable proximity to equipment for such vehicles. If parking is provided on only one side of the right-of-way, a means of crossing from one platform to the other with wheeled carts shall be provided. Revenue carts as specified by Metro's Revenue Department will be used on Metro Rail facilities with ticket vending machines. The purpose of the revenue carts shall be to transport smart card and receipt stock and money between the ticket vending machines located in the stations and the revenue processing facility. The carts will be hand-pushed by revenue collection personnel en-route between station equipment and revenue trucks, and between revenue trucks and the revenue processing facility, and shall be designed to fit on Metro System elevators and revenue trucks. The revenue cart and station fare collection equipment shall accommodate coin and currency transfer without requiring revenue personnel to handle money at the stations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.2.5	STATION DESIGN													
2736	Performance Criteria		Communications provisions shall be included in the station design to accommodate fare collection data communication back to the CDCS, SCADA alarm indications to ROC, and for fare gates, tie in the ROC and EMP Evacuation Message System (EMS) for underground stations, and Fire Control Panel (FCP) for all other stations, as well as other communications requirements such as PA, CCTV, VMS, etc. back to Rail Operations Control (ROC). A secured communications room/building/enclosure shall be provided at each station and shall be equipped with power, air-conditioning, entrance blocks and backboard as required by the communications systems and local telephone carrier and grounding to support installation of leased phone line (potential future) and conduit infrastructure and racks to mount communication equipment supporting each system, including station network equipment for fare collection system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2737	Performance Criteria		Canopies with lighting shall be provided to cover TVM and fare gate equipment locations. Lighting shall be configured to illuminate the front of the TVMs without creating glare on the TVM display screen that would make it unreadable. Lighting shall be configured to provide a measure of security for station patrons. For minimum lighting requirement/criteria, refer to Table 7.1 Metro Design Criteria, IES, and ANSI criteria and recommendations. CCTV coverage shall be provided as required, including the face of TVMs, Transfer SAVs and telephones including PTELs and GTELs. CCTV shall also be provided to monitor both sides of fare gate arrays.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2738	Performance Criteria	A	Location of Equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2739	Performance Criteria	A	Paid and non-paid areas of station platform shall be defined for each Metro Rail station. The paid area is considered the entire boarding area or at gated stations beginning on the inside of the fare barrier after entering from a non-paid area. TVMs shall be located within non-paid areas of the station. Fare gates shall be located at boundaries between the paid and non-paid areas of the station. Transfer SAVs at transfer stations shall be installed within the paid area of the station. The boundary between paid and non-paid areas of the platform shall be marked with signage to indicate requirement for patrons to possess proof of payment before entering the paid area. Other architectural elements (such as floor colors or textures) shall be used together with signage to indicate the separation between paid and non-paid areas. Refer to Metro Signage Standards. Each station platform entrance shall have a minimum of two TVMs and a minimum of two fare gate aisles, with the second provided as back-up in event of equipment failure. In cases where there are multiple entrances to a single platform, each station platform entrance shall have a minimum of one TVM and one fare gate aisle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2740	Standard Criteria	A	Provisions for additional future TVM and Transfer SAV installations beyond the minimum required shall be considered based on Maximum Line capacity determined from Equipment Quantities Analysis (Refer to Section 9.2.6). Initial fare gate installation and provisions for same shall be based on Maximum Line Capacity Requirement, modified as necessary by results of queuing modeling analysis and as necessary to comply with NFPA 130 station egress requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2741	Standard Criteria	A	TVM and Transfer SAV locations shall allow for sufficient front clear space to comply with ADAAG accessibility regulation front and side wheelchair access requirements. Fare gate locations providing ADAAG access shall comply with ADAAG accessibility regulations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2742	Performance Criteria	A	TVM and fare gate locations on non-paid areas of platforms, and transfer SAVs in paid areas of the platform, shall be such that equipment is outside of Metro Rail Right-of-Way clearance envelopes to ensure that equipment does not obstruct the path of approaching vehicles and attachments, or obstruct train operator full field of vision at station platform, pedestrian and vehicular grade crossings. Fare gates and associated fencing shall be located to provide queuing spaces and clearances/spacings with other station elements as identified Section 6, Architectural Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2743	Prescriptive Spec	A	Fare gate aisle widths shall be 20" wide for turnstile aisles and 36" for ADAAG aisles. At least one ADAAG aisle shall be provided in each faregate array at ADA accessible entrances. Emergency Swing Gates and Fencing used in fare barriers shall be 5 ft. in height above finish surface and be of stainless steel construction for underground stations and painted steel construction for other than underground stations. TVM locations shall allow for front TVM door swing opening at least 90 degrees, based on door being full width of machine and hinged on the left side of cabinet. Transfer SAV locations shall allow for top cover swing opening at least 130 degrees, based on the angled cover being full width and depth and hinged at the top back side of the cabinet. This shall be considered in locating fare collection equipment near support columns, trash enclosures, and other vertical elements in the station design. TVM, Fare Gate and Transfer SAV locations shall account for patron sight distances of trains and vehicles at intersections.													
2744	Performance Criteria	A	The maximum dimensions of each TVM are 36" wide x 25" deep x 74" high (76.2" to top of fan shroud). The maximum dimensions of each SAV are 14" wide x 7" deep x 43" high. An additional side clearance of 12" minimum, back clearance of 6" minimum, and front clearance of 48" minimum shall be provided for the TVM. SAVs shall be sited with 14" side parallel to patron flow across the paid/non-paid boundary, have a back-to-back clearance of at least 4" and have a minimum front-to-front clearance of at least 48" for ADAAG compliance. Side clearance is required for patron queuing space, ADAAG clear space, equipment installation, and for opening the doors of the machines for maintenance and service. If TVMs are grouped such that two or more machines are side-by-side in a grouping, the external side clearance needed to either external side of the grouping shall be 6" for TVMs, and 12" separation between adjacent TVMs. In event Transfer SAVs need to be located side-by-side forward of walls or railings, a minimum 16" separation shall be provided. These space requirements shall be taken into account when locating TVMs or Transfer SAVs near support columns, trash enclosures, and/or other vertical elements in the station design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2745	Performance Criteria	A	Canopy coverage shall be provided for TVMs and fare gates for protection of equipment when it is opened for maintenance and revenue servicing during inclement weather. This will also provide weather protection for passengers using the equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2746	Performance Criteria	B	Basic Provision Requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2747	Performance Criteria	B1	**Equipment Pad – TVMs, Fare Gates and Transfer SAVs** TVMs, Fare Gates, and Transfer SAVs shall be designed for outdoor installation and be freestanding, suitable for mounting to finish surface using anchors at the four corners within the base of each equipment cabinet type. The minimum concrete slab thickness in area for mounting TVMs, fare gates, and Transfer SAVs shall be at least 8" throughout footprint of the device, extending at least 12" beyond the footprint perimeter to allow for drilling and setting anchors. Station platform slopes at equipment location shall be limited to a maximum of 2% transverse and 2.4% longitudinal. The pad surface shall be as level as possible to minimize the gap between equipment bases and finish surface of pad. TVMs and Transfer SAVs shall be installed level by fare collection equipment personnel. Fare gate consoles shall be installed level side to side and parallel front to back by fare collection equipment personnel. Any resulting gap between TVM, fare gate, or Transfer SAV base and the finish mounting surface shall be sealed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2748	Performance Criteria	B2	Conduits	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2749	Performance Criteria	B2	For Communications, minimum branch conduit sizes to be run from each device location to nearest communication pull box or junction box located within area of TVM Group shall be 1" for Telephones, 1" for CCTV cameras, 1" for separate PA zone, two (2) 1" for message boards, 2" for TVMs, 1" for Transfer SAVs, 1" for fare gate underfloor duct junction boxes, with minimum 2" size home conduit run for each subsystem continuing to the Communication room or the cabinet for installation of communications and SCADA interface cables. For Power, minimum 1" size branch conduit shall be run from each message board, TVM, and Transfer SAV location and from each fare gate underfloor duct junction box to nearest power pull box, with continuation conduit of appropriate size (per NEC) for wiring requirements running to the station power panel for installation of power wiring.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2750	Performance Criteria	B2	Conduits shall have all sharp edges removed. Communications conduit shall be installed between the location of station network equipment and the location of each TVM, fare gate underfloor duct junction box, and Transfer SAV. Communication pull boxes shall also be appropriately located for length of main conduit run(s). Conduit arrangement shall use main run to each general location of equipment with branch runs continuing between junction box and each TVM location, each Transfer SAV location, and to each fare gate underfloor duct junction box. Conduit arrangement shall allow for node-type (node at communication room or cabinet) communications cable connections (between TVMs, fare gates, and Transfer SAVs, and the UFS station network equipment at communication room or cabinet) through the use of appropriately located communication pull boxes and/or junction boxes. Conduit arrangement shall support installation of both copper and fiber optic cable runs between station network equipment connected to node at communication room or cabinet and TVM with hub, and between TVM with hub to each additional TVM, fare gate, and Transfer SAV within the TVM and Fare Gate Group, along with copper SCADA Interface Cable (SIC) from MDF at communication room or cabinet to each TVM Group (station platform entrance), with SIC cable connected to additional TVMs within same Group in daisy chain manner.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2751	Performance Criteria	B2	Dedicated, minimum 2" size conduit shall be provided from a telephone utility box/pole to the enclosure for communications to bring in and terminate telephone company cable or other communications lines as appropriate. Dedicated to fare collection communication equipment UPS powered duplex power outlet shall be provided in this communications enclosure to support power connection to UFS station network equipment power supplies. Communications room/enclosure/cabinet shall be properly grounded for communications equipment. Pull ropes shall be installed in all conduits or underfloor ducts connecting communications enclosure/room/building (location of station network equipment) with location of each TVM, fare gate, and Transfer SAV to facilitate pulling in of necessary communications cable during installation. Provisions for storage of power wiring and communications cabling shall be provided within pull boxes or junction boxes near TVM, fare gate underfloor duct, and Transfer SAV locations to allow for secure cable storage in the event of future machine removal or new installation. These communications and power pull boxes shall be of sufficient size to allow for cable and wiring to be pulled back from stub-ups and stored. Conduits entering pull boxes shall be permanently identified as to destination using metal tags. For locations where equipment is mounted to slab on grade, conduits shall be run a minimum of 2' below grade and sweep up into center of footprint at equipment locations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2752	Performance Criteria	B2	Embedded underfloor duct shall be installed under each fare gate array extending under all fare gate console positions within the array, with one duct for power and one duct for communications. Embedded underfloor duct junction box shall be used at end(s) of underfloor ducts to transition power and communication runs to conduit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2753	Performance Criteria	B2	No. 2 Walkerduct shall be minimum size used at Metro rail at grade stations with end underfloor duct junction box to intercept power run from station power panel and communications run from TVM location back to UFS station network equipment location inside the communication room or cabinet. No. 4 Walkerduct shall be minimum size used in similar manner at Metro underground Rail stations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2754	Performance Criteria	B2	At Emergency Swing Gate Latch Post locations not adjacent to faregate consoles. 1" embedded conduit shall be run between underfloor duct junction box (Communications side) to location of swing gate latch post. At telephone (PTEL and GTEL) locations, 1" embedded conduit shall be run to communication room or cabinet. At CCTV cameras locations, 1" embedded conduit shall be run to communication room or cabinet. At PA speakers locations, 1" embedded conduit shall be run to communication room or cabinet. At message board locations, two (2) x 1" embedded conduit shall be run to communication room or cabinet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2755	Performance Criteria	B3	**Connections to Fare Collection Equipment**	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2756	Performance Criteria	B3	Connections from the power panel and the station communications room or the cabinet at locations of TVMs and Transfer SAVs shall utilize one of two options below, Connections from same at locations of fare gate consoles shall utilize underfloor duct only.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2757	Performance Criteria	B3a	Conduit Stub-ups If conduit stub-ups are used (as opposed to underfloor duct), conduit stubs up for power (1" Branch Conduit), to secure 6 ft station ground pigtail (1" Branch Conduit), and for communications (2" Branch Conduit for TVM; 1" Branch Conduit for Transfer SAV) shall be installed in the center of each TVM footprint an in the center of each Transfer SAV footprint. Conduit stub-ups at TVM and Transfer SAV locations shall be sealable with removable threaded metal plug inside metal female conduit coupling that is flush with the finish surface. Conduits stubbed into the Transfer SAV footprints shall be orientated to fit within the 4" x 6" base opening of the SAV (6" side parallel with the 14" width of the SAV) centered within the SAV footprint. These requirements shall also apply to spare TVM and spare Transfer SAV locations (locations with provisions to install additional machines in future).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2758	Performance Criteria	B3b	Underfloor (Under platform) Raceway System	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2759	Performance Criteria	B3b	An underfloor raceway system shall have separate power and communication conduits (ducts) going to each TVM, fare gate console, and Transfer SAV Location. Raceways shall be embedded in the floor to support all initial TVM and Transfer SAV locations, and fare gate console locations, as well as allowance for future additions of TVMs, Transfer SAVs, and fare gate consoles. Cover on underfloor duct and conductor fill shall be implemented per NEC requirements, One end junction box shall be positioned directly above the pullbox in the slab to facilitate pulling both power and communication cables from the pull box in the structural slab into the underfloor raceway system for later connection to the fare collection equipment above.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2760	Performance Criteria	B3b	Underfloor duct risers (aftersets) at TVM, fare gate console, and Transfer SAV locations shall be installed by the equipment installation contractor in the center of each TVM, fare gate, and Transfer SAV footprint, one from the communications duct and one from the power duct. Each riser shall be sealable with removable threaded metal plug that is flush with the finish surface. For conductors run on common conduit or raceway, two additional guidelines shall apply. The voltage insulation rating of all conductors shall match the highest insulation rating. Wires for conductors in common raceway shall be shielded type wires.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2761	Performance Criteria	B4	Electrical	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2762	Performance Criteria	B4	Power conduit shall be installed to run power circuits from the station power panel to each TVM, fare gate console, and Transfer SAV location, and to the station communications facility. Conduit shall utilize intermediate power pull boxes appropriate for the length of main conduit run(s). Conduit arrangement shall use main run to each general location of equipment with branch runs continuing between junction box and each TVM location, each Transfer SAV location and to the fare gate array underfloor duct junction box.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2763	Performance Criteria	B4	Dedicated 120V, 60 Hz, and 20 amp circuits shall be provided at station power panel for each fare collection equipment item. Separate dedicated circuits from essential load panel shall be provided for each TVM, each fare gate console, and each Transfer SAV, and be UPS powered to the UFS station network equipment power supplies inside the station communications room or the cabinet via the critical load panel. Circuits for TVMs, fare gates, and Transfer SAVs shall be essential load. The circuit for UFS station network equipment shall be critical load and shall be provided directly from the communication UPS power panel, terminated at duplex outlet adjacent UFS network equipment rack location. Each circuit shall be labeled on the power panel. Three-conductor (Line/Neutral/Ground) circuit with dedicated neutrals shall be provided from power panel to each equipment (TVM, fare gate, and Transfer SAV) location. Power conductors shall be #12 AWG minimum, XHHW-insulated, and sized per the National Electrical Code (NEC). A six-foot wiring pigtail shall be provided at each TVM, fare gate console, and Transfer SAV location to allow for connection of power conductors to equipment. Pigtails shall be added at equipment end of power conductors to enable connection to equipment where power conductors exceed #10 AWG in size.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2764	Performance Criteria	B4	Power wiring shall be kept separate of communications cabling and shall be run continuously, without splices, from source to each TVM, fare gate console, and Transfer SAV location including identified future locations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2765	Prescriptive Spec	B5	Communications Equipment Each station shall require a station communications room or the cabinet, within or near the station facility for fare collection equipment personnel to install required station network equipment. The internal space requirements to support the UFS station fare collection equipment (TVM, fare gates, Transfer SAV) communication system shall be 24" of rack space for vertical rack mounting on standard 19" racks with this rack space to be located on upper portion of lower half of the rack. The rack space for UFS station network equipment shall include duplex outlet on critical power circuit dedicated to same. Station network equipment shall consist of hubs, routers, power supplies, fiber optic network equipment, and copper/fiber cabling; and shall interface to the Cable Transmission System Sonet Node at same location via connection to a dedicated port (to UFS) FastEthernet card provided by the Communications contract to support data communication between TVMs, fare gates, and Transfer SAVs, and the Central Data Collection System (CDCS) computer located on second floor of the Metro Union Station Gateway (USG) building using Fast Ethernet (10/100 Base T) connectivity.													
2766	Performance Criteria	B5	Two dark fiber optic strands, daisy chained at each station, shall be provided for fare collection equipment communications path to USG as well as space and power for future fiber optic multiplexing equipment in the communication room or the cabinet. In addition, a minimum 2" communication conduit connection shall be provided to local phone company point of connection to allow local phone company to install future circuit termination inside the communication room or the cabinet as necessary. The communication room or the cabinet shall also be equipped with appropriate air conditioning to keep equipment within their specified temperature range for performance. Communications cabling shall be kept separate of power wiring; and shall be run continuously, without splices, from source to System Components location.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.2.6	SIZING METHODOLOGY													
2767	Performance Criteria		All calculations shall be done based on Maximum Line Capacity requirements and based on projected ridership minimum Metro policy requirement. For fare gates, final quantities shall be established based on Maximum Line Capacity Requirement, modified as necessary by results of queuing modeling analysis and as necessary to comply with NFPA 130 station egress requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2768	Performance Criteria	A	Parameters and Overall Methodology – TVMs, Fare Gates, and SAVs This section describes the method used for calculating total quantities of TVMs required at a station beyond the minimum quantity requirements stated above. General principles for allocating the calculated totals to separate arrays are also indicated. Calculations of TVM, fare gate, and Transfer SAV (at transfer stations only) quantities shall be made for each station's AM and PM peak patronage, including surges due to arriving buses and trains at connecting stations. Whichever period requires the greater number of pieces of equipment governs. Passenger volumes may be revised by future studies or data. Fare collection equipment shall be grouped by array. Each fare array is a grouping of TVMs, fare gates, within a free area and transfer SAVs within a paid area. Allocation of the total number of pieces of equipment to each array in a station shall be based on station configuration, and site-access-related factors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2769	Performance Criteria	B	Calculation Methodology	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2770	Performance Criteria	B	Enough ticket vending machines shall be provided at a station so that no passenger will be required to wait more than two minutes for a TVM or twenty seconds for a Transfer SAV or fare gates. Equipment quantity needs shall be developed using a queuing model that analyzes machine usage patterns to determine the effect of different equipment quantities on passenger throughput and wait times. The model output shall be the maximum process time – queuing plus actual transaction time – for various alternative numbers of machines available at each station. Required functionality of the model is summarized below. The model requires input data to calculate a number of intermediate variables. These are used to determine final maximum wait time statistics.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2771	Performance Criteria	B	Input Data include: * System-wide inputs apply to all stations: Ridership growth adjustment Month of year adjustment Day of week adjustment Machine availability percentage (minimum 95%) Mean transaction time by form of payment or transaction (for example, average transaction time needed to perform a transaction at a TVM if using two $10 bills.) Distribution of payment / transaction types (percentage sold by the TVM that is expected to be paid by each combination of coins and bills.) * Inputs for individual station: Daily ridership AM peak ridership PM peak ridership Ridership surge percentage (the percent by which sudden surges exceed the "constant arrival rate", for example as would be caused by a train arriving at the North Hollywood station) Proportion of ridership of each fare type among machine users For each type fare equipment projected usage counts, including daily, AM peak and PM peak.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2772	Performance Criteria	B	Given these data inputs, each station spreadsheet then automatically calculates several intermediate variables that will be used to determine final maximum wait time statistics for each type of fare equipment: Equipment composite peak hour transaction time by station Adjusted peak hour ridership by station – Based on ridership multiplied by the adjusted ridership growth Total peak hour equipment users by station – Based on the adjusted peak hour ridership	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2773	Performance Criteria	B	If the calculated number of TVMs is less than two per array (at separate entrances), two TVMs and two fare gate aisles shall be used. At station platforms with more than one entrance, a single TVM and a single fare gate aisle may be placed at each entrance. Exceptions to the minimum requirement shall be made only after review of the individual station's layout (with consideration for safety of passengers who may cross the vehicle path to reach alternate ticket vending machines or locations), the fare processing rate of each machine, and the reliability of the procured fare collection equipment,	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2774	Performance Criteria	C	Parameters and Overall Methodology – Fare Gates	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2775	Performance Criteria	C	All station designs considered for implementation of fare gating shall have queuing analysis/modeling and exit calculations performed in addition to equipment quantities analysis to determine feasibility in station design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2776	Performance Criteria	C1	Queuing Analyses/Modeling:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2777	Performance Criteria	C1	Queuing analysis/modeling of station design, number of initially proposed fare gates and Metro ridership forecasts shall be performed to determine appropriate fare gate quantities for station entrances considered for fare gating.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2778	Prescriptive Spec	C1	Ridership forecasts used shall be based on 10-year out forecasts and Maximum Line Capacity developed by Metro Operations. Surge time, the length of time between the first and last person arriving at the fare gates during a surge, shall be determined based on distance from the mid-point of the station platforms to the planned fare gate areas. For evaluation, both one and two minute surges times shall be evaluated when this distance is less than 200 feet, and only the two minute surge time shall be used for distances greater than 200 feet. Passengers per peak surge (1-2 minutes) shall be derived from ridership forecasts. The peak surge demand (the highest amount of arrivals at a fare gate within a 1-2 minute time period) shall be dependent upon the number of trains that arrive at each station during a peak hour.													
2779	Prescriptive Spec	C1	The number of people per 10 seconds (demand) over the surge period shall be determined and compared with worst case fare gate capacity and existing fare gate capacity. Worst Case fare gate capacity shall be 3 second service time per person Existing fare gate capacity shall be 2 second service time per person Maximum wait time (seconds), Maximum number of people in queue, and Maximum queue length (feet) per gate shall be determined based on both Worst Case and existing fare gate capacities. Maximum wait time is the maximum time a person entering at the peak of a queue length would have to wait. Maximum number of people in queue is the expected maximum amount of people that will be delayed at the fare gates.													
2780	Prescriptive Spec	C1	Maximum queue length per gate is the queue space that would be needed behind each fare gate to accommodate people waiting in the queue, based on the maximum number of people in the queue. Fare gates that serve only elevator passenger flow shall be considered negligible due to varying elevator utilization factors, service times and capacities. The peak surge flow shall be applied to all turnstile and ADAAG leaf barrier fare gates that are not elevator-only to represent a worst case situation. The throughput of turnstile and ADAAG leaf barrier fare gates shall be considered equivalent in the analysis. A maximum queuing time of 55 seconds during surges shall be considered an acceptable service standard. Wait time results shall be evaluated as follows: - Less than 5 seconds - No significant queues - 5-30 seconds – Slight queues - 30-55 seconds – Noticeable queues - Greater than 55 seconds – Significant queues													
2781	Prescriptive Spec	C1	The quantity of fare gates recommended shall be based on maintaining the maximum queuing times below a 55 second service standard during the worst case scenario (3 seconds per person per fare gate).													
2782	Performance Criteria	C2	Exit Calculations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2783	Performance Criteria	C2	Exit Calculations shall be performed for Metro Rail stations to evaluate impact of fare barriers on station egress. Exit calculations for station shall be performed in accordance with current edition of NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems, to determine results of 4 minute tests, 6 minute tests, and waiting times at fare barriers for station egress specified within.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2784	Performance Criteria	C2	Calculations shall be based upon use of 10 year ridership projections and Maximum Line Capacity as furnished by Metro Operations. Ridership projections shall be used to derive maximum hourly entraining loads in both peak and off-peak directions, which based on surge factor and headway, shall be used to derive peak and off-peak entraining loads to arrive at total entraining load for platform. Train loads shall be based on crush load capacity of train in peak direction and one-half seated load capacity of train in off peak direction. Total Occupant Load shall be the sum of the total entraining load and total train loads based on crush capacity defined by Metro. Comparison of total entraining load to Net Platform Area divided by 4 square feet per person shall be made to determine if constrained platform access required. The greater number of total occupant load compared to Net Platform Area divided by 7 square feet per person shall be made to determine number to use for egress calculation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2785	Standard Criteria	C2	Fare gate equipment used, including turnstile fare gates, ADAAG barrier leaf fare gates, and emergency swing gates, shall be based upon the existing Cubic Transportation Systems, Inc. (Cubic) design used on Metro' s UFS Gating Project. Capacity for exiting for each fare barrier element shall be the following per current edition (2010) of NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems, NPFA 130: Turnstile Fare Gate Aisle: 25 PPM (People Per Minute) (2010 edition) ADAAG Barrier Leaf Fare Gate Aisle: 50 PPM (2010 edition) Emergency Swing Gate (Bi-Parting): PPM = Width of swing gate opening x 2.08 PIM Emergency Swing Gate (Single Leaf): PPM=60 PPM	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2786	Standard Criteria	C2	Exits other than fare collection gates shall provide for at least 50 percent of the required exit capacity in any fare barrier in accordance with current edition of NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems, Section 5.5.6.3.3.4 (Doors and Gates, 2010 edition). Exit Calculations shall assume worst case scenarios, including but not limited to: Maximum ridership based on fully loaded peak entraining load Two trains arriving simultaneously on the platform Maximum length trains operating in peak and off-peak directions Crush capacity of 400 people per Metro Heavy Rail "married pair" per Metro Fire/Life Safety Recommendation, and 220 per Light Rail articulated vehicle per Metro Fire/Life Safety Recommendation. Walking distance beginning from the furthest point on station platform and ending at Point of Safety (defined by Metro) Do not consider emergency exits that lead only to the track area Exit calculations together with station gating layout design shall be reviewed and approved by Metro Fire/Life Safety	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.2.7	SECURITY MONITORING													
2787	Performance Criteria		CCTV cameras shall be positioned to provide full coverage of the front of each TVM array, each fare gate array facing entering people and fare gate array facing exiting people, and coverage of Transfer SAVs to support patron and equipment security monitoring. CCTV cameras shall be positioned to provide full coverage of the face of the patron communication on PTEL and GTEL Station lighting levels in area of TVM arrays, fare gate arrays, and Transfer SAVs shall be sufficient to support patron and equipment security. For minimum lighting requirement/criteria, refer to MRDC Section 7 Electrical, IES, and ANSI criteria and recommendations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.2.8	UFS COMMUNICATIONS													
2788	Performance Criteria	A	Scope and General Description Labeled pull ropes shall be provided in each communication conduit and underfloor duct.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2789	Performance Criteria	B	Communication Link Requirements Each station shall require: All infrastructure requirements for leased phone line and conduits infrastructure provisions All equipment necessary for one Fast Ethernet (10/100 Base T) connectivity at each station and at ROC, including dedicated port (for UFS) on Fast Ethernet Card installed in node at each station and at ROC. Two dark fiber optic strands, daisy chained at each station, for UFS communication path to Gateway as well as space and power for the future fiber optic multiplexing equipment in the communication room or the cabinet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2790	Performance Criteria	C	SCADA Interface Requirements SCADA input (voltage provided by SCADA) shall be provided for the TVM Vibration/Intrusion Alarm. One set of SCADA alarm points shall be provided at the station MDF within the communication room or the cabinet for each TVM Group within the station. The SCADA Interface cable shall be installed in the 2" UFS communications conduit between TVMs and punch block on MDF backboard in the communication room or cabinet. Cross-connects from the punch block on MDF backboard shall be provided by the Communications Contractor to the SCADA PLC rack for connection to SCADA points for this alarm. This cable shall connect each TVM within a TVM Group together in daisy chain manner to the MDF. Opening of Normally-Closed dry contact within any TVM in a TVM Group shall result in SCADA alarm indication at ROC for the TVM Group security condition.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2791	Performance Criteria	D	Evacuation Message Interface (EMS) Interface Requirements Normally Closed dry contacts shall be provided for the Fare Gate Array/EMS interface. One Normally Closed dry contact shall be provided at the MDF within the communication room or the cabinet for each fare gate array within the station, The EMS pair running in the 2" UFS communications conduit between the Fare Gate Array and the station communication room or the cabinet shall be terminated at the punch block on MDF backboard. Cross-connects from the punch block on MDF backboard shall be provided by the Communications Contractor to interface with the provided dry contact. Opening of the Normally Closed dry contact shall occur automatically upon activation of the Evacuation Message System from ROC or locally from the station Emergency management Panel (EMP) for underground stations; and upon activation of the station Fire Control Panel (FCP) at all stations. Upon the activation, the fare gates shall go into Emergency Mode causing turnstiles to free-spin and barrier leafs to retract, plus cause electric latch on each swing gate de-energize (release) to support emergency exiting of public from paid area of station as required by NFPA 130.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.3	**RAIL VEHICLE INTERFACE**													
		9.3.1	INTRODUCTION													
2792	Performance Criteria		This section only summarizes the required functional, operational, and physical characteristics of Metro Transit Rail Vehicles. This section is intended to provide a definition of the existing vehicles to assist in the project design. Each line segment (LRT or HRT) shall be designed to meet the interface requirements of all corresponding Metro's existing vehicle types. This section is not intended to serve as design criteria, or specifications for future vehicle procurements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		9.3.2	VEHICLE CHARACTERISTICS													
2793	Performance Criteria	A	General	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2794	Performance Criteria	A	The vehicles defined in this Section will be for Light Rail Projects and Heavy Rail Projects. The vehicles may be of the articulated or married-pair type, double ended, four doors on each side for articulated type and three doors per side for the married pair type, with access from high-level platforms. The vehicles shall utilize in design and construction as much "off-the-shelf" technology as possible. The center truck shall be unpowered if the vehicle is of the articulated type. The design minimum service life of the vehicles shall be 30 years. Each lead vehicle in a consist shall be equipped with at least a horn and headlight to assist in alerting station occupants to an arriving train. Materials shall be based on characteristics of:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2795	Performance Criteria	A	Light Rail Vehicles: (P865/P2020, P2000, P2550 and P3010) ? Articulated ? Double Ended ? Four (4) doors on each side (Total 8 per car, 16 per vehicle) ? Access from high-level platform ? The vehicles shall utilize in design and construction as much" off-the-shelf" technology as possible. ? Center truck shall be unpowered if the vehicle is of the articulated type ? The design minimum service life of the vehicles shall be 30 years ? Each lead vehicle in a consist shall be equipped with at least a horn and headlight to assist in alerting station occupants to an arriving train ? Power Collection System – Pantograph, one per Vehicle, 750 Vdc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2796	Performance Criteria	A	Heavy Rail Vehicles: (A650 Base and Option) ? Married–Pair (MP) attached by a semi-permanent coupler ? Double Ended ? Three (3) doors per side (Total: 6 per Vehicle, 12 per MP) ? Access from high-level platform ? The vehicles shall utilize in design and construction as much" off-the-shelf" technology as possible. ? The design minimum service life of the vehicles shall be 30 years ? Each lead vehicle in a consist shall be equipped with at least a horn and headlight to assist in alerting station occupants to an arriving train ? Power Collection System – Third Rail "Collector-Shoe" two per truck, 750 Vdc	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2797	Performance Criteria	A	A current collector/contact rail isolation device, suitable for on-board vehicle storage shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2798	Performance Criteria	B	Operating Characteristics Vehicles operate as single units, or as multiple units consisting of: ? Two or three Light Rail vehicles and in an emergency operation of up to twice that number of vehicles. ? Two or three Heavy Rail vehicles (Married Pairs) and in an emergency operation or dead tow only Two married pairs.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2799	Performance Criteria	C	Vehicle Dimensions	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2800	Performance Criteria	D	Truck Dimensions	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2801	Performance Criteria	E	Vehicle Weight and Design Loading	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2802	Performance Criteria	F	Jacking Pad (JP) Location	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2803	Performance Criteria	G	Regenerative Braking – Current Limits as measured in voltages (Vdc) These values are based upon the OEM's calculated measurement for each vehicle. ? 825 Vdc line voltage for Ansaldo-Breda A650 ? 900 Vdc line voltage for Siemens P2000 ? 920 Vdc line voltage for Ansaldo-Breda P2550 ? 860 Vdc line voltage for Nippon-Sharyo P865/P2020 ? Kinki-Sharyo P3010 TBD.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2804	Performance Criteria	H	Wheel Profile – As built Drawing ? The Metro Red Line Ansaldo-Breda A650 Heavy Rail Vehicle (HRV) utilizes the Resco Wheel Profile while the other Light Rail Vehicles (LRV), i.e. Ansaldo-Breda P2550, Nippon-Sharyo P865/P2020, and Siemens P2000, uses the RTD-1 Wheel Profile.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2805	Performance Criteria	I	Vehicle Static and Dynamic Envelopes • The static and dynamic envelope shall be as defined in Section 4 and must follow the California Public Utilities Commission (CPUC) General Order No. 24-D (CLEARANCES ON RAILROADS & STREETS RAILROADS WITH REFERENCE TO SIDE AND OVERHEAD STRUCTURES, PARALLEL TRACKS, CROSSING OF PUBLIC ROADS, HIGHWAYS AND STREETS) or later revision if any.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2806	Performance Criteria	J	Vehicle Performance	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2807	Performance Criteria	J	Speed Light Rail Vehicle Operating Speed 65 MPH maximum Heavy Rail Vehicle 70 MHP maximum	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2808	Performance Criteria	J	Acceleration Light Rail Vehicle Nominal initial 3.0 MPHPS + 5% for car weights AW-0 to AW2 Heavy Rail Vehicle Nominal initial rate 3.0 MPHPS + 5% for car weight AW0 to AW2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2809	Performance Criteria	J	Braking Emergency Brake For Heavy and Light Rail: At any given entry speed below overspeed limit, the emergency brake rates shall be within the range specified (Table 9.3.4) and shall be calculated by averaging the average deceleration rates (v/t) from several stops made in opposite directions on the same section of dry, level tangent track for all conditions of loading (AWO to Full Load). The velocity (v) is the velocity that exists after the maximum mode change dead time has elapsed and the brake rate has increased to the command value. The time (t) is the elapsed time from the point where velocity has attained a value equal to "v" until the car has stopped. Service Brake Light Rail Vehicle – AW0 to Full load 3.5 mphps Heavy Rail Vehicle – AW0 to Full load 3.0 mphps Hi-Rail Maintenance Vehicle Design Loading • Refer to Section 4 for loading parameters.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2810	Performance Criteria	K	Communications On-board communications shall be provided as follows: • Communications capability between ROC and the train operator and from/to on-board patrons shall be provided by a combination of on-board intercom (IC) and the train-borne two-way radio system. • All vehicles shall be numbered uniquely to provide for positive identification. The train-borne two-way radio shall transmit the train identification each time the train-borne radio is used to transmit. • Operating instructions and vehicle number shall be applied to the sidewall immediately below each remote IC station on each vehicle. There shall be a minimum of four IC per train car. • Emergency communication capabilities, including train operator radio, Digital Video Recorders, the associated cameras, the associated cab microphone, and IC system, for the vehicle shall be provided with a battery backup power system that has a minimum capacity of 4 hours of run time with the assumption of 50% transmission time of the two-way radio. • Wireless communication of vehicle data (DVR and diagnostics) will be incorporated into future vehicles via 802.11 type of wireless technologies. The train-borne two-way radio system that is used for voice communications shall not be used for this type of data transmission.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4	**TRAIN CONTROL**													
		9.4.1	DESCRIPTION													
		9.4.1.1	DESCRIPTION													
2811	Definition		This section describes the design criteria for the signaling and automatic train control (ATC) systems to be used on the Light Rail Transit (LRT) and heavy Rail Transit (HRT) systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.1.2	APPLICABLE STANDARDS AND REFERENCE DOCUMENTS													

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2812	Standard Criteria		**A.** All apparatus and work included in the design, manufacturinge, and installation and testing of the ATC System shall conform to current relevant specifications and recommendations by the following agencies or organizations: **1.** American Railway Engineering and Maintenance of Way Association (AREMA) **2.** American National Standards Institute (ANSI) **3.** American Public Transit Association (APTA) **4.** Electronic Industries Alliance (EIA) **5.** Federal Communications Commission (FCC) **6.** Federal Railroad Administration (FRA) **7.** Federal Transportation Administration (FTA) **8.** Institute of Electrical and Electronics Engineers (IEEE) **9.** National Electrical Code (NEC) **10.** National Electrical Manufacturers Association (NEMA) **11.** National Fire Protection Association (NFPA) **12.** Public Utilities Commission of the State of California (PUC) General Orders **13.** Title 8 of the California Code of Regulations (CCR) **14.** U.S. Government Code of Federal Regulations and Military Standards. **15.** U.S. Department of Transportation Manual of Uniform Traffic Control Devices (MUTCD) part VIII.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.1.3	FUNCTIONAL REQUIREMENTS													
2813	Performance Criteria		The ATC system shall be designed to enforce train safety, control train operations, and direct train movements. The ATC System shall be designed with an emphasis on safety, operational efficiency, cost effectiveness, maintainability and upgradeability.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2814	Performance Criteria	A	System Configuration The ATC system is to be comprised of four major subsystems:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2815	Performance Criteria	A1	Automatic Train Protection (ATP) An Automatic Train Protection subsystem shall maintain safe train operation by enforcing speed restrictions. Speed restrictions shall be enforced by comparing the actual speed of the train with maximum allowable speeds derived from braking distance formulas and civil restrictions. Maximum allowable speeds shall be transmitted to the train through track circuits or wire loops, from wayside equipment. Detection of an overspeed shall force the train into service or emergency braking to maintain safe train operation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2816	Performance Criteria	A2	Automatic Train Supervision (ATS) An Automatic Train Supervision system shall control and direct train movements on the main line and in the yard. The ATS system monitors train operation and provides controls, indications, automatic route initiation, and automatic dispatching necessary to maintain intended traffic patterns to minimize the effect of train delays on the operations schedule. ATS is an integral part of Rail Operations Control (ROC). ROC will contain the necessary displays, control consoles, communications apparatus, and the operating personnel responsible for the overall safety and security of passengers and for the daily operations of the trains, stations, and all supporting apparatus. The ROC will serve as the focal point from which all Rail System operations will be supervised.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2817	Performance Criteria	A3	Highway Crossing Warning System (HCWS) HCWS shall provide an interface between the wayside signal equipment and the crossing warning devices, such that flashing lights and gates are controlled to provide timely information of and protection from an approaching train.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2818	Performance Criteria	A4	Train to Wayside Communication System (TWC) The TWC subsystem shall allow trains to communicate the following information between the vehicle equipment and wayside interrogators at appropriate points along the route such as: • Vehicle identification • Routing information • Establish routes • Cancel routes • Activate or deactivate HCWS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2819	Performance Criteria	B	System Expansion 1. The ATC subsystems shall be designed to allow for expansion of the system with minimal modification to hardware, software and facilities of the systems being installed. To facilitate this requirement the system shall avoid the use of proprietary hardware and software and all application logic/circuit designs shall follow AREMA recommended practices to the fullest extent feasible. 2. ATS shall include automatic routing capabilities based on train identification/destination to accommodate future routes for automated lines. 3. Application logic shall be free from unnecessary complexities and well commented such that an experienced train control designer can follow the logic. 4. All non-COTS (Commercial Off-the-Shelf) software and application logic shall be provided to enable future maintenance and modification.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2820	Performance Criteria	C	Operational Considerations In design and implementation of the ATC system, the following operational considerations shall apply: **1.** The ATC system shall provide for minimal degradation of service under certain definable anomalous scenarios. These scenarios shall include, but not be limited to: utility power loss, vehicle equipment malfunctions and ROC operating malfunctions. Bi-directional single-track operation shall enable service around unusable sections of track. **2.** Train operations in the reverse direction of traffic shall be done with vehicles with fully functional Automatic Train Protection systems. **3.** Interlockings shall enable trains to turn back and / or operate on a single track. **4.** Train locations and movements throughout the main line shall be displayed at ROC. **5.** All movements of trains between yard tracks and main line tracks shall be coordinated by Yard Controllers and ROC dispatchers, or local control panel operators and ROC Controller. **6.** Trains shall be able to clear and release mainline tracks, prior to entering yard territory.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2821	Performance Criteria	D	Performance Requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2822	Performance Criteria	D	The ATC system shall be designed to address train safety, control train operations, and direct train movements, with the highest practicable levels of safety and service. The ATC system shall optimize reliability and maintainability for efficiency of operation and cost effectiveness. The system shall include the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2823	Performance Criteria	D	**1.** A block design based on the maximum allowable speeds consistent with track alignment and other speed restriction requirements. **2.** Reverse running capability with ATP on each track, with following move capability. **3.** Entry of trains into main line service, with ATP, from any station, terminal, or yard. **4.** The capability of aligning any non-conflicting route, controlling traffic, and performing control functions from ROC or local control panels and the TWC equipment when neither ROC or local control is in control. **5.** Display of all information relative to train operations, including the position and identification of trains, route alignment, and traffic direction. **6.** Centralized control from a control console capable of controlling all functions for each main line interlocking, as required, and displaying all indications and trouble alarms necessary for system control and supervision. **7.** Automatic or Fleet routing at interlockings. **8.** ATC shall include automatic routing capabilities based on train identification/destination. **9.** Where ventilation zones are exclusive to a single track, the ATC System shall allow no more than 1 train to occupy that ventilation zone at any given time.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2824	Performance Criteria	D	Main line train control shall be governed by cab signaling, with wayside signals provided at interlockings and at other locations as required by Metro Rail Operations. The main line includes a combination of double track and multiple track railroad, which shall be signal controlled to provide safe train separation. Operations on the main line shall run with either automatic routing or fleeting. Manual route setting shall be provided via Train-to-Wayside Communication (TWC), accessible from the Rail Vehicle cab. Manual route setting shall also be possible from the Local Control Panel (LCP) provided in each signal house and from Rail Operations Control (ROC) via SCADA.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2	METRO GOLD LINE EXPANSION AND ANY NEW CONSTRUCTION													
		9.4.2.1	General Requirements													
2825	Performance Criteria		The signaling system shall provide the following functions: Interlocking control of switches and signals Safe routing of trains Safe separation of trains to prevent collisions and side swipes by physically separated operation on the main line, protected by vital systems Protection of highway crossings against road/rail collisions giving railroad traffic priority by provision of highway crossing warning and protection systems and interfaces with highway traffic control equipment and foreign railroad crossing equipment at shared crossings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2826	Performance Criteria		The signaling system and grade crossings shall comply with the AREMA Manual of Recommended Practices - Signals and CPUC General Orders 75, and 143. Automatic route setting shall be for normal train operation. Manual selection of routes shall be provided for abnormal train operation or when automatic routing is not desirable. Bi-directional operation at full line speed and headway shall be provided throughout the main line. All sections under signal control shall be signaled such that, in the event either of the tracks in the double track sections is taken out of service, safe operations can be maintained. The signal system shall provide continuous overspeed protection and speed commands (cab signal) operation, which shall prevent unsafe operation with respect to other trains, interlocking conditions, civil speed limits, and grade crossings. Any transition from street running to cab signal territory shall be governed by a wayside signal. Overrun of these signals, as well as, any other interlocked wayside signals displaying a STOP aspect shall be prevented by ATP.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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2827	Performance Criteria		The cab signal system shall impose speed restrictions due to civil/track speed limits. In the normal direction of traffic the following design requirements shall be followed: The speed code reduction shall occur at a point no further than 110% of the Civil Braking Distance from the point of restriction. The cab signal and block design shall enable acceleration to the authorized speed (within safe braking constraints) to commence within 400 feet of the end of the speed restriction area. The maximum block length shall be 5,000 feet. Maximum cab code reduction between successive blocks shall not exceed 25 mph. All track circuits shall have a provision to allow for a manual downgrade to a more restrictive speed code via local control panel or hardware cards. Manual speed code selection shall not override safe train separation function of ATP. Exceptions to the above criteria shall be reviewed on a case-by-case basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2828	Performance Criteria		The cab signal system shall impose speed restrictions on the approach to stations with an at grade crossing on the exit side of the station. In the normal direction of traffic the following design requirements shall be followed: • Speed code reduction, or removal of cab code shall occur on the approach to, or the exit from, the station to ensure that a train that fails to make a station stop, or does not make a full 20-second dwell, cannot enter the crossing unless the entrance gates are fully down. • Speed code reduction, or removal of cab code shall, never–the-less, maximize the train speed into the station. • Speed code reductions shall be calculated using the Civil Braking Distance formula. • Speed code reductions shall occur at a point no further than 120% of the Civil Braking Distance from the near side of the crossing. • Crossings shall be activated automatically, assuming a 20-second station dwell. Once the entrance gates are down, full speed cab code shall be available. • Where the crossing is within 100 feet of the station, a TWC system shall be provided to enable crossing calls to be called or cancelled. Same functionality shall be provided wherever the crossing approach, including pre-emption and advanced warning extends into limits of the passenger or motorman's platform	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.2	SAFE BRAKING DISTANCE MODEL													
		9.4.2.2.1	INTRODUCTION													
2829	Performance Criteria		The Safe Braking Distance (SBD) is the calculated distance that a worst-case train will travel between the time that a speed reduction is commanded until the required speed reduction is achieved. The train operator is in control of the speed with the cab signal system providing over-speed protection only. The design shall utilize the SBD formula for all safety braking requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2830	Performance Criteria		The Civil Braking Distance (CBD) is the calculated distance that a train will travel between the time that a civil speed reduction is commanded until the required speed reduction is achieved. The train operator is in control of the speed with the cab signal system providing over-speed protection only. The CBD formula shall not be applied to safe train separation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.2.2	INITIAL ENTRY SPEED													
2831	Performance Criteria		For SBD and CBD calculations, an initial entry speed (S) is used, which is derived from a combination of Cab Signal Speed (CSS), Cab Signal Tolerance (CST), Cab Signal Overspeed Allowance (CSO), and the Acceleration Allowance (AA) as follows (all values are mph unless specified otherwise):	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2832	Performance Criteria		CSS = 55, 45, 35, 25, 15, 10, or 0 mph according to the cab signal code immediately prior to entry.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2833	Performance Criteria		CST = Tolerance in speed detection, which shall be as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2834	Performance Criteria		CSO = Allowable exceedance of cab signal speed as detected by the carborne cab signal system, which shall be as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2835	Performance Criteria		AA = An allowance to account for instantaneous acceleration of the vehicle for the time delay between the decoding of the speed code by the carborne equipment, and removal of propulsion power. The allowance shall also include for jerk-limited removal of power and application of braking.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2836	Performance Criteria		For SBD calculations, S = CSS + CST + CSO + AA For CBD calculations, S = CSS + CST + CSO	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.2.3	SAFE BRAKING DISTANCE CALCULATION													

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2837	Definition		SBD = Dr + Db + Do, where: Dr = Reaction distance in feet = S x R x 1.467 Db = Braking Distance in feet = 0.733 x S2 / (B ⍰ 0.2G) Do = Overhang distance of two vehicles = 30 feet S = Initial entry speed (mph) prior to braking. R = Reaction time in seconds (includes operator, cab signal delays and brake build-up) = 9.8 seconds for a change in speed code and 7.2 seconds for code-to-no code. B = Safe Braking rate = 2.0 mphps G = Alignment grade as a decimal fraction For safe braking calculations to bumping posts, the overhang distance of one vehicle (15 feet) can be used for distance Do.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.2.4	CIVIL BRAKING DISTANCE CALCULATION													
2838	Definition		CBD = Dr + Db, where: Dr = Reaction distance in feet = (CSS) x R x 1.467 Db = Braking Distance in feet = 0.733 x (CSS2-V2) / (B ⍰ 0.2G) CSS =Cab Signal Speed (mph) prior to braking. V = Target speed at speed restriction R = Reaction time in seconds (includes operator, cab signal delays and brake build-up) = 4.0 seconds. B = Safe Braking rate = 2.0 mphps G = Alignment grade as a decimal fraction The target point for achieving the speed reduction shall be the tangent-to-spiral point on curves and the point of switch for turnouts. Civil speed restrictions shall be maintained until the rear of the train is clear of the restriction. For curves, this shall be the curve-to-spiral point.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.3	CAB SIGNAL SYSTEM													
2839	Definition		Functionality Overview The cab signal received on-board the car shall be interpretedas a speed limit, the aspect of which, shall be displayed to the operator.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2840	Definition		Code rates and their meanings shall be: <table><tr><th>CODE RATE</th><th>INDICATION</th></tr><tr><td>410 PPM (6.83 Hz)</td><td>Cab signal cutout. Used for Street Running mode (35 mph speed limit).</td></tr><tr><td>270 PPM (4.5 Hz)</td><td>Proceed at 55 mph.</td></tr><tr><td>180 PPM (3 Hz)</td><td>Proceed at 45 mph.</td></tr><tr><td>120 PPM (2 Hz)</td><td>Proceed at 35 mph.</td></tr><tr><td>75 PPM (1.25 Hz)</td><td>Proceed at 25 mph.</td></tr><tr><td>50 PPM (0.833 Hz) @ 100Hz, asynchronously combined with 50 PPM (0.833 Hz) @ 250Hz</td><td>Proceed at 15 mph.</td></tr><tr><td>50 PPM (0.833 Hz)</td><td>Restricted (Yard). Proceed at maximum of 10 mph, prepared to stop.</td></tr><tr><td>Unmodulated 100 Hz</td><td>Stop</td></tr><tr><td>No Code</td><td>Stop and Proceed. Approaching a signal at stop or when occupancy exists ahead that requires immediate brake application to safely avoid a collision.</td></tr></table>	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2841	Definition		The cab signal rail current shall be no less than 3 amps at the entering end of track circuits and the feed end shall be no greater than 20 amps. The carrier frequency shall be 100 Hz ⍰2 Hz. The code rate tolerance shall be ⍰5%. The code duty cycle shall be 60/40 to 40/60. Dead sections, such as at insulated rail joints, shall be no greater than 14 feet in length. Use pre-cab, as necessary, to ensure no momentary loss of cab (cab flip).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.4	TRAIN-TO-WAYSIDE COMMUNICATION													
2842	Definition		The Train-to-Wayside Communication (TWC) system shall be compatible with Hanning & Kahl HCS-V system. TWC transponders shall be provided at the following minimum locations: ⍰ Approach to all wayside signals • At stations with near-side at-grade crossings and where crossing activation, pre emption or advanced warning extends into the limits of the passenger or motorman's platform. • At the terminus station (for calling of a route onto the main line). Loops must accommodate two- and three-car consists such that two- or three-car train is able to request departing route from its outbound berthing position	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.5	TRAIN DETECTION													

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2843	Definition		The signaling system shall detect all cars operating independently or in consist, and any other rail vehicle present, except hi-rail vehicles. The presence of a rail vehicle in a section of the route shall be detected continuously by means of track circuits. Detection of the occupation of the track circuit shall be fail-safe, such that a de-energized position is interpreted as an occupation of the track circuit. In the event of a temporary loss of detection, the design shall ensure that indication of the presence of a rail vehicle in a section will be maintained while a rail vehicle is actually in the section.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2844	Definition		If a rail vehicle is parted in an unscheduled manner, the signal system shall ensure that all parts of the rail vehicle are detected. The signal system shall ensure that safe separation is maintained between the parted vehicle and all other rail vehicles. The minimum effective length of a track circuit shall be longer than the maximum inner wheelbase of all vehicles used on this track. The maximum length for Power frequency and Coded Track Circuits shall be 5000 feet. The maximum length for Audio Frequency Track Circuits shall be 2000 feet. For track circuits used to control signals and locking functions, including grade crossing activation devices, the minimum shunt sensitivity shall be 0.25 Ohms. The shunting requirements shall be met for ballast conditions of 5 ohms per thousand feet or greater. Track circuit layout shall provide sufficient resolution to SCADA for train tracking purposes	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.6	BROKEN RAIL DETECTION													
2845	Performance Criteria		Broken rail detection shall be provided throughout all mainline track. A broken rail shall de energize the associated track circuit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.7	ROUTE SETTING													
2846	Performance Criteria		There shall be four methods for control of train movement through the signalized sections, as described below:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.7.1	AUTOMATIC ROUTE SETTING													
2847	Performance Criteria		Routes shall either normally operate automatically by signal and switch control subsystems responding to the approach of the train, or by use of a Fleet command. In normal operation, routes shall clear automatically for consists without intervention by the train operator. At terminal stations the train operator shall be able, via TWC, to request that the departing signal be cleared for the train to proceed. Trains shall be normally routed reverse across before reaching the station as the preferred route, or the normal direction route if the preferred platform is occupied. The ATC system shall use train ID, transmitted by the TWC system, in order to automatically route trains at junctions, terminals and other locations as defined by the project for their designated route. Fleeting, if implemented, shall be provided for the normal traffic direction only.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.7.2	SELECTION OF ROUTES FROM THE TRAIN													
2848	Performance Criteria		Train-to-Wayside Communication route selection shall be provided at all interlocking signals.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.7.3	LOCAL ROUTE SELECTION CAPABILITY													
2849	Performance Criteria		Local control capability shall be provided to ensure the safe operation of trains by means of Local Control Panels (LCP) in each signal house. The LCP shall indicate track circuit occupancy, signal status, switch position and correspondence, switch locking, traffic direction, manual control, automatic control, and crossing gate position, speed restriction enabled, AC alarm, DC alarm, communication failure alarm, system failure (Electrolgixs, VHLC, iVPI, or Microlok), and all indications described in the specifications. LCP shall be of size such that it can display the complete layout of the territory controlled from the location, without need to change screens or scrolling. Displayed track layout shall include at least one adjacent track circuit, beyond the boundary of control. Display used for local control panel purpose shall be 32" minimum and be wall mounted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.7.4	RAIL OPEARTIONS CONTROL													
2850	Performance Criteria		Central control capability shall be provided at each interlocking.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.8	WAYSIDE SIGNALS													
		9.2.4.8.1	MAIN LINE													
2851	Performance Criteria		LED wayside color signals shall be provided to indicate movement authority, block occupation and route locking information to train operators. Signals shall be installed to govern movements into and through interlocking limits.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2852	Performance Criteria		Wayside color signals shall show the following aspects, which are in compliance with Metro rules: Aspect: Meaning Red: Stop Flashing Red: Stop and contact ROC. Proceed when authorized by ROC. Flashing Yellow: Proceed on diverging route into reverse traffic. Yellow: Proceed on diverging route into normal traffic Flashing Green: Proceed on normal route into reverse traffic. Green: Proceed on normal route into normal traffic.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2853	Performance Criteria		Indication on signals or switches shall be fail-safe, such that no less restrictive aspect is shown than intended. Wayside signals shall be located such that they are sufficiently visible to preclude confusion with signals governing the operation of motor vehicles, and similarly do not confuse motor vehicle drivers. When viewed from a height of 7 feet above top of rail, at a distance of 500 ft, lenses shall present a distinct aspect under the most adverse operating conditions. Provide a signal number plate for each signal. The signal number plate shall be placed under the lowest signal lens in the assembly. Signal plates shall meet the requirements of the AREMA Manual of Recommended Practices – Signals. The alphanumeric characters shall be a minimum of 3 inches high. The top of the top-most aspect shall be set at 5'-5 3/8" above Top of Rail or as approved by Metro. Signal aspects shall use 8" Light Emitting Diode (LED) units.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.8.2	TUNNEL HOLD													
2854	Performance Criteria		Provide two-aspect LED wayside signals mounted in the immediate vicinity of a tunnel portal, oriented towards tunnel-bound trains. Signals shall have the following aspects: Aspect: Meaning Green: Ventilation zone clear. Red: Ventilation zone occupied. Ventilation zone occupancy detection and indication circuits shall be fail safe. Other requirements for these signals, including sighting distance, construction and circuit requirements shall be as described in 9.4.2.8.1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.9	INTERLOCKINGS													
2855	Performance Criteria		As a minimum, the following locking functions shall be provided for powered switch interlocking:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2856	Performance Criteria	a	Switch locking - A locking function shall ensure that a signal governing a switch or combination of switches shall only show a less restrictive aspect than "stop", when all switches are in the correct position.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2857	Performance Criteria	b	Automatic Block locking - A home signal governing a block shall only show a less restrictive aspect than "stop", when the entire block is unoccupied by any trains or vehicles. This shall be controlled automatically by means of track circuits throughout the entire block.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2858	Performance Criteria	c	Route locking - Route locking shall lock switches within a route after a signal has been requested for train movement onto that route, and shall prevent clearing of opposing and conflicting signals within the interlocking. Route locking shall be in effect when approach locking is in effect, and it shall remain in effect until the rear of the train has cleared the route. Switches, which are part of the route, and switches or signals, which are protecting against flanking (side-swipe), shall be disabled from moving when the route is locked. Signals protecting this route shall be prevented from showing aspects other than stop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2859	Performance Criteria	d	Approach locking - Approach locking shall lock switches within a route governed by a cleared wayside signal to prevent clearing wayside signals for opposing or conflicting routes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2860	Performance Criteria	e	Time locking - Time locking shall ensure that all switches and signals forming a route, and those protecting it, remain in position and locked for a predetermined time after the entry signal has been caused to display its most restrictive aspect again.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2861	Performance Criteria	f	Traffic locking - Setting and locking of a route shall be prohibited unless the opposing signals show the most restrictive aspect. The signal system shall furthermore prevent any trains simultaneously entering the same block section from different directions or tracks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2862	Performance Criteria		Independent of any route locking function, the movement of any powered switch shall be prevented when track occupancy is detected in the track section in which that switch is located. The switch locking function shall have 5 seconds loss of shunt protection. However, sectional release shall be provided where practicable, to support headways through junctions. Any failure, including false occupancy, loss of power, to any part of an interlocking shall not result in the premature release of any locking function. Overrun detection shall be provided for every interlocking signal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.10	PUBLIC HIGHWAY CROSSINGS													
		9.4.2.10.1	GENERAL													
2863	Performance Criteria		Activation of grade crossing warning devices shall be normally achieved by all rail vehicles using the main line, but excluding hi-rail vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		9.4.2.10.2	HIGHWAY CROSSING WARNING ACTIVATION													
2864	Standard Criteria		Warning devices shall normally be automatically activated by the approach of a rail vehicle with a nominally uniform warning time. The devices shall be direction sensitive, and shall be activated by the approach of a train on any track from either direction. The calculation of the exact warning time shall be done for each crossing according to CPUC GO 75 and AREMA C&S Manual Part 3.3.10 requirements. Minimum of 28 seconds warning time shall be provided unless required otherwise by governing jurisdiction. Advanced Pre-Emption shall be provided where required to clear traffic queues and provide sufficient time for adjacent controlled intersections to configure for crossing activation. Design shall ensure that full warning and preemption time is provided under all operating scenarios. The design shall assume all trains stop at all stations for the purposes of setting Advanced Pre-Emption and Crossing Warning times. Where the start of a Crossing Warning extends to, or through, a station the contractor shall ensure, by means of cab signal code, that a train that fails to make a station stop cannot enter the crossing before the entrance gates are lowered. However, reductions in cab signal code to enforce minimum warning time shall not be implemented earlier than necessary. The goal shall be for such code reductions to be invisible to a train making a normal station stop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2865	Performance Criteria		Where a crossing is in advance of a station such that a minimum time cannot be given (after departure from the station), the crossing gates shall remain inactivated. If the operator does not stop, the gates shall be activated and the signal system shall impose a speed reduction or STOP code to ensure the train cannot enter the crossing before the entrance gates are lowered. The design shall provide a system for automatic gate activation prior to train departure. TWC shall be provided to cancel crossing activation and to reactivate the crossing. The warning devices shall remain active until the crossing is cleared totally. These grade crossing systems shall be designed and installed in accordance with applicable Governmental Rules and, the recommendations of the AREMA and Manual of Uniform Traffic Control Devices (MUTCD). All flashing light signals used in highway-rail crossing warning system installation shall be per requirements of CPUC GO-75D. Where a 4-quadrant full-closure gate arrangement is required, the design shall arrange for the leading and trailing gates to operate as specified in CPUC GO 75. The design shall extend the approach time to take account of the delay in dropping all gates. All gates shall be individually monitored.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2866	Performance Criteria		Crossing bell shall be an electronic type, conforming with AREMA Signal Manual, Part 3.2.61. The bell sound level shall be set to 77 dBa ±2 dBa at 10 feet in accordance with AREMA Signal Manual, Part 3.2.61, unless ambient noise levels dictate otherwise. Where an electronic processor is used for the crossing equipment, the design shall be such that the end user may elect, by means of external wiring alteration and without logic redesign, to silence the bells once all gates are horizontal. Such design shall prevent the bells from re-activating as the gates rise. Provide an 8-inch lunar white LED Motorman's Signal for each track,. Separate signals shall accommodate normal and reverse direction of traffic. Each Motorman's Signal shall display a solid aspect when the crossing approach is occupied and a flashing aspect when the entrance and exit gates are down and there is no detected malfunction of the crossing system. Provide override test, raise and lower pushbuttons in a locked box.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.11	TRACK SWITCHES													
2867	Performance Criteria		All track switches shall be powered and interlocked. They shall normally be set and locked automatically. All route-setting functions shall apply. An over-switch (OS) track circuit shall be provided, occupation of which shall prevent powered movement of the switch. A manual switch setting facility shall be provided at powered switch locations. The placing of a powered switch into manual operation shall result in loss of indication. Signals shall revert to their most restrictive aspect in the event of loss of indication of switch position. Switch and lock mechanisms shall meet or exceed the recommendations of the AREMA Manual of Recommended Practices–Signals. The electrical, electromechanical or mechanical locking equipment shall prevent switch point movement when the switch points are in full normal or full reverse position. Three-phase operated switch machines shall be avoided unless exceptional site conditions (e.g. distance from control point) dictate use of same. Parts of switch operating layouts shall be interchangeable between similar layouts. Provide green/yellow switch position indicators for facing point switches that are not directly governed by a signal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.12	TRACTION RETURN BONDING													

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2868	Performance Criteria		The design shall provide impedance bonds and running rail continuity and cross bonding sufficient to comply with the traction return power requirements. The design shall ensure that no single failure, including broken rail or loss of a bonding cable, shall result in loss of traction return capability through loss of continuity or failure due to overheating. Traction power return capability shall be provided on all tracks regardless of whether OCS is present or not.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.13	EVENT RECORDERS													
2869	Standard Criteria		AREMA recommended event recorders that store information for future playback shall be provided for vital systems, including grade crossings, to record changes in state of the vital systems and their devices, all alarms, as well as status of non-vital controls and indications. Each recorder shall be standalone, capable of recording up to two weeks of events assuming a train movement in each direction at design headway 24 hours a day, 7 days a week. Each recording device shall provide access to the data through a standard USB interface port.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.14	ENVIRONMENTAL REQUIREMENTS													
2870	Standard Criteria		All equipment shall meet the environmental provisions of the AREMA ATCS environmental specifications and environmental requirements specified in these Design Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.15	POWER SUPPLY													
2871	Standard Criteria		All housings shall be equipped with an external socket for the connection of a mobile generator. Signaling power supplies shall not be used for any purpose other than to power signaling equipment. In case of failure of the primary power source, backup power supply shall be provided to ensure safe train operation as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.16	LIGHTNING PROTECTION													
2872	Performance Criteria		Lightning protection shall be provided for all equipment and circuits, which could be damaged by electrical transients.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.17	DESIGN INTEGRITY													
2873	Performance Criteria		The system shall be designed and operated in a safe manner. Failure of the system shall not compromise the safety of train operation, road traffic or pedestrians. Any circuit directly affecting the safety of train movement shall be considered "vital". Circuits performing functions of control, indication, communication, and other tasks, which do not directly affect the safety of train movement, shall be considered "non-vital". All vital components shall be highly reliable, of proven design and have predictable failure modes, such that no single failure shall create a less restrictive state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2874	Performance Criteria		The signal system logic and its components shall be designed to meet the following: **a)** All vital components shall be designed so that restrictive (rather than permissive) actions occur when a component fails. **b)** All vital control logic shall be designed such that, if interrupted or de-energized, it shall cause the controlled function to assume its most restrictive condition. **c)** All relays or solid-state equivalents being energized by a vital circuit shall be vital units. All contacts used within any vital circuit shall be contacts of vital relays. **d)** All errors of hardware and software that may compromise vital data, whether stored within a logical process, sampled as digital or analog inputs, or produced as digital or analog output, shall result in a safe system state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2875	Performance Criteria		Non-vital circuits may use non-vital relay or solid-state technology. Failures of non-vital equipment shall not affect the safety of the system. Non-vital systems shall interface with vital systems in a manner, which isolates the vital systems from malfunctions of the non-vital systems. Vital microprocessor systems shall be used. The use of radio, land cable, or any combination, which forms a serial communication channel for the signal system, shall not be considered vital in itself. Design techniques shall be employed such that the equipment at each end of the communication link shall be capable of detecting errors in the data transmitted and received, such that system operation remains safe. Train Control system shall not be used for functions not directly related to train control functionality	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.18	MATERIALS AND EQUIPMENT													
		9.4.2.18.1	GENERAL													
2876	Performance Criteria		Assemblies and components used to perform identical functions within the system shall be mechanically and electrically interchangeable. Standard commercially available equipment and material from multiple sources shall be used where practicable. All wayside equipment shall be secured and protected by the use of tamper-resistant covers. Where deemed appropriate by the Designer, further protection shall be provided with intrusion detection devices. All cables and wires shall be suitably protected. Conduits shall be provided under tracks, along bridges and through roadways, to meet AREMA recommendations. All material and equipment furnished shall be new and standard products of manufacturers regularly engaged in the production of like equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.18.2	EQUIPMENT LOCATION													

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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ID	**TYPE**	**SECTION**	**DESCRIPTION**	**LOS ANGELES**	**HUNTINGTON PARK**	**BELL**	**CUDAHY**	**DOWNEY**	**SOUTH GATE**	**PARAMOUNT**	**BELLFLOWER**	**CERITOS**	**ARTESIA**	**VERNON**	**VARIANCE**	**DOCUMENT/SECTION**
2877	Performance Criteria		Signal equipment shall be located along the wayside only where necessary. All other equipment shall be located on the outer edge of the right-of-way, in easily accessible equipment housings. Signal masts, grade crossing gates, flasher masts, cantilever signal masts and all concrete signal structures shall follow CPUC GO 75 and City requirements for these structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.18.3	EQUIPMENT HOUSINGS													
2878	Performance Criteria		All signal equipment housings shall include all required environmental controls to facilitate maintenance and operation, including any necessary heating, ventilation and air conditioning. As a minimum, air conditioning and forced air ventilation shall be provided at every enclosure. Heat load calculations shall support any heating, ventilation and air conditioning (HVAC) installation. Designed inside (indoor) temperature shall be less than a maximum operating temperature of any equipment to be installed in the case. The signal equipment shall be capable of operation in the event of a failure of any environmental control subsystems. Houses, cases and junction boxes shall be steel or aluminum. Signal houses and cases containing electronic equipment shall be coated with reflective paint. Wayside signal cases and bungalows shall not be placed between tracks without prior approval. Wayside signal cases and bungalows shall be placed within the fenced right-of-way, with access to the right-of-way within 30 feet. Minimum electrical service shall be 100 Amps. A manual transfer switch and generator plug-in point with rating matching main service breaker shall be provided. Plug-in point shall be accessible without having cables laid across or under the track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2879	Performance Criteria		All equipment-housing openings shall be screened or sealed to prevent entry of animals and insects to the extent practicable. All entryways shall be sealed following installation of cables and wiring entering the housing. All insulation material used to line the interior of equipment housing walls, doors and roofs shall be flame retarding and non-electrically conductive, and shall not introduce a hazard of any type. All equipment housings including component racks (card files, backplanes) shall be designed to accommodate possible future expansion of equipment space by 30%. Signal housings shall be provided with a fire detection system. NFPA 2001 Compliant Clean Agent Fire Extinguishing System shall be installed in the housings containing vital microprocessor equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.18.4	SECURITY OF EQUIPMENT													
2880	Performance Criteria		All signal equipment housings, cases, junction boxes, switch mechanisms, and signals shall be secured with an appropriate security device. Fencing shall be provided around each train control bungalow or case in order to isolate the enclosure from the Right of Way. At a minimum there shall be 2 ft of clearance between the fence and the enclosure on the sides without doors and four feet of clearance on the sides with doors although four feet on all sides of the enclosure is preferred. Doors of housings shall be capable of being secured by a standard electric lock with mechanical key bypass and equipped with a weatherproof seal. Provide card key access control in all rooms, bungalows and cases housing train control equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.18.5	TRAIN CONTROL LOGIC SECURITY													
2881	Performance Criteria		Whenever microprocessor logic is used, both for vital and non-vital train control purposes, implement security procedures to prevent unauthorized access to, modifications to, and operation of such.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.18.6	MAINTAINABILITY													
2882	Performance Criteria		The signaling equipment shall be designed and constructed to facilitate quick and easy troubleshooting and module replacement. The design shall require a minimum of testing following module replacement. Built-in indicators or meters shall be provided for routine maintenance, testing, and diagnostic purposes. The use of plug-in devices, such as laptop computers for the downloading of data from devices, including microprocessor interlockings, shall be allowed in addition to a basic set of fault indicators. As a minimum, LED indicators shall be provided for circuit boards to indicate the health status of a circuit board. A failed indication shall signify to a maintainer that the board should be replaced.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.19	SCADA INTERFACE													
2883	Performance Criteria		The design shall provide remote control and monitoring of train control via the SCADA system. The design shall provide remote controls and indications as defined in Metro Rail Design Criteria Section 9 Appendix B.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.20	TIME SYNCHRONIZATION													
2884	Performance Criteria		Internal clock of all microprocessor-based signaling equipment, including event recorders, shall be synchronized to a stratum-1 time source.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.2.21	GROUNDING													
2885	Performance Criteria		All at grade wayside equipment and housings shall be individually grounded to their own individual ground rods. Each ground rod shall have a separate hand hole for maintenance and inspection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		9.4.2.22	DOOR ENABLE SYSTEM													
2886	Performance Criteria		Provide a wayside system capable of indicating passenger platform position to the vehicle. Such system shall: Indicate to onboard equipment whether right-hand, left-hand, or both platforms are present Indicate to onboard equipment whether train is properly berthed within the platform limits. Indicate to the onboard equipment whether train had reached a radio channel change point. Design of the system shall utilize a vital digital communications between wayside and the vehicle and shall not require additional hardware changes in the existing carborne ATC package. Design shall prevent false indications from being transmitted to the vehicle in the event of component failure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3	METRO BLUE LINE EXPANSION													
		9.4.3.1	GENERAL REQUIREMENTS													
2887	Performance Criteria		The signaling system shall provide the following functions: Interlocking control of switches and signals Safe routing of trains Safe separation of trains to prevent collisions and side swipes by physically separated operation on the main line, protected by vital systems Protection of highway crossings against road/rail collisions giving railroad traffic priority by provision of highway crossing warning and protection systems and interfaces with highway traffic control equipment and foreign railroad crossing equipment at shared crossings. The signaling system and grade crossings shall comply with the AREMA Manual of Recommended Practices - Signals and CPUC General Orders 75, and 143. Automatic route setting shall be for normal train operation. Manual selection of routes shall be provided for abnormal train operation or when automatic routing is not desirable. Bi-directional operation at full line speed and headway shall be provided throughout the main line. All sections under signal control shall be signaled such that, in the event either of the tracks in the double track sections is taken out of service, safe operations can be maintained.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2888	Performance Criteria		The signal system shall provide continuous overspeed protection and speed commands (cab signal) operation, which shall prevent unsafe operation with respect to other trains, interlocking conditions, civil speed limits, and grade crossings. Any transition from street running to cab signal territory shall be governed by a wayside signal. Overrun of these signals, as well as any other interlocked wayside signals displaying a STOP aspect shall be prevented by ATP.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2889	Performance Criteria		The cab signal system shall impose speed restrictions due to civil/track speed limits. In the normal direction of traffic the following design requirements shall be followed: The speed code reduction shall occur at a point no further than 110% of the Civil Braking Distance from the point of restriction. The cab signal and block design shall enable acceleration to the authorized speed (within safe braking constraints) to commence within 400 feet of the end of the speed restriction area. The maximum block length shall be 5,000 feet. Maximum cab code reduction between successive blocks shall not excel 25 mph. All track circuits shall have a provision to allow for a manual downgrade to a more restrictive speed code via local control panel or hardware cards. Manual speed code selection shall not override safe train separation function of ATP. Exceptions to the above criteria shall be reviewed on a case-by-case basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2890	Performance Criteria		The cab signal system shall impose speed restrictions on the approach to stations with an at grade crossing on the exit side of the station. In the normal direction of traffic the following design requirements shall be followed: • Speed code reduction, or removal of cab code shall occur on the approach to, or the exit from, the station to ensure that a train that fails to make a station stop, or does not make a full 20-second dwell, cannot enter the crossing unless the entrance gates are fully down. • Speed code reduction, or removal of cab code shall, never–the-less, maximize the train speed into the station. • Speed code reductions shall be calculated using the Civil Braking Distance formula. • Speed code reductions shall occur at a point no further than 120% of the Civil Braking Distance from the near side of the crossing. • Crossings shall be activated automatically, assuming a 20-second station dwell. Once the entrance gates are down, full speed cab code shall be available. • Where the crossing is within 100 feet of the station, a TWC system shall be provided to enable crossing calls to be called or cancelled. Same functionality shall be provided wherever the crossing approach, including pre-emption and advanced warning extends into limits of the passenger or motorman's platform	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.2	SAFE BRAKING DISTANCE MODEL													

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		9.4.3.2.1	INTRODUCTION													
2891	Performance Criteria		The Safe Braking Distance (SBD) is the calculated distance that a worst-case train will travel between the time that a speed reduction is commanded until the required speed reduction is achieved. The train operator is in control of the speed with the cab signal system providing over-speed protection only. The design shall utilize the SBD formula for all safety braking requirements. The Civil Braking Distance (CBD) is the calculated distance that a train will travel between the time that a civil speed reduction is commanded until the required speed reduction is achieved. The train operator is in	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2892	Standard Criteria		Initial Entry Speed For SBD and CBD calculations, an initial entry speed (S) is used, which is derived from a combination of Cab Signal Speed (CSS), Cab Signal Tolerance (CST), Cab Signal Overspeed Allowance (CSO), and the Acceleration Allowance (AA) as follows: CSS = 55, 45, 35, 25, 15, 10, or 0 mph according to the cab signal code immediately prior to entry.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2893	Standard Criteria		CST = Tolerance in speed detection, which shall be as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2894	Standard Criteria		CSO = Allowable exceedance of cab signal speed as detected by the carborne cab signal system, which shall be as follows:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2895	Standard Criteria		AA = An allowance to account for instantaneous acceleration of the vehicle for the time delay between the decoding of the speed code by the carborne equipment, and removal of propulsion power. The allowance shall also include for jerk-limited removal of power and application of braking	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2896	Standard Criteria		For SBD calculations, S = CSS + CST + CSO + AA For CBD calculations, S = CSS + CST + CSO	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.2.3	SAFE BRAKING DISTANCE CALCULATION													
2897	Standard Criteria		SBD = Dr + Db + Do, where: Dr = Reaction distance in feet = S x R x 1.467 Db = Braking Distance in feet = 0.733 x S2 / (B [illegible] 0.2G) Do = Overhang distance of two vehicles = 30 feet S = Initial entry speed (mph) prior to braking. R = Reaction time in seconds (includes operator, cab signal delays and brake build-up) = 9.8 seconds for a change in speed code and 7.2 seconds for code-to-no code. B = Safe Braking rate = 2.0 mphps G = Alignment grade as a decimal fraction For safe braking calculations to bumping posts, the overhang distance of one vehicle (15 feet) can be used for distance Do.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.2.4	CIVIL BRAKING DISTANCE CALCULATION													
2898	Standard Criteria		CBD = Dr + Db, where: Dr = Reaction distance in feet = (CSS) x R x 1.467 Db = Braking Distance in feet = 0.733 x (CSS2-V2) / (B [illegible] 0.2G) CSS =Cab Signal Speed (mph) prior to braking. V = Target speed at speed restriction R = Reaction time in seconds (includes operator, cab signal delays and brake build-up) = 4.0 seconds. B = Safe Braking rate = 2.0 mphps G = Alignment grade as a decimal fraction The target point for achieving the speed reduction shall be the tangent-to-spiral point on curves and the point of switch for turnouts. Civil speed restrictions shall be maintained until the rear of the train is clear of the restriction. For curves, this shall be the curve-to-spiral point.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.3	CAB SIGNAL SYSTEM													
		9.4.3.3.1	FUNCTIONALITY OVERVIEW													

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2899	Prescriptive Spec		The cab signal received on-board the car shall be interpreted as a speed limit, the aspect of which, shall be displayed to the operator.													
2900	Prescriptive Spec		Code rates and their meanings shall be: CODE RATE – INDICATION 410 PPM (6.83 Hz) – Cab signal cutout. Used for Street Running mode (35 mph speed limit). 270 PPM (4.5 Hz) – Proceed at 55 mph. 180 PPM (3 Hz) – Proceed at 45 mph. 120 PPM (2 Hz) – Proceed at 35 mph. 75 PPM (1.25 Hz) – Proceed at 25 mph. 50 PPM (0.833 Hz) @ 100Hz, asynchronously combined with 50 PPM (0.833 Hz) @ 250Hz – Proceed at 15 mph. 50 PPM (0.833 Hz) – Restricted (Yard). Proceed at maximum of 10 mph, prepared to stop. Unmodulated 100 Hz – Stop No Code – Stop and Proceed. Approaching a signal at stop or when occupancy exists ahead that requires immediate brake application to safely avoid a collision.													
2901	Prescriptive Spec		The nominal cab signal rail current shall be 3 amps at the entering end of track circuits and the feed end shall be no greater than 20 amps. The carrier frequency shall be 100 Hz ▯2 Hz. The code rate tolerance shall be ▯5%. The code duty cycle shall be 60/40 to 40/60. Dead sections, such as at insulated rail joints, shall be no greater than 14 feet in length.													
		9.4.3.4	TRAIN-TO-WAYSIDE COMMUNICATION													
2902	Performance Criteria		The Train-to-Wayside Communication (TWC) system shall be compatible with Hanning & Kahl HCS-V. TWC transponders shall be provided at the following minimum locations: ▯ Approach to all wayside signals ▯ At stations with near-side at-grade crossings and where crossing activation, preemption or advanced warning extends into the limits of the passenger or motorman's platform. ▯ At the terminus station (for calling of a route onto the main line). Loops must accommodate two- and three-car consists such that two- or three- car train is able to request departing route from its outbound berthing position	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.5	TRAIN DETECTION													
2903	Performance Criteria		The signaling system shall detect all cars operating independently or in consist, and any other rail vehicle present, except hi-rail vehicles. The presence of a rail vehicle in a section of the route shall be detected continuously by means of track circuits. Detection of the occupation of the track circuit shall be fail-safe, such that a de-energized position is interpreted as an occupation of the track circuit. In the event of a temporary loss of detection, the design shall ensure that indication of the presence of a rail vehicle in a section will be maintained while a rail vehicle is actually in the section.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2904	Performance Criteria		If a rail vehicle is parted in an unscheduled manner, the signal system shall ensure that all parts of the rail vehicle are detected. The signal system shall ensure that safe separation is maintained between the parted vehicle and all other rail vehicles. The minimum effective length of a track circuit shall be longer than the maximum inner wheelbase of all vehicles used on this track. The maximum length for Power frequency and Coded Track Circuits shall be 5000 feet. The maximum length for Audio Frequency Track Circuits shall be 2000 feet. For track circuits used to control signals and locking functions, including grade crossing activation devices, the minimum shunt sensitivity shall be 0.25 Ohms. The shunting requirements shall be met for ballast conditions of 5 ohms per thousand feet or greater. Track circuit layout shall provide sufficient resolution to SCADA for train tracking purposes	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.6	BROKEN RAIL DETECTION													
2905	Performance Criteria		Broken rail detection shall be provided throughout all mainline track. A broken rail shall de energize the associated track circuit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.7	ROUTE SETTING													
2906	Performance Criteria		There shall be four methods for control of train movement through the signalized sections as described below:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.7.1	AUTOMATIC ROUTE SETTING													

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2907	Performance Criteria		Routes shall either normally operate automatically by signal and switch control subsystems responding to the approach of the train, or by use of a Fleet command (Metro shall designate which shall be used for each interlocking). In normal operation, routes shall clear automatically for consists without intervention by the train operator. At terminal stations the train operator shall be able, via TWC, to request that the departing signal be cleared for the train to proceed. Trains shall be normally routed reverse across before reaching the station as the preferred route, or the normal direction route if the preferred platform is occupied. The ATC system shall use train ID, transmitted by the TWC system, in order to automatically route trains at junctions, terminals and other locations as defined by the project for their designated route. Fleet, if implemented, shall be provided for the normal traffic direction only.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.7.2	SELECTION OF ROUTES FROM THE TRAIN													
2908	Performance Criteria		Train-to-Wayside Communication route selection shall be provided at all interlocking signals.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.7.3	LOCAL ROUTE SELECTION CAPABILITY													
2909	Performance Criteria		Local control capability shall be provided to ensure the safe operation of trains by means of Local Control Panels (LCP) in each signal house. The LCP shall indicate track circuit occupancy, signal status, switch position and correspondence, switch locking, traffic direction, manual control, automatic control, and crossing gate position. Speed restriction enabled, AC alarm, DC alarm, communication failure alarm, system failure (Electrologixs, VHLC, iVPI, or Microlok) and all indications described in the specifications. LCP shall be of size such that it can display the complete layout of the territory controlled from the location, without need to change screens or scrolling. Displayed track layout shall include at least one adjacent track circuit, beyond the boundary of control. Display used for local control panel purpose shall be 32" minimum and be wall mounted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.7.4	RAIL OPERATIONS CONTROL													
2910			Central control capability shall be provided at each interlocking.													
		9.4.3.8	WAYSIDE SIGNALS													
		9.4.3.8.1	MAIN LINE													
2911	Performance Criteria		LED wayside color signals shall be provided to indicate movement authority, block occupation and route locking information to train operators. Signals shall be installed to govern movements into and through interlocking limits.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2912	Performance Criteria		Wayside color signals shall show the following aspects, which are in compliance with Metro rules: Aspect: Meaning Red/Red: Stop Flashing Green/Red: Block clear. Proceed on normal route. Trains operating with ATP Bypass activated shall be prepared to STOP at the next interlocking Signal. Green/Red: Block occupied. Proceed on normal route with Cab Signals. Trains without cab signals or operating with ATP Bypass activated shall STOP and contact ROC. Red/Flashing Green: Block clear. Proceed on diverging route. Trains operating with ATP Bypass activated shall be prepared to STOP at the next interlocking Signal. Red/Green: Block occupied. Proceed on diverging route with Cab Signals. Trains without Cab Signals or operating with ATP Bypass activated shall STOP and contact ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2913	Performance Criteria		Flashing Red/Red: STOP and contact ROC. Proceed indication cannot be displayed. When authorized by ROC, proceed in Stop and Proceed mode on Normal Route. Red/Flashing Red: STOP and contact ROC. Proceed indication cannot be displayed. When authorized by ROC, proceed in Stop and Proceed mode on diverging route.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2914	Performance Criteria		Indication on signals or switches shall be fail-safe, such that no less restrictive aspect is shown than intended. "Block Clear" aspects shall not be used in street-running areas. Wayside signals shall be located such that they are sufficiently visible to preclude confusion with signals governing the operation of motor vehicles, and similarly do not confuse motor vehicle drivers. When viewed from a height of 7 feet above top of rail, at a distance of 500 ft, lenses shall present a distinct aspect under the most adverse operating conditions. Provide a signal number plate for each signal. The signal number plate shall be placed under the lowest signal lens in the assembly. Signal plates shall meet the requirements of the AREMA Manual of Recommended Practices – Signals. The alphanumeric characters shall be a minimum of 3 inches high. The top of the top-most aspect shall be set at 5'-5 3/8" above Top of Rail or as approved by Metro. Signal aspects shall use 8" Light Emitting Diode (LED) units	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.8.2	TUNNEL HOLD													

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2915	Performance Criteria		Provide two-aspect LED wayside signals mounted in the immediate vicinity of a tunnel portal, oriented towards tunnel-bound trains. Signals shall have the following aspects: Aspect: Meaning Green: Ventilation zone clear. Red: Ventilation zone occupied. Ventilation zone occupancy detection and indication circuits shall be fail safe. Other requirements for these signals, including sighting distance, construction and circuit requirements shall be as described in 9.4.3.8.1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.9	INTERLOCKINGS													
2916	Performance Criteria		As a minimum, the following locking functions shall be provided for powered switch interlockings:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2917	Performance Criteria	a-c	**a)** Switch locking - A locking function shall ensure that a signal governing a switch or combination of switches shall only show a less restrictive aspect than "stop", when all switches are in the correct position. **b)** Automatic Block locking - A home signal governing a block shall only show a less restrictive aspect than "stop", when the entire block is unoccupied by any trains or vehicles. This shall be controlled automatically by means of track circuits throughout the entire block. **c)** Route locking - Route locking shall lock switches within a route after a signal has been requested for train movement onto that route, and shall prevent clearing of opposing and conflicting signals within the interlocking. Route locking shall be in effect when approach locking is in effect, and it shall remain in effect until the rear of the train has cleared the route. Switches, which are part of the route, and switches or signals, which are protecting against flanking (side-swipe), shall be disabled from moving when the route is locked. Signals protecting this route shall be prevented from showing aspects other than stop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2918	Performance Criteria	d-f	**d)** Approach locking - Approach locking shall lock switches within a route governed by a cleared wayside signal to prevent clearing wayside signals for opposing or conflicting routes. **e)** Time locking - Time locking shall ensure that all switches and signals forming a route, and those protecting it, remain in position and locked for a predetermined time after the entry signal has been caused to display its most restrictive aspect again. **f)** Traffic locking - Setting and locking of a route shall be prohibited unless the opposing signals show the most restrictive aspect. The signal system shall furthermore prevent any trains simultaneously entering the same block section from different directions or tracks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2919	Performance Criteria		Independent of any route locking function, the movement of any powered switch shall be prevented when track occupancy is detected in the track section in which that switch is located. The switch locking function shall have 5 seconds loss of shunt protection. However, sectional release shall be provided where practicable, to support headways through junctions. Any failure, including false occupancy, loss of power, to any part of an interlocking shall not result in the premature release of any locking function. Overrun detection shall be provided for every interlocking signal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.10	PUBLIC HIGHWAY CROSSINGS													
		9.4.3.10.1	GENERAL													
2920	Performance Criteria		Activation of grade crossing warning devices shall be normally achieved by all rail vehicles using the main line, but excluding hi-rail vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.10.2	HIGHWAY CROSSING WARNING ACTIVATION													
2921	Standard Criteria		Warning devices shall normally be automatically activated by the approach of a rail vehicle with a nominally uniform warning time. The devices shall be direction sensitive, and shall be activated by the approach of a train on any track from either direction. The calculation of the exact warning time shall be done for each crossing according to CPUC GO 75 and AREMA C&S Manual Part 3.3.10 requirements. Minimum of 28 seconds warning time shall be provided unless required otherwise by governing jurisdiction. Advanced Pre-Emption shall be provided where required to clear traffic queues and provide sufficient time for adjacent controlled intersections to configure for crossing activation. Design shall ensure that full warning and preemption time is provided under all operating scenarios.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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ID	TYPE	SECTION	DESCRIPTION	LOS ANGELES	HUNTINGTON PARK	BELL	CUDAHY	DOWNEY	SOUTH GATE	PARAMOUNT	BELLFLOWER	CERITOS	ARTESIA	VERNON	VARIANCE	DOCUMENT/SECTION
2922	Performance Criteria		The design shall assume all trains stop at all stations for the purposes of setting Advanced Pre-Emption and Crossing Warning times. Where the start of a Crossing Warning extends to, or through, a station the contractor shall ensure, by means of cab signal code, that a train that fails to make a station stop cannot enter the crossing before the entrance gates are lowered. However, reductions in cab signal code to enforce minimum warning time shall not be implemented earlier than necessary. The goal shall be for such code reductions to be invisible to a train making a normal station stop. Where a crossing is in advance of a station such that a minimum time cannot be given (after departure from the station), the crossing gates shall remain inactivated. If the operator does not stop, the gates shall be activated and the signal system shall impose a speed reduction or STOP code to ensure the train cannot enter the crossing before the entrance gates are lowered. The design shall provide a system for automatic gate activation prior to train departure. TWC shall be provided to cancel crossing activation and to reactivate the crossing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2923	Standard Criteria		The warning devices shall remain active until the crossing is cleared totally. These grade crossing systems shall be designed and installed in accordance with applicable Governmental Rules and, the recommendations of the AREMA and Manual of Uniform Traffic Control Devices (MUTCD). All flashing light signals used in highway-rail crossing warning system installation shall be per requirements of CPUC GO-75D. Where a 4-quadrant full-closure gate arrangement is required, the design shall arrange for the leading and trailing gates to operate as specified in CPUC GO 75. The design shall extend the approach time to take account of the delay in dropping all gates. All gates shall be individually monitored.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2924	Performance Criteria		Crossing bell shall be an electronic type, conforming with AREMA Signal Manual, Part 3.2.61. The bell sound level shall be set to 77 dBa ±2 dBa at 10 feet in accordance with AREMA Signal Manual, Part 3.2.61, unless ambient noise levels dictate otherwise. Where an electronic processor is used for the crossing equipment, the design shall be such that the end user may elect, by means of external wiring alteration and without logic redesign, to silence the bells once all gates are horizontal. Such design shall prevent the bells from re-activating as the gates rise. Provide an 8-inch lunar white LED Motorman's Signal for each track,. Separate signals shall accommodate normal and reverse direction of traffic. located on the normal approach side of the crossing and facing trains approaching in the normal direction of traffic. Each Motorman's Signal shall display a solid aspect when the crossing approach is occupied and a flashing aspect when the entrance and exit gates are down and there is no detected malfunction of the crossing system. Provide override test, raise and lower pushbuttons in a locked box.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.11	TRACK SWITCHES													
2925	Performance Criteria		All track switches shall be powered and interlocked. They shall normally be set and locked automatically. All route-setting functions shall apply. An over-switch (OS) track circuit shall be provided, occupation of which shall prevent powered movement of the switch. A manual switch setting facility shall be provided at powered switch locations. The placing of a powered switch into manual operation shall result in loss of indication. Signals shall revert to their most restrictive aspect in the event of loss of indication of switch position. Switch and lock mechanisms shall meet or exceed the recommendations of the AREMA Manual of Recommended Practices–Signals. The electrical, electromechanical or mechanical locking equipment shall prevent switch point movement when the switch points are in full normal or full reverse position. Three-phase operated switch machines shall be avoided unless exceptional site conditions (e.g. distance from control point) dictate use of same. Parts of switch operating layouts shall be interchangeable between similar layouts. Provide green/yellow switch position indicators for facing point switches that are not directly governed by a signal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.12	TRACTION RETURN BONDING													
2926	Performance Criteria		The design shall provide impedance bonds and running rail continuity and cross bonding sufficient to comply with the traction return power requirements. The design shall ensure that no single failure, including broken rail or loss of a bonding cable, shall result in loss of traction return capability through loss of continuity or failure due to overheating. Traction power return capability shall be provided on all tracks regardless of whether OCS is present or not.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.13	EVENT RECORDERS													
2927	Performance Criteria		AREMA recommended event recorders that store information for future playback shall be provided for vital systems, including grade crossings, to record changes in state of the vital systems and their devices, all alarms, as well as status of non-vital controls and indications. Each recorder shall be standalone, capable of recording up to two weeks of events assuming a train movement in each direction at design headway 24 hours a day, 7 days a week. Each recording device shall provide access to the data through a standard USB interface port.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.14	ENVIRONMENTAL REQUIREMENTS													

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2928	Performance Criteria		All equipment shall meet the environmental provisions of the AREMA ATCS environmental specifications and environmental requirements specified in these Design Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.15	POWER SUPPLY													
2929	Performance Criteria		All housings shall be equipped with an external socket for the connection of a mobile generator. Signaling power supplies shall not be used for any purpose other than to power signaling equipment. In case of failure of the primary power source, backup power supply shall be provided to ensure safe train operation as follows: Grade crossings: 8 hours minimum Vital equipment: 4 hours minimum Non-vital equipment: 4 hours minimum Switch machines: 4 hours minimum at all interlockings	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.16	LIGHTNING PROTECTION													
2930	Performance Criteria		Lightning protection shall be provided for all equipment and circuits, which could be damaged by electrical transients.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.17	DESIGN INTEGRITY													
2931	Performance Criteria		The system shall be designed and operated in a safe manner. Failure of the system shall not compromise the safety of train operation, road traffic or pedestrians. Any circuit directly affecting the safety of train movement shall be considered “vital”. Circuits performing functions of control, indication, communication, and other tasks, which do not directly affect the safety of train movement, shall be considered “non-vital”. All vital components shall be highly reliable, of proven design and have predictable failure modes, such that no single failure shall create a less restrictive state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2932	Performance Criteria		The signal system logic and its components shall be designed to meet the following: **a)** All vital components shall be designed so that restrictive (rather than permissive) actions occur when a component fails. **b)** All vital control logic shall be designed such that, if interrupted or de-energized, it shall cause the controlled function to assume its most restrictive condition. **c)** All relays or solid-state equivalents being energized by a vital circuit shall be vital units. All contacts used within any vital circuit shall be contacts of vital relays. **d)** All errors of hardware and software that may compromise vital data, whether stored within a logical process, sampled as digital or analog inputs, or produced as digital or analog output, shall result in a safe system state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2933	Performance Criteria		Non-vital circuits may use non-vital relay or solid-state technology. Failures of non-vital equipment shall not affect the safety of the system. Non-vital systems shall interface with vital systems in a manner, which isolates the vital systems from malfunctions of the non-vital systems. Vital microprocessor systems shall be used. The use of radio, land cable, or any combination, which forms a serial communication channel for the signal system, shall not be considered vital in itself. Design techniques shall be employed such that the equipment at each end of the communication link shall be capable of detecting errors in the data transmitted and received, such that system operation remains safe. Train Control system shall not be used for functions not directly related to train control functionality.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.18	MATERIALS AND EQUIPMENT													
		9.4.3.18.1	General													
2934	Performance Criteria		Assemblies and components used to perform identical functions within the system shall be mechanically and electrically interchangeable. Standard commercially available equipment and material from multiple sources shall be used where practicable. All wayside equipment shall be secured and protected by the use of tamper-resistant covers. Where deemed appropriate by the Designer, further protection shall be provided with intrusion detection devices. All cables and wires shall be suitably protected. Conduits shall be provided under tracks, along bridges and through roadways, to meet AREMA recommendations. All material and equipment furnished shall be new and standard products of manufacturers regularly engaged in the production of like equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.18.2	EQUIPMENT LOCATION													
2935	Standard Criteria		Signal equipment shall be located along the wayside only where necessary. All other equipment shall be located on the outer edge of the right-of-way, in easily accessible equipment housings. Signal houses and rooms shall be provided with a fire and intrusion detection system. Signal masts, grade crossing gates, flasher masts, cantilever signal masts and all concrete signal structures shall follow CPUC GO 75 and City requirements for these structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.18.3	EQUIPMENT HOUSINGS													

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2936	Performance Criteria		All signal equipment housings shall include all required environmental controls to facilitate maintenance and operation, including any necessary heating, ventilation and air conditioning. As a minimum, air conditioning and forced air ventilation shall be provided at every enclosure. Heat load calculations shall support any heating, ventilation and air conditioning (HVAC) installation. Designed inside (indoor) temperature shall be less than a maximum operating temperature of any equipment to be installed in the case. The signal equipment shall be capable of operation in the event of a failure of any environmental control subsystems. Houses, cases and junction boxes shall be steel or aluminum. Signal houses and cases containing electronic equipment shall be coated with reflective paint. Wayside signal cases and bungalows shall not be placed between tracks without prior approval. Wayside signal cases and bungalows shall be placed within the fenced right-of-way, with access to the right-of-way within 30 feet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2937	Performance Criteria		Minimum electrical service shall be 100 Amps 120V single phase. A manual transfer switch and generator plug-in point, with rating matching main service breaker, shall be provided. Plug-in point shall be accessible without having cables laid across or under the track. All equipment-housing openings shall be screened or sealed to prevent entry of animals and insects to the extent practicable. All entryways shall be sealed following installation of cables and wiring entering the housing. All insulation material used to line the interior of equipment housing walls, doors and roofs shall be flame retarding and non-electrically conductive, and shall not introduce a hazard of any type. Signal housings shall be provided with a fire detection system. All equipment housings including component racks (card files, backplanes) shall be designed to accommodate possible future expansion of equipment space by 30%. NFPA 2001 Compliant Clean Agent Fire Extinguishing System shall be installed in the housings containing vital microprocessor equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.18.4	SECURITY OF EQUIPMENT													
2938	Performance Criteria		All signal equipment housings, cases, junction boxes, switch mechanisms, and signals shall be secured with an appropriate security device. Fencing shall be provided around each train control bungalow or case in order to isolate the enclosure from the Right of Way. At a minimum there shall be 2 ft of clearance between the fence and the enclosure on the sides without doors and four feet of clearance on the sides with doors although four feet on all sides of the enclosure is preferred. Doors of housings shall be capable of being secured by a standard electric lock with a mechanical key bypass and equipped with a weatherproof seal. Provide intrusion detection in all rooms, bungalows and cases housing train control equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.18.5	TRAIN CONTROL LOGIC SECURITY													
2939	Performance Criteria		Whenever microprocessor logic is used, both for vital and non-vital train control purposes, implement security procedures to prevent unauthorized access to, modifications to, and operation of such.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.18.6	MAINTAINABILITY													
2940	Performance Criteria		The signaling equipment shall be designed and constructed to facilitate quick and easy troubleshooting and module replacement. The design shall require a minimum of testing following module replacement. Built-in indicators or meters shall be provided for routine maintenance, testing, and diagnostic purposes. The use of plug-in devices, such as laptop computers for the downloading of data from devices, including microprocessor interlockings, shall be allowed in addition to a basic set of fault indicators. As a minimum, LED indicators shall be provided for circuit boards to indicate the health status of a circuit board. A failed indication shall signify to a maintainer that the board should be replaced.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.19	SCADA INTERFACE													
2941	Performance Criteria		The design shall provide remote control and monitoring of train control via the SCADA system. The design shall provide remote controls and indications as defined in Metro Rail Design Criteria Section 9 Appendix B.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.20	TIME SYNCHRONIZATION													
2942	Performance Criteria		Internal clock of all microprocessor-based signaling equipment, including event recorders, shall be synchronized to a stratum-1 time source.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.3.21	GROUNDING													
2943	Performance Criteria		All at grade wayside equipment and housings shall be individually grounded to their own individual ground rods. Each ground rod shall have a separate hand hole for maintenance and inspection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4	METRO GREEN LINE EXPANSION													
		9.4.4.1	GENERAL REQUIREMENTS													

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2944	Performance Criteria		The signaling system shall provide the following functions: ⍰ Interlocking control of switches and signals ⍰ Safe routing of trains ⍰ Safe separation of trains to prevent collisions and side swipes by physically separated operation on the main line, protected by vital systems ⍰ Protection of highway crossings against road/rail collisions giving railroad traffic priority by provision of highway crossing warning and protection systems and interfaces with highway traffic control equipment and foreign railroad crossing equipment at shared crossings. ⍰ Automatic Train Operation (ATO) in fully-exclusive Right-of-Way	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2945	Performance Criteria		The signaling system and grade crossings shall comply with the AREMA Manual of Recommended Practices - Signals and CPUC General Orders 75, and 143. Automatic route setting shall be for normal train operation. Manual selection of routes shall be provided for abnormal train operation or when automatic routing is not desirable. Bi-directional operation at full line speed and headway shall be provided throughout the main line. All sections under signal control shall be signaled such that, in the event either of the tracks in the double track sections is taken out of service, safe operations can be maintained. The signal system shall provide continuous overspeed protection and speed commands (cab signal) operation, which shall prevent unsafe operation with respect to other trains, interlocking conditions, civil speed limits, and grade crossings. Any transition from street running to cab signal territory shall be governed by a wayside signal. Overrun of these signals, as well as any other interlocked wayside signals such signal displaying a STOP aspect shall be prevented by ATP.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2946	Performance Criteria		The cab signal system shall impose speed restrictions due to civil/track speed limits. In the normal direction of traffic the following design requirements shall be followed: ⍰ The speed code reduction shall occur at a point no further than 110% of the Civil Braking Distance from the point of restriction. ⍰ The cab signal and block design shall enable acceleration to the authorized speed (within safe braking constraints) to commence within 400 feet of the end of the speed restriction area. ⍰ The maximum block length shall be 2,000 feet. ⍰ All track circuits with a Maximum Authorized speed (MAS) exceeding 35 mph shall have at least one intermediate speed code before "STOP". ⍰ All track circuits shall have a provision to allow for a manual downgrade to a more restrictive speed code via local control panel or hardware cards. Manual speed code selection shall not override safe train separation function of ATP. ⍰ Exceptions to the above criteria shall be reviewed on a case-by-case basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2947	Performance Criteria		The cab signal system shall impose speed restrictions on the approach to stations with an at grade crossing on the exit side of the station. In the normal direction of traffic the following design requirements shall be followed: • Speed code reduction, or removal of cab code shall occur on the approach to, or the exit from, the station to ensure that a train that fails to make a station stop, or does not make a full 20-second dwell, cannot enter the crossing unless the entrance gates are fully down. • Speed code reduction, or removal of cab code shall, never–the-less, maximize the train speed into the station. • Speed code reductions shall be calculated using the Civil Braking Distance formula. • Speed code reductions shall occur at a point no further than 120% of the Civil Braking Distance from the near side of the crossing. • Crossings shall be activated automatically, assuming a 20-second station dwell. Once the entrance gates are down, full speed cab code shall be available. • Where the crossing is within 100 feet of the station, a TWC system shall be provided to enable crossing calls to be called or cancelled. Same functionality shall be provided wherever the crossing approach, including pre-emption and advanced warning extends into limits of the passenger or motorman's platform	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.2	TRAIN-TO-WAYSIDE COMMUNICATION													
2948	Performance Criteria		The Train-to-Wayside Communications (TWC) System shall be fully compatible with existing TWC system used on Metro Green Line. TWC loops shall be provided at the following minimum locations: • All station tracks • At motorman's platform if crossing warning, preemption or advanced warning extends through it • All pocket and siding tracks • All mainline track segments used for turnback moves • In transfer zones of yard leads	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.3	TRAIN DETECTION													

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2949	Performance Criteria		The signaling system shall detect all cars operating independently or in consist, and any other rail vehicle present, except hi-rail vehicles. The presence of a rail vehicle in a section of the route shall be detected continuously by means of track circuits. Detection of the occupation of the track circuit shall be fail-safe, such that a de-energized position is interpreted as an occupation of the track circuit. In the event of a temporary loss of detection, the design shall ensure that indication of the presence of a rail vehicle in a section will be maintained while a rail vehicle is actually in the section. If a rail vehicle is parted in an unscheduled manner, the signal system shall ensure that all parts of the rail vehicle are detected. The signal system shall ensure that safe separation is maintained between the parted vehicle and all other rail vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2950	Performance Criteria		The minimum effective length of a track circuit shall be longer than the maximum inner wheelbase of all vehicles used on this track. The maximum length for Power frequency and Coded Track Circuits shall be 5000 feet. The maximum length for Audio Frequency Track Circuits shall be 2000 feet. For track circuits used to control signals and locking functions, including grade crossing activation devices, the minimum shunt sensitivity shall be 0.25 Ohms. The shunting requirements shall be met for ballast conditions of 5 ohms per thousand feet or greater. Track circuit layout shall provide sufficient resolution to SCADA for train tracking purposes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.4	BROKEN RAIL DETECTION													
2951	Performance Criteria		Broken rail detection shall be provided throughout all mainline track. A broken rail shall de energize the associated track circuit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.5	ROUTE SETTING													
2952	Performance Criteria		There shall be four methods for control of train movement through the signalized sections as described below.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.5.1	AUTOMATIC ROUTE SETTING													
2953	Performance Criteria		Routes shall normally operate automatically by signal and switch control subsystems responding to the approach of the train. In normal operation, routes shall clear automatically for consists without intervention by the train operator. At terminal stations the train operator shall be able, via TWC, to request that the departing signal be cleared for the train to proceed. Trains shall be normally routed reverse across before reaching the station as the preferred route, or the normal direction route if the preferred platform is occupied. The ATC system shall use train ID, transmitted by the TWC system, in order to automatically route trains at junctions, terminals and other locations as defined by the project for their designated route.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.5.2	SELECTION OF ROUTES FROM THE TRAIN													
2954	Performance Criteria		Train-to-Wayside Communication route selection shall be provided at all interlockings, and at the terminal station.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.5.3	LOCAL ROUTE SELECTION CAPABILITY													
2955	Performance Criteria		Local control capability shall be provided to ensure the safe operation of trains by means of Local Control Panels (LCP) in each signal house. The LCP shall indicate track circuit occupancy, signal status, switch position and correspondence, switch locking, traffic direction, manual control, automatic control, and crossing gate position, speed restriction enable and reset, AC alarm, DC alarm, communication failure alarm and system failure (Electrologixs, VHLC, iVPI, or Microlok). LCP shall be of size such that it can display the complete layout of the territory controlled from the location, without need to change screens or scrolling. Displayed track layout shall include at least one adjacent track circuit, beyond the boundary of control. Display used for local control panel purpose shall be 32” minimum and be wall mounted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.5.4	RAIL OPERATIONS CONTROL													
2956	Performance Criteria		Central control capability shall be provided at each interlocking.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.6	WAYSIDE SIGNALS													
		9.4.4.6.1	MAIN LINE													

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2957	Performance Criteria		Wayside color signals shall be provided to indicate movement authority, block occupation and route locking information to train operators. Signals shall be installed to govern movements into and through interlocking limits. Wayside color signals shall show the following aspects, which are in compliance with Metro rules: Aspect: Meaning Red: Stop Flashing Red: STOP and contact ROC. Proceed when authorized by ROC. Flashing Yellow: Proceed on diverging route into reverse traffic. Yellow: Proceed on diverging route into normal traffic. Flashing Green: Proceed on normal route into reverse traffic. Green: Proceed on normal route into normal traffic.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2958	Performance Criteria		Indication on signals or switches shall be fail-safe, such that no less restrictive aspect is shown than intended. Wayside signals shall be located such that they are sufficiently visible to preclude confusion with signals governing the operation of motor vehicles, and similarly do not confuse motor vehicle drivers. When viewed from a height of 7 feet above top of rail, at a distance of 500 ft, lenses shall present a distinct aspect under the most adverse operating conditions. Provide a signal number plate for each signal. The signal number plate shall be placed under the lowest signal lens in the assembly. Signal plates shall meet the requirements of the AREMA Manual of Recommended Practices – Signals. The alphanumeric characters shall be a minimum of 3 inches high.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.6.2	TUNNEL HOLD													
2959	Performance Criteria		Aspect: Meaning Green: Ventilation zone clear. Red: Ventilation zone occupied. Ventilation zone occupancy detection and indication circuits shall be fail safe. Other requirements for these signals, including sighting distance, construction and circuit requirements shall be as described in 9.4.2.8.1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.7	INTERLOCKINGS													
2960	Performance Criteria		As a minimum, the following locking functions shall be provided for powered switch interlockings:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2961	Performance Criteria	a-c	**a)** Switch locking - A locking function shall ensure that a signal governing a switch or combination of switches shall only show a less restrictive aspect than "stop", when all switches are in the correct position. **b)** Automatic Block locking - A home signal governing a block shall only show a less restrictive aspect than "stop", when the entire block is unoccupied by any trains or vehicles. This shall be controlled automatically by means of track circuits throughout the entire block. **c)** Route locking - Route locking shall lock switches within a route after a signal has been requested for train movement onto that route, and shall prevent clearing of opposing and conflicting signals within the interlocking. Route locking shall be in effect when approach locking is in effect, and it shall remain in effect until the rear of the train has cleared the route. Switches, which are part of the route, and switches or signals, which are protecting against flanking (side-swipe), shall be disabled from moving when the route is locked. Signals protecting this route shall be prevented from showing aspects other than stop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2962	Performance Criteria	d-f	**d)** Approach locking - Approach locking shall lock switches within a route governed by a cleared wayside signal to prevent clearing wayside signals for opposing or conflicting routes. **e)** Time locking - Time locking shall ensure that all switches and signals forming a route, and those protecting it, remain in position and locked for a predetermined time after the entry signal has been caused to display its most restrictive aspect again. **f)** Traffic locking - Setting and locking of a route shall be prohibited unless the opposing signals show the most restrictive aspect. The signal system shall furthermore prevent any trains simultaneously entering the same block section from different directions or tracks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2963	Performance Criteria		Independent of any route locking function, the movement of any powered switch shall be prevented when track occupancy is detected in the track section in which that switch is located. The switch locking function shall have 5 seconds loss of shunt protection. However, sectional release shall be provided where practicable, to support headways through junctions. Any failure, including false occupancy, loss of power, to any part of an interlocking shall not result in the premature release of any locking function. Overrun detection shall be provided for every interlocking signal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.8	PUBLIC HIGHWAY CROSSINGS													
		9.4.4.8.1	GENERAL													
2964	Performance Criteria		Activation of grade crossing warning devices shall be normally achieved by all rail vehicles using the main line, but excluding hi-rail vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		9.4.4.8.2	HIGHWAY CROSSING WARNING ACTIVATION													
2965	Performance Criteria		Warning devices shall normally be automatically activated by the approach of a rail vehicle with a nominally uniform warning time. The devices shall be direction sensitive, and shall be activated by the approach of a train on any track from either direction. The calculation of the exact warning time shall be done for each crossing according to CPUC GO 75 and AREMA SignalC&S Manual Part 3.3.10 requirements. Minimum of 28 seconds warning time shall be provided unless required otherwise by governing jurisdiction. Advanced Pre-Emption shall be provided where required to clear traffic queues and provide sufficient time for adjacent controlled intersections to configure for crossing activation. Design shall ensure that full warning and preemption time is provided under all operating scenarios. The design shall assume all trains stop at all stations for the purposes of setting Advanced Pre-Emption and Crossing Warning times. Where the start of a Crossing Warning extends to, or through, a station the contractor shall ensure, by means of cab signal code, that a train that fails to make a station stop cannot enter the crossing before the entrance gates are lowered. However, reductions in cab signal code to enforce minimum warning time shall not be implemented earlier than necessary. The goal shall be for such code reductions to be invisible to a train making a normal station stop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2966	Performance Criteria		Where a crossing is in advance of a station such that a minimum time cannot be given (after departure from the station), the crossing gates shall remain inactivated. If the operator does not stop, the gates shall be activated and the signal system shall impose a speed reduction or STOP code to ensure the train cannot enter the crossing before the entrance gates are lowered. The design shall provide a system for gate activation prior to train departure. This system shall be by means of TWC. The warning devices shall remain active until the crossing is cleared totally. These grade crossing systems shall be designed and installed in accordance with applicable Governmental Rules and, the recommendations of the AREMA and Manual of Uniform Traffic Control Devices (MUTCD). All flashing light signals used in highway-rail crossing warning system installation shall be per requirements of CPUC GO-75D. Where a 4-quadrant full-closure gate arrangement is required, the design shall arrange for the leading and trailing gates to operate as specified in CPUC GO 75. The design shall extend the approach time to take account of the delay in dropping all gates. All gates shall be individually monitored.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2967	Standard Criteria		Crossing bell shall be an electronic type, conforming with AREMA Signal Manual, Part 3.2.61. The bell sound level shall be set to 77 dBa ±2 dBa at 10 feet in accordance with AREMA Signal Manual, Part 3.2.61, unless ambient noise levels dictate otherwise. Where an electronic processor is used for the crossing equipment, the design shall be such that the end user may elect, by means of external wiring alteration and without logic redesign, to silence the bells once all gates are horizontal. Such design shall prevent the bells from re-activating as the gates rise. Provide an 8-inch lunar white LED Motorman's Signal for each track,. Separate signals shall accommodate normal and reverse direction of traffic. Each Motorman's Signal shall display a solid aspect when the crossing approach is occupied and a flashing aspect when the entrance and exit gates are down and there is no detected malfunction of the crossing system. Provide override test, raise and lower pushbuttons in a locked box.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.9	TRACK SWITCHES													
2968	Performance Criteria		All track switches shall be powered and interlocked. They shall normally be set and locked automatically. All route-setting functions shall apply. An over-switch (OS) track circuit shall be provided, occupation of which shall prevent powered movement of the switch. A manual switch setting facility shall be provided at powered switch locations. The placing of a powered switch into manual operation shall result in loss of indication. Signals shall revert to their most restrictive aspect in the event of loss of indication of switch position. Switch and lock mechanisms shall meet or exceed the recommendations of the AREMA Manual of Recommended Practices–Signals. The electrical, electromechanical or mechanical locking equipment shall prevent switch point movement when the switch points are in full normal or full reverse position. Three-phase operated switch machines shall be avoided unless exceptional site conditions (e.g. distance from control point) dictate use of same. Parts of switch operating layouts shall be interchangeable between similar layouts. Provide green/yellow switch position indicators for facing point switches that are not directly governed by a signal	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.10	TRACTION RETURN BONDING													

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2969	Performance Criteria		The design shall provide impedance bonds and running rail continuity and cross bonding sufficient to comply with the traction return power requirements. The design shall ensure that no single failure, including broken rail or loss of a bonding cable, shall result in loss of traction return capability through loss of continuity or failure due to overheating. Traction power return capability shall be provided on all tracks regardless of whether OCS is present or not.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.11	EVENT RECORDERS													
2970	Performance Criteria		AREMA recommended event recorders that store information for future playback shall be provided for vital systems, including grade crossings, to record changes in state of the vital systems and their devices, all alarms, as well as, status of non-vital controls and indications. Each recorder shall be standalone, capable of recording up to onetwo weeks of events, assuming a train movement in each direction at design headway 24 hours a day, 7 days a week. Each recording device shall provide access to the data through a standard USB interface port.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.12	ENVIRONMENTAL REQUIREMENTS													
2971	Performance Criteria		All equipment shall meet the environmental provisions of the AREMA ATCS environmental specifications and environmental requirements specified in these Contract Documents.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.13	POWER SUPPLY													
2972	Performance Criteria		All housings shall be equipped with an external socket for the connection of a mobile generator. Signaling power supplies shall not be used for any purpose other than to power signaling equipment. In case of failure of the primary power source, backup power supply shall be provided to ensure safe train operation as follows: Grade crossings: 8 hours minimum Vital equipment: 4 hours minimum Non-vital equipment: 4 hours minimum Switch machines: 4 hours minimum at all interlockings	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.14	LIGHTNING PROTECTION													
2973	Performance Criteria		Lightning protection shall be provided for all equipment and circuits, which could be damaged by electrical transients.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.15	DESIGN INTEGRITY													
2974	Performance Criteria		The system shall be designed and operated in a safe manner. Failure of the system shall not compromise the safety of train operation, road traffic or pedestrians. Any circuit directly affecting the safety of train movement shall be considered "vital". Circuits performing functions of control, indication, communication, and other tasks, which do not directly affect the safety of train movement, shall be considered "non-vital". All vital components shall be highly reliable, of proven design and have predictable failure modes, such that no single failure shall create a less restrictive state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2975	Performance Criteria		The signal system logic and its components shall be designed to meet the following: **a)** All vital components shall be designed so that restrictive (rather than permissive) actions occur when a component fails. **b)** All vital control logic shall be designed such that, if interrupted or de-energized, it shall cause the controlled function to assume its most restrictive condition. **c)** All relays or solid-state equivalents being energized by a vital circuit shall be vital units. All contacts used within any vital circuit shall be contacts of vital relays. **d)** All errors of hardware and software that may compromise vital data, whether stored within a logical process, sampled as digital or analog inputs, or produced as digital or analog output, shall result in a safe system state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2976	Performance Criteria		Non-vital circuits may use non-vital relay or solid-state technology. Failures of non-vital equipment shall not affect the safety of the system. Non-vital systems shall interface with vital systems in a manner, which isolates the vital systems from malfunctions of the non-vital systems. Vital microprocessor systems may be used. The use of radio, land cable, or any combination, which forms a serial communication channel for the signal system, shall not be considered vital in itself. Design techniques shall be employed such that the equipment at each end of the communication link shall be capable of detecting errors in the data transmitted and received, such that system operation remains safe. Train Control system shall not be used for functions not directly related to train control functionality.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.16	MATERIALS AND EQUIPMENT													
		9.4.4.16.1	GENERAL													

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2977	Performance Criteria		Assemblies and components used to perform identical functions within the system shall be mechanically and electrically interchangeable. Standard commercially available equipment and material from multiple sources shall be used where practicable. All wayside equipment shall be secured and protected by the use of tamper-resistant covers. Where deemed appropriate by the Designer, further protection shall be provided with intrusion detection devices. All cables and wires shall be suitably protected. Conduits shall be provided under tracks, along bridges and through roadways, to meet AREMA recommendations. All material and equipment furnished shall be new and standard products of manufacturers regularly engaged in the production of like equipment, and shall be the latest design, which complies with the requirements of these Contract Documents.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.16.2	EQUIPMENT LOCATION													
2978	Performance Criteria		Signal equipment shall be located along the wayside only where necessary. All other equipment shall be located on the outer edge of the right-of-way, in easily accessible equipment housings. Signal masts, grade crossing gates, flasher masts, cantilever signal masts and all concrete signal structures shall follow CPUC GO 75 and City requirements for these structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.16.3	EQUIPMENT HOUSINGS													
2979	Performance Criteria		All signal equipment housings shall include all required environmental controls to facilitate maintenance and operation, including any necessary heating, ventilation and air conditioning. As a minimum, air conditioning and forced air ventilation shall be provided at every enclosure. Heat load calculations shall support any heating, ventilation and air conditioning (HVAC) installation. Designed inside (indoor) temperature shall be less than a maximum operating temperature of any equipment to be installed in the case. The signal equipment shall be capable of operation in the event of a failure of any environmental control subsystems. Houses, cases and junction boxes shall be steel or aluminum. Signal houses and cases containing electronic equipment shall be coated with reflective paint. Wayside signal cases and bungalows shall not be placed between tracks without prior approval. Wayside signal cases and bungalows shall be placed within the fenced right-of-way, with access to the right-of-way within 30 feet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2980	Performance Criteria		Minimum electrical service shall be 100 Amps 120V single phase. A change-overmanual transfer switch and 100 Amp generator plug-in point with rating matching main service breaker, shall be provided. Plug-in point shall be accessible without having cables laid across or under the track. All equipment-housing openings shall be screened or sealed to prevent entry of animals and insects to the extent practicable. All entryways shall be sealed following installation of cables and wiring entering the housing. All insulation material used to line the interior of equipment housing walls, doors and roofs shall be flame retarding and non-electrically conductive, and shall not introduce a hazard of any type. All equipment housings including component racks (card files, backplanes) shall be designed to accommodate possible future expansion of equipment space by 30%. Signal housings shall be provided with a fire detection system. NFPA 2001 Compliant Clean Agent Fire Extinguishing System shall be installed in the housings containing vital microprocessor equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.16.4	SECURITY OF EQUIPMENT													
2981	Performance Criteria		All signal equipment housings, cases, junction boxes, switch mechanisms, and signals shall be secured with an appropriate security device. Fencing shall be provided around each train control bungalow or case in order to isolate the enclosure from the Right of Way. At a minimum there shall be 2 ft of clearance between the fence and the enclosure on the sides without doors and four feet of clearance on the sides with doors although four feet on all sides of the enclosure is preferred. Doors of housings shall be capable of being secured by a standard electric lock with a mechanical key bypass and equipped with a weatherproof seal. Provide intrusion detection in all rooms, bungalows and cases housing train control equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.16.5	TRAIN CONTROL LOGIC SECURITY													
2982	Performance Criteria		Whenever microprocessor logic is used, both for vital and non-vital train control purposes, implement security procedures to prevent unauthorized access to, modifications of, and operation of such.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.16.6	MAINTAINABILITY													

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2983	Performance Criteria		The signaling equipment shall be designed and constructed to facilitate quick and easy troubleshooting and module replacement. The design shall require a minimum of testing following module replacement. Built-in indicators or meters shall be provided for routine maintenance, testing, and diagnostic purposes. The use of plug-in devices, such as laptop computers for the downloading of data from devices, including microprocessor interlockings, shall be allowed in addition to a basic set of fault indicators. As a minimum, LED indicators shall be provided for circuit boards to indicate the health status of a circuit board. A failed indication shall signify to a maintainer that the board should be replaced.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.17	SCADA INTERFACE													
2984	Standard Criteria		The design shall provide remote control and monitoring of train control via the SCADA system. The design shall provide remote controls and indications as defined in Metro Rail Design Criteria Section 9 Appendix B.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.18	TIME SYNCHRONIZATION													
2985	Standard Criteria		Internal clock of all microprocessor-based signaling equipment, including event recorders, shall be synchronized to a stratum-1 time source.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.4.19	GROUNDING													
2986	Standard Criteria		All at grade wayside equipment and housings shall be individually grounded to their own individual ground rods. Each ground rod shall have a separate hand hole for maintenance and inspection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5	METRO RED LINE EXPANSION AND ANY NEW HRT CONSTRUCTION													
		9.4.5.1	GENERAL REQUIREMENTS													
2987	Performance Criteria		The signaling system shall provide the following functions: • Interlocking control of switches and signals • Safe routing of trains • Safe separation of trains to prevent collisions and side swipes by physically separated operation on the main line, protected by vital systems • Automatic Train Operation (ATO)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2988	Performance Criteria		The signaling system and grade crossings shall comply with the AREMA Manual of Recommended Practices - Signals. Automatic route setting shall be for normal train operation. Manual selection of routes shall be provided for abnormal train operation or when automatic routing is not desirable. Bi-directional operation at full line speed and headway shall be provided throughout the main line. All sections under signal control shall be signaled such that, in the event either of the tracks in the double track sections is taken out of service, safe operations can be maintained. The signal system shall provide continuous overspeed protection and speed commands (cab signal) operation, which shall prevent unsafe operation with respect to other trains, interlocking conditions, civil speed limits, and grade crossings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2989	Performance Criteria		The cab signal system shall impose speed restrictions due to civil/track speed limits. In the normal direction of traffic the following design requirements shall be followed: • Locate block limits in approach to and exit from civil speed restriction zone in accordance with requirements of Section 9.4.5.2.4. • The maximum block length shall be 2,000 feet. • All track circuits with a Maximum Authorized speed (MAS) exceeding 40 mph shall have at least one intermediate speed code before "STOP". • All track circuits shall have a provision to allow for a manual downgrade to a more restrictive speed code via local control panel or hardware cards. Manual speed code selection shall not override safe train separation function of ATP. • Exceptions to the above criteria shall be reviewed on a case-by-case basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.2	SAFE BRAKING DISTANCE MODEL													
		9.4.5.2.1	INTRODUCTION													
2990	Performance Criteria	A	SBD is the calculated distance that a worst-case train will travel between the time that a speed reduction is commanded at a block boundary and the speed reduction is achieved. See Contract Drawings for graphic representation. The SBD is the sum of the following distances:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2991	Performance Criteria	A1	Signal Recognition Distance - The distance traveled from the block boundary to the point at which the ATP vehicle equipment recognizes the more restrictive speed limit signal. Calculate the signal recognition distance on the basis of constant train speed for a maximum time period of 2 sec. Use the maximum train speed permitted by the overspeed tolerance for the ATP speed limit in effect just prior to the reception of the changed speed limit signal. See Table 3 for overspeed tolerance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2992	Performance Criteria	A2	Overspeed Detection Distance - The distance traveled from the point at which the ATP vehicle equipment recognizes the change of the ATP speed limit to the point at which the ATP vehicle equipment commands traction power removal and a service brake application. The train achieves instantaneous maximum available acceleration per Table 1, with consideration for the effects of track geometry during this time interval. The worst-case overspeed detection time is 0.75 sec.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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2993	Performance Criteria	A3	Brake Assurance Reaction Distance - The distance traveled from the point at which the ATP vehicle equipment commands a service brake application to the point at which the ATP vehicle equipment determines that the minimum safe deceleration rate has not been achieved and commands an emergency brake application. This time interval is 3.0 sec. maximum. This is inclusive of the traction power removal time which starts when overspeed is detected and continues until traction power is removed. The train removes traction power at a worse-case minimum jerk-limited rate of 1.8 mi/hr/sec². Once tractive effort is reduced to zero, it remains at zero for the remainder of the interval. Base the initial acceleration on the available tractive effort per Table 1. The track geometry shall affect the acceleration throughout this period. For calculation purposes, the train resistance shall affect the acceleration when the tractive effort equals zero.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2994	Performance Criteria	A4	Emergency Brake Reaction Distance - The distance traveled from the point at which the ATP vehicle equipment commands an emergency brake application to the point at which emergency braking begins to build. Assume tractive effort is zero for the entire time interval, and base acceleration solely on the effects of train resistance and track geometry. This time interval is 0.4 sec.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2995	Prescriptive Spec	A5	Emergency Brake Build-up Distance - The distance traveled from the point at which emergency braking begins to build to the point at which emergency brakes are fully applied. The braking rate increases linearly from zero to 1.7 mi/hr/sec in 1.1 sec. Adjust deceleration for track geometry.													
2996	Performance Criteria	A6	Emergency Braking Distance - The distance traveled from the point at which the emergency brakes are fully applied and the train begins to decelerate at the worst case net braking rate of 1.7 mi/hr/sec to the stopping point. The braking rate shall be 1.7 mi/hr/sec for the entire interval. Adjust deceleration for track geometry.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2997	Prescriptive Spec	A7	Vehicle Overhang Distance - The distance comprising that portion of the leading train extending behind the center line of the rear-most axle, plus that part of the following train extending forward of the center line of the front-most axle for a total of 14 ft.													
2998	Prescriptive Spec	A8	Vehicle Characteristics - In the SBD design, use the following vehicle characteristics in all combinations to determine the longest braking distance: Length: Two or six cars. Car Weight: AW0 (78,000 lbs.) or AW3 (128,000 lbs.)													
		9.4.5.2.2	TRAIN RESISTANCE FACTORS													
2999	Prescriptive Spec	A	Track Geometry Factors Retarding or accelerating force of 20 lb/ton of vehicle weight per percent of grade, with consideration given to vertical alignment. Retarding force of 0.8 lb/ton of vehicle weight per degree of horizontal curvature.													
3000	Prescriptive Spec	B	Vehicle Resistance Factors - Train resistance on level tangent track (to be considered only during coasting for SBD purposes): Retarding force in lb, due to bearing friction and resistance proportional to weight: FR1 = N (116 + 1.3W) Retarding force in lb, due to rolling friction and resistance proportional to velocity: FR2 = N (0.045VW) Retarding force in lb, due to wind resistance, lead vehicle: FR3 = 0.0024 AV2 Retarding force in lb, due to wind resistance, trailing vehicle: FR4 = (N-1) (0.00034AV2) Average train resistance in lb per vehicle: FR =[N (116 + 1.3W + 0.045VW) + 0.0024AV2 + (N-1)0.00034AV2]/N													
3001	Prescriptive Spec	B	Symbols: W = Vehicle weight (ton) V = Speed (mi/hr) A = Vehicle frontal area = 98 ft2 N = Number of vehicles in train consist (2 or 6) For use in vehicle resistance factors, the acceleration resistance due to vehicle inertia = 100 lb/ton/mi/hr/sec.													
3002	Prescriptive Spec	C	Distributed Force - Calculate the forces due to train resistance and track geometry factors as either distributed point masses located at truck centers or as a uniformly distributed line mass.													
		9.4.5.2.3	SPEED LIMITS													
3003	Prescriptive Spec		**A.** Maximum Authorized Speed - MAS is the highest ATP speed limit that can be transmitted in a block for the purpose of enforcing civil speed limits and station run through speed. **B.** The MAS for approach to civil speed limit zones shall not exceed the SBD profile to achieve the speed limit at the start of the restriction using all track geometry and train resistance factors. **C.** Station run-through speed shall not exceed 45 mi/hr for an ideal train. **D.** Design Profile Speed - Design profile speed is the highest speed limit to be given in a block and is equal to MAS, except as otherwise indicated. Use the maximum design profile speed as indicated for each station-to-station zone to provide the least runtime even when the train may not achieve that velocity. Use the design profile speed for control line and headway requirements.													
		9.4.5.2.4	BLOCK BOUNDARIES													

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3004	Prescriptive Spec	A-C	**A.** General - Locate block boundaries to ensure compliance with safety and headway requirements in addition to those specified herein. **B.** Impedance Bond Boundaries - Utilize impedance bonds to locate block boundaries at Insulated joints defining interlockings. **C.** Speed Restriction Zone Approach - Locate a block boundary in the normal direction of traffic on the approach to the zone with a more restrictive civil speed limit, in order to slow a worst-case train to the more restrictive speed when entering the zone. Locate this boundary no farther from the more restrictive zone than the SBD necessary to slow the train to the restricted speed plus 50 ft.													
3005	Prescriptive Spec	D, E	**D.** Speed Restriction Exit - Locate a block boundary at the normal direction exit end of a speed restriction zone. Provide look-back capability so that as soon as the rear of the train crosses the block boundary it can receive the higher ATP speed code, providing SBD conditions permit an increased speed. If the exit from the speed restriction area would not result in a higher speed code for an ideal train due to approach of another speed restriction zone or station stopping profile, then a block boundary to define the exit from the speed restriction is not required. The look back block boundary would be ideally located within the speed restriction zone at the distance that allows the rear of a train traveling at the ATP speed limit to reach the speed restriction velocity at the exit point of the speed restriction. This distance would also include the time required for the exited track circuit to pick and the time required for the train to recognize the increased speed code and apply acceleration. Locate the boundary within 50 ft. of the ideal boundary location in normal direction of travel. **E.** Station Speed Restriction - Locate a block boundary in the normal traffic direction approach to a station in order to slow an ideal train not stopping at the station to 45 mi/hr when entering the station platform. This boundary does not apply to locations where civil speed restrictions have already reduced the velocity to 45 mph or less.													
		9.4.5.3	CIVIL BRAKING DISTANCE MODEL													
3006	Performance Criteria	A	The Civil Braking Distance (CBD) is the calculated distance that a train will travel between the time that a civil speed reduction is commanded until the required speed reduction is achieved. The train operator is in control of the speed with the cab signal system providing over-speed protection only. The CBD formula shall not be applied to safe train separation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3007	Prescriptive Spec	B	The Civil Braking Distance (CBD) model shall be the same as the Safe Braking Distance (SBD) model, except:													
3008	Prescriptive Spec	B1-3	**1.** Overspeed Detection Distance shall be the distance traveled from the point at which the ATP vehicle equipment recognizes the change of the ATP speed limit to the point at which the ATP vehicle equipment commands traction power removal and a service brake application, without runaway acceleration. The worst-case overspeed detection time is 0.75 sec. **2.** Brake Assurance Reaction Distance and Emergency Brake Reaction Distance are replaced with Service Brake Reaction Distance **3.** Service Brake Reaction Distance - The distance traveled from the point at which the ATP vehicle equipment commands a service brake application to the point at which full service braking begins to build. Assume tractive effort is zero for the entire time interval, and base acceleration solely on the effects of train resistance and track geometry. This time interval is 3.4 sec.													
3009	Prescriptive Spec	B4-7	**4.** Emergency Brake Build-up Distance is replaced by Service Brake Build-up Distance. **5.** Service Brake Build-up Distance - The distance traveled from the point at which service braking begins to build to the point at which service brakes are fully applied. The braking rate increases linearly from zero to 2.0 mi/hr/sec in 1.1 sec. Adjust deceleration for track geometry. **6.** Emergency Braking Distance is replaced by Service Braking Distance. **7.** Service Braking Distance - The distance traveled from the point at which the service brakes are fully applied and the train begins to decelerate at the worst-case net braking rate of 2.0 mi/hr/sec to the target speed. The braking rate shall be 2.0 mi/hr/sec for the entire interval. Adjust deceleration for track geometry.													
		9.4.5.4	CAB SIGNAL SYSTEM													
		9.4.5.4.1	FUNCTIONALITY OVERVIEW													
3010	Prescriptive Spec		The cab signal received on-board the car shall be interpreted as a speed limit, the aspect of which, shall be displayed to the operator. Code rates and their meanings shall be: CODE RATE INDICATION 21.50 Hz: Proceed at 70 mph. 18.10 Hz: Proceed at 55 mph. 15.30 Hz: Proceed at 45 mph. 12.43 Hz: Proceed at 40 mph. 10.10 Hz: Proceed at 25 mph. 8.31 Hz: Proceed at 9 mph. 6.83 Hz: Proceed at 8 mph. 5.50 Hz: Stop and Stay No Code: Stop and Proceed. Approaching a signal at stop or when occupancy exists ahead that requires immediate brake application to safely avoid a collision. The carrier frequency shall be 2.34 kHz. Dead sections, such as at insulated rail joints, shall be no greater than 14 feet in length.													
		9.4.5.5	TRAIN DETECTION													

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3011	Performance Criteria		The signaling system shall detect all cars operating independently or in consist, and any other rail vehicle present, except hi-rail vehicles. The presence of a rail vehicle in a section of the route shall be detected continuously by means of track circuits. Detection of the occupation of the track circuit shall be fail-safe, such that a de-energized position is interpreted as an occupation of the track circuit. In the event of a temporary loss of detection, the design shall ensure that indication of the presence of a rail vehicle in a section will be maintained while a rail vehicle is actually in the section. If a rail vehicle is parted in an unscheduled manner, the signal system shall ensure that all parts of the rail vehicle are detected. The signal system shall ensure that safe separation is maintained between the parted vehicle and all other rail vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3012	Prescriptive Spec		The minimum effective length of a track circuit shall be longer than the maximum inner wheelbase of all vehicles used on this track. The maximum length for Power frequency and Coded Track Circuits shall be 5000 feet. The maximum length for Audio Frequency Track Circuits shall be 2000 feet. For track circuits used to control signals and locking functions, the minimum shunt sensitivity shall be 0.25 Ohms. The shunting requirements shall be met for ballast conditions of 5 ohms per thousand feet or greater.													
		9.4.5.6	BROKEN RAIL DETECTION													
3013	Performance Criteria		Broken rail detection shall be provided throughout all mainline track. A broken rail shall de energize the associated track circuit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.7	ROUTE SETTING													
3014	Performance Criteria		There shall be four methods for control of train movement through the signalized sections, as described below.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.7.1	AUTOMATIC ROUTE SETTING													
3015	Performance Criteria		Routes shall normally operate automatically by signal and switch control subsystems responding to the approach of the train. In normal operation, routes shall clear automatically for consists without intervention by the train operator. At terminal stations trains shall be normally routed reverse across before reaching the station as the preferred route, or the normal direction route if the preferred platform is occupied.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.7.2	SELECTION OF ROUTES FROM THE TRAIN													
3016	Performance Criteria		Train-to-Wayside Communication route section shall be provided at all interlocking signals and terminals.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.7.3	LOCAL ROUTE SELECTION CAPABILITY													
3017	Performance Criteria		Local control capability shall be provided to ensure the safe operation of trains by means of Local Control Panels (LCP) in each signal house. The LCP shall indicate track circuit occupancy, signal status, switch position and correspondence, switch locking, traffic direction, manual control, automatic control, and crossing gate position, speed restriction enabled, AC alarm, DC alarm, communication failure alarm, system failure (Electrologixs, VHLC, iVPI, or Microlok), and all indications described in the specifications. LCP shall be of size such that it can display the complete layout of the territory controlled from the location, without need to change screens or scrolling. Displayed track layout shall include at least one adjacent track circuit, beyond the boundary of control. Display used for local control panel purpose shall be 32" minimum and be wall mounted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.7.4	RAIL OPERATIONS CONTROL													
3018	Performance Criteria		Central control capability shall be provided at each interlocking.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.8	WAYSIDE SIGNALS													
		9.4.5.8.1	MAIN LINE													
3019	Performance Criteria		Wayside color signals shall be provided to indicate movement authority, block occupation and route locking information to train operators. Signals shall be installed to govern movements into and through interlocking limits. Wayside color signals shall show the following aspects, which are in compliance with Metro rules: Aspect: Meaning Red: Stop Flashing Red: STOP and contact ROC. Proceed when authorized by ROC. Flashing Yellow: Proceed on diverging route into reverse traffic. Yellow: Proceed on diverging route into normal traffic. Flashing Green: Proceed on normal route into reverse traffic. Green: Proceed on normal route into normal traffic.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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ID	TYPE	SECTION	DESCRIPTION	LOS ANGELES	HUNTINGTON PARK	BELL	CUDAHY	DOWNEY	SOUTH GATE	PARAMOUNT	BELLFLOWER	CERITOS	ARTESIA	VERNON	VARIANCE	DOCUMENT/SECTION
3020	Performance Criteria		Indication on signals or switches shall be fail-safe, such that no less restrictive aspect is shown than intended. Wayside signals shall be located such that they are sufficiently visible to preclude confusion with signals governing the operation of motor vehicles, and similarly do not confuse motor vehicle drivers. When viewed from a height of 7 feet above top of rail, at a distance of 500 ft, lenses shall present a distinct aspect under the most adverse operating conditions. Provide a signal number plate for each signal. The signal number plate shall be placed under the lowest signal lens in the assembly. Signal plates shall meet the requirements of the AREMA Manual of Recommended Practices – Signals. The alphanumeric characters shall be a minimum of 3 inches high. Signal aspects shall use 8" Light Emitting Diode (LED) units.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.9	MAIN LINE													
3021	Performance Criteria		As a minimum, the following locking functions shall be provided for powered switch interlockings:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3022	Performance Criteria	a-c	**a)** Switch locking - A locking function shall ensure that a signal governing a switch or combination of switches shall only show a less restrictive aspect than "stop", when all switches are in the correct position. **b)** Automatic Block locking - A home signal governing a block shall only show a less restrictive aspect than "stop", when the entire block is unoccupied by any trains or vehicles. This shall be controlled automatically by means of track circuits throughout the entire block. **c)** Route locking - Route locking shall lock switches within a route after a signal has been requested for train movement onto that route, and shall prevent clearing of opposing and conflicting signals within the interlocking. Route locking shall be in effect when approach locking is in effect, and it shall remain in effect until the rear of the train has cleared the route. Switches, which are part of the route, and switches or signals, which are protecting against flanking (side-swipe), shall be disabled from moving when the route is locked. Signals protecting this route shall be prevented from showing aspects other than stop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3023	Performance Criteria	d-f	**d)** Approach locking - Approach locking shall lock switches within a route governed by a cleared wayside signal to prevent clearing wayside signals for opposing or conflicting routes. **e)** Time locking - Time locking shall ensure that all switches and signals forming a route, and those protecting it, remain in position and locked for a predetermined time after the entry signal has been caused to display its most restrictive aspect again. **f)** Traffic locking - Setting and locking of a route shall be prohibited unless the opposing signals show the most restrictive aspect. The signal system shall furthermore prevent any trains simultaneously entering the same block section from different directions or tracks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3024	Performance Criteria		Independent of any route locking function, the movement of any powered switch shall be prevented when track occupancy is detected in the track section in which that switch is located. The switch locking function shall have 5 seconds loss of shunt protection. However, sectional release shall be provided where practicable, to support headways through junctions. Any failure, including false occupancy, loss of power, to any part of an interlocking shall not result in the premature release of any locking function. Overrun detection shall be provided for every interlocking signal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.10	TRACK SWITCHES													
3025	Performance Criteria		All track switches shall be powered and interlocked. They shall normally be set and locked automatically. All route-setting functions defined in Section 0 shall apply. An over-switch (OS) track circuit shall be provided, occupation of which shall prevent powered movement of the switch. A manual switch setting facility shall be provided at powered switch locations. The placing of a powered switch into manual operation shall result in loss of indication. Signals shall revert to their most restrictive aspect in the event of loss of indication of switch position. Switch and lock mechanisms shall meet or exceed the recommendations of the AREMA Manual of Recommended Practices–Signals. The electrical, electromechanical or mechanical locking equipment shall prevent switch point movement when the switch points are in full normal or full reverse position. Parts of switch operating layouts shall be interchangeable between similar layouts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.11	TRACTION RETURN BONDING													

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3026	Performance Criteria		The design shall provide impedance bonds and running rail continuity and cross bonding sufficient to comply with the traction return power requirements. The design shall ensure that no single failure, including broken rail or loss of a bonding cable, shall result in loss of traction return capability through loss of continuity or failure due to overheating. Traction power return capability shall be provided on all tracks regardless of whether OCS is present or not.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.12	EVENT RECORDERS													
3027	Performance Criteria		AREMA recommended event recorders that store information for future playback shall be provided for vital systems to record changes in state of the vital systems, their devices, all alarms, as well as status of non-vital controls and indications. Each recorder shall be standalone, capable of recording up to two weeks of events assuming a train movement in each direction at design headway 24 hours a day, 7 days a week. Each recording device shall provide access to the data through a standard USB interface port.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.13	ENVIRONMENTAL REQUIREMENTS													
3028	Performance Criteria		All equipment shall meet the environmental provisions of the AREMA ATCS environmental specifications and environmental requirements specified in these Contract Documents.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.14	POWER SUPPLY													
3029	Prescriptive Spec		All housings shall be equipped with an external socket for the connection of a mobile generator. Signaling power supplies shall not be used for any purpose other than to power signaling equipment. In case of failure of the primary power source, backup power supply shall be provided to ensure safe train operation as follows: Vital equipment: 4 hours minimum Non-vital equipment: 4 hours minimum Switch machines: 4 hours minimum at all interlockings													
		9.4.5.15	LIGHTNING PROTECTION													
3030	Performance Criteria		Lightning protection shall be provided for all equipment, which could be damaged by electrical transients.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.16	DESIGN INTEGRITY													
3031	Performance Criteria		The system shall be designed and operated in a safe manner. Failure of the system shall not compromise the safety of train operation, road traffic or pedestrians. Any circuit directly affecting the safety of train movement shall be considered "vital". Circuits performing functions of control, indication, communication, and other tasks, which do not directly affect the safety of train movement, shall be considered "non-vital". All vital components shall be highly reliable, of proven design and have predictable failure modes, such that no single failure shall create a less restrictive state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3032	Performance Criteria		The signal system logic and its components shall be designed to meet the following: **a)** All vital components shall be designed so that restrictive (rather than permissive) actions occur when a component fails. **b)** All vital control logic shall be designed such that, if interrupted or de-energized, it shall cause the controlled function to assume its most restrictive condition. **c)** All relays or solid-state equivalents being energized by a vital circuit shall be vital units. All contacts used within any vital circuit shall be contacts of vital relays. **d)** All errors of hardware and software that may compromise vital data, whether stored within a logical process, sampled as digital or analog inputs, or produced as digital or analog output, shall result in a safe system state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3033	Performance Criteria		Non-vital circuits may use non-vital relay or solid-state technology. Failures of non-vital equipment shall not affect the safety of the system. Non-vital systems shall interface with vital systems in a manner, which isolates the vital systems from malfunctions of the non-vital systems. Vital microprocessor systems may be used. The use of radio, land cable, or any combination, which forms a serial communication channel for the signal system, shall not be considered vital in itself. Design techniques shall be employed such that the equipment at each end of the communication link shall be capable of detecting errors in the data transmitted and received, such that system operation remains safe. Train Control system shall not be used for functions not directly related to train control functionality.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.17	MATERIALS AND EQUIPMENT													
		9.4.5.17.1	GENERAL													

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3034	Performance Criteria		Assemblies and components used to perform identical functions within the system shall be mechanically and electrically interchangeable. Standard commercially available equipment and material from multiple sources shall be used where practicable. All wayside equipment shall be secured and protected by the use of tamper-resistant covers. Where deemed appropriate by the Designer, further protection shall be provided with intrusion detection devices. All cables and wires shall be suitably protected. Conduits shall be provided under tracks, along bridges and through roadways, to meet AREMA recommendations. All material and equipment furnished shall be new and standard products of manufacturers regularly engaged in the production of like equipment, and shall be the latest design, which complies with the requirements of these Contract Documents.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.17.2	EQUIPMENT LOCATION													
3035	Performance Criteria		Signal equipment shall be located along the wayside only where necessary. All other equipment shall be located on the outer edge of the right-of-way, in easily accessible equipment housings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.17.3	EQUIPMENT HOUSINGS													
3036	Performance Criteria		All signal equipment housings shall include all required environmental controls to facilitate maintenance and operation, including any necessary heating, ventilation and air conditioning. As a minimum, air conditioning and forced air ventilation shall be provided at every enclosure. Heat load calculations shall support any heating, ventilation and air conditioning (HVAC) installation. Designed inside (indoor) temperature shall be less than a maximum operating temperature of any equipment to be installed in the case. The signal equipment shall be capable of operation in the event of a failure of any environmental control subsystems. All equipment-housing openings shall be screened or sealed to prevent entry of animals and insects to the extent practicable. All entryways shall be sealed following installation of cables and wiring entering the housing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3037	Performance Criteria		All insulation material used to line the interior of equipment housing walls, doors and roofs shall be flame retarding and non-electrically conductive, and shall not introduce a hazard of any type. All equipment housings including component racks (card files, backplanes) shall be designed to accommodate possible future expansion of equipment space by 30%. Standalone enclosures (cases, bungalows) must be supplied with at least 100A 120V single-phase electrical service and generator plug-in point rated to match main service breaker. Manual transfer switch shall be provided to switch between these power sources. Signal housings shall be provided with a fire detection system. NFPA 2001 Compliant Clean Agent Fire Extinguishing System shall be installed in the housings containing vital microprocessor equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.17.4	SECURITY OF EQUIPMENT													
3038	Performance Criteria		All signal equipment housings, cases, junction boxes, switch mechanisms, and signals shall be secured with an appropriate security device. Provide intrusion detection in all rooms, bungalows and cases housing train control equipment. Fencing shall be provided around each train control bungalow or case in order to isolate the enclosure from the Right of Way. At a minimum there shall be 2 ft of clearance between the fence and the enclosure on the sides without doors and four feet of clearance on the sides with doors although four feet on all sides of the enclosure is preferred. Doors of housing shall be capable of being secured by a standard electric lock with mechanical key bypass and equipped with a weatherproof seal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.17.5	TRAIN CONTROL LOGIC SECURITY													
3039	Performance Criteria		Whenever microprocessor logic is used, both for vital and non-vital train control purposes, implement security procedures to prevent unauthorized access to, modifications of, and operation of such.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.17.6	MAINTAINABILITY													
3040	Performance Criteria		The signaling equipment shall be designed and constructed to facilitate quick and easy troubleshooting and module replacement. The design shall require a minimum of testing following module replacement. Built-in indicators or meters shall be provided for routine maintenance, testing, and diagnostic =purposes. The use of plug-in devices, such as laptop computers for the downloading of data from devices, including microprocessor interlockings, shall be allowed in addition to a basic set of fault indicators. As a minimum, LED indicators shall be provided for circuit boards to indicate the health status of a circuit board. A failed indication shall signify to a maintainer that the board should be replaced.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.18	SCADA INTERFACE													
3041	Performance Criteria		The design shall provide remote control and monitoring of train control via the SCADA system. The design shall provide remote controls and indications as defined in Metro Rail Design Criteria Section 9 Appendix B.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.19	ATO SUBSYSTEM													

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3042	Performance Criteria		Provide wayside solid state wayside ATO package that is compatible in features and performance with the existing ATO system. This includes: ATO signal generators Program Station Stop and Berthing Verification system that is compatible with existing MRL fleet and wayside system	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.20	TRAIN-TO-WAYSIDE COMMUNICATION													
3043	Performance Criteria		The Train-to-Wayside Communication (TWC) system shall be compatible with Hanning & Kahl HCS-V. TWC transponders shall be provided at the following minimum locations: • Approach to all wayside signals • At the terminus station (for calling of a route onto the main line). Loops must accommodate six-, four- and two–car stopping positions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.21	TIME SYNCHRONIZATION													
3044	Performance Criteria		Internal clock of all microprocessor-based signaling equipment, including event recorders, shall be synchronized to a stratum-1 time source.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.5.22	GROUNDING													
3045	Performance Criteria		All at grade wayside equipment and housings shall be individually grounded to their own individual ground rods. Each ground rod shall have a separate hand hole for maintenance and inspection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6	YARD TRAIN CONTROL SYSTEM													
		9.4.6.1	YARD TRAIN CONTROL SYSTEM GENERAL REQUIREMENTS													
3046	Performance Criteria		The following section describes design criteria pertaining only to the train control system within a yard. The yard signaling system shall be designed to provide safe routing of trains with maximum operational flexibility within the yard confines. As a minimum it shall have the following functions: Interlocking control of switches and signals Protection of highway (grade) crossings against road/rail collisions. All signal and train control equipment necessary to enable a train to clear the main line shall comply with mainline requirements. The mainline signal system shall control alignment of routes into yard and from yard to mainline.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.2	WAYSIDE SIGNALS													
3047	Performance Criteria		LED wayside color signals shall be provided to indicate movement authority, and switch position information to train operators. Signals shall be installed to govern movements into, within, and out of the yard limits. Provide a signal number plate for each signal. The signal number plate shall be placed under the lowest signal lens in the assembly. Signal plates shall meet the requirements of the AREMA Manual of Recommended Practices – Signals. The alphanumeric characters shall be a minimum of 3 inches high. Signals, authorizing train movements into mainline territory shall adhere to the requirements of mainline train control design criteria. Signals, except for runway-style installations, shall use 8” Light Emitting Diode (LED) units.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.3	TRAIN-TO-WAYSIDE COMMUNICATION													
3048	Standard Criteria		The Train-to-Wayside Communication (TWC) system shall be compatible with Hanning & Kahl HCS-V.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.4	TRAIN DETECTION													
3049	Performance Criteria		All switch locking and train detection circuits outside of storage tracks and car wash facilities shall be failsafe. Track circuits in the storage tracks, car wash facilities, and track circuit repeaters may be non-vital provided that no track repeater contacts are used in detector locking circuits. The signaling system shall detect all cars operating independently or in consist, and any other rail vehicle present, except hi-rail vehicles. This detection requirement applies to all yard trackage. Occupancy of storage tracks designed to accommodate more than one maximum car length train shall indicate section of storage track being occupied. Single rail, power frequency, vane-relay based track circuits shall be used in all over-switch (detector) track circuits. Indicating-type track circuits are permitted to be installed on storage tracks only. Double-rail track circuits are to be used for mainline interface and on test tracks. The minimum effective length of a track circuit shall be longer than the maximum inner wheelbase of all vehicles used on this track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.5	ROUTE SETTING													
3050	Performance Criteria		There shall be three methods for control of train movement through the signalized sections, as described below:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.5.1	YARD CONTROL													
3051	Performance Criteria		Routes within the yard limits shall normally be controlled by yard tower	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.5.2	SELECTION OF ROUTES FROM THE TRAIN													
3052	Performance Criteria		Train-to-Wayside Communication route selection shall be provided at all interlocking signals.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		9.4.6.5.3	LOCAL CONTROL													
3053	Performance Criteria		Local control capability shall be provided to ensure the safe operation of trains by means of Local Control Panels (LCP). At a minimum, the LCP shall indicate track circuit occupancy, signal status, switch position and correspondence, switch locking, traffic direction, manual control, automatic control, and crossing gate position, AC Alarm, DC Alarm, Communication failure Alarm, Microprocessor System failure (Electrologixs, VHLC, iVPI, or Microlok), Intrusion detection. These indications shall also be available at Yard Control Tower. LCP shall be of size such that it can display the complete layout of the territory controlled from the location, without need to change screens or scrolling. Mainline track lead indications must be included in the layout, if adjacent to the area of control. Display used for local control panel purpose shall be 32" minimum and be wall mounted.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.6	YARD DWARF SIGNALS													
3054	Performance Criteria		**a)** Dwarf signals shall be either a 2 head or 3 head unit. The signal shall be used to display permissive aspects at the entrance to each Yard interlocking when routes have been established within the Yard. **b)** Dwarf signal number plates shall be provided below the lowest dwarf signal lens in the assembly. Signal plates shall meet the requirements of the AREMA C&S Manual and contain alphanumeric characters a minimum of 3 inches high. **c)** Aspects displayed shall be as follows Aspect: Meaning Green: First switch point in route is in the normal position. Proceed in Yard mode of Operations. Yellow: First switch point in route in reverse position. Proceed in Yard mode of Operations. Red: Stop. Contact Yard Control. If project requirements allow, dwarf signal heads might be substituted by runway-type color signals.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.7	INTERLOCKINGS													
3055	Performance Criteria		As a minimum, the following locking functions shall be provided for powered switch interlockings: **a)** Switch locking - A locking function shall ensure that a signal governing a switch or combination of switches shall only show a less restrictive aspect than "stop", when all switches in a route are locked in their correct position. **b)** Route locking - Route locking shall lock switches within a route after a signal has been requested and switches are in their proper position. Route lockers shall prevent clearing of opposing and conflicting signals within the interlocking. Route locking shall be in effect when approach locking is in effect, and it shall remain in effect until the rear of the train has cleared the route. **c)** Switches, which are part of the route, and switches or signals, which are protecting against flanking (side-swipe), shall be disabled from moving when the route is locked. Signals protecting this route shall be prevented from showing aspects other than stop. **d)** Approach/Time locking – Approach/Time locking shall maintain switch locking for a predetermined time after a signal has been canceled and there is a train on approach to the signal. . **e)** Detector Locking – Detector locking shall prevent movement of a switches within an interlocking when any of the track circuits in the interlocking are occupied. Detector locking circuits shall only use contacts from the ac vane track relay. Contacts from non-vital repeaters shall not be used in switch locking circuits.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3056	Performance Criteria		Detector tracks shall have 5 seconds loss of shunt protection. Sectional release shall be provided where practicable. Any failure, including loss of power, to any part of an interlocking shall not result in the premature release of any locking function.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.8	TRACK SWITCHES													
3057	Performance Criteria		All track switches shall be powered and interlocked. They shall normally be set and locked automatically. An over-switch (OS) track circuit shall be provided, occupation of which shall prevent powered movement of the switch. A manual switch setting facility shall be provided at powered switch locations. The pPlacing of a powered switch into manual operation shall result in loss of indication. Signals shall revert to their most restrictive aspect in the event of loss of indication of switch position. Switch and lock mechanisms shall meet or exceed the recommendations of the AREMA Communications & Signals Manual of Recommended Practice, Part 4.2.5. Parts of switch operating layouts shall be interchangeable between similar layouts. All switch machines in the yard shall have battery backup of 4 hours and have hand throw capability. Mainline switch machines shall be installed for all track switches leading to mainline tracks. Provide green/yellow switch position indicators for facing point switches that are not directly governed by a signal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		9.4.6.9	TRACTION RETURN BONDING													
3058	Performance Criteria		The design shall provide impedance bonds and running rail continuity and cross bonding sufficient to comply with the traction return power requirements. The design shall ensure that no single failure, including broken rail or loss of a bonding cable, shall result in loss of traction return capability through loss of continuity or failure due to overheating. Traction power return capability shall be provided on all tracks regardless of whether they are electrified or not.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.10	EVENT RECORDERS													
3059	Standard Criteria		AREMA recommended event recorders that stores information for future playback shall be provided to record changes in state of the vital systems, their devices, all alarms, as well as, status of non-vital controls and indications. Each recorder shall be standalone capable of recording up to 2 weeks of events assuming a train movement in each direction every 3.5 minutes continuously. Each recording device shall provide access to the data through a standard USB interface port.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.11	ENVIRONMENTAL REQUIREMENTS													
3060	Performance Criteria		All equipment shall meet the environmental provisions of the AREMA ATCS environmental specifications and environmental requirements specified in these Design Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.12	POWER SUPPLY													
3061	Performance Criteria		All housings shall be equipped with an external, self-starting, permanently mounted generator providing a minimum of 4hr backup to all loads in the enclosure. Uninterruptible Power Supply (UPS) System shall be used to provide backup power during generator startup. Signaling power supplies shall not be used for any purpose other than to power signaling equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.13	LIGHTNING PROTECTION													
3062	Performance Criteria		Lightning protection shall be provided for all equipment and circuits, which could be damaged by electrical transients.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.14	DESIGN INTEGRITY													
3063	Performance Criteria		The system shall be designed and operated in a safe manner. Failure of the system shall not compromise the safety of mainline train operation, road traffic or pedestrians. Any circuit directly affecting the safety of mainline train movement shall be considered “vital”. Circuits performing functions of control, indication, communication, and other tasks, which do not directly affect the safety of train movement, shall be considered “non-vital”. All vital components shall be highly reliable, of proven design and have predictable failure modes, such that no single failure shall create a less restrictive state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3064	Performance Criteria	a-d	The signal system logic and its components shall be designed to meet the following: **a)** All vital components shall be designed so that restrictive (rather than permissive) actions occur when a component fails. **b)** All vital control logic shall be designed such that, if interrupted or de-energized, it shall cause the controlled function to assume its most restrictive condition. **c)** All relays or solid-state equivalents being energized by a vital circuit shall be vital units. All contacts used within any vital circuit shall be contacts of vital relays. **d)** All errors of hardware and software that may compromise vital data, whether stored within a logical process, sampled as digital or analog inputs, or produced as digital or analog output, shall result in a safe system state.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3065	Performance Criteria		Non-vital circuits may use non-vital relay or solid-state technology. Failures of non-vital equipment shall not affect the safety of the system. Non-vital systems shall interface with vital systems in a manner, which isolates the vital systems from malfunctions of the non-vital systems. The use of radio, land cable, or any combination, which forms a serial communication channel for the signal system, shall not be considered vital in itself. Design techniques shall be employed such that the equipment at each end of the communication link shall be capable of detecting errors in the data transmitted and received, such that system operation remains safe. System such as train-to-wayside communication, local control panel and SCADA shall have a dedicated link to train control logic.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.15	MATERIALS AND EQUIPMENT													
		9.4.6.15.1	GENERAL													

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3066	Performance Criteria		Assemblies and components used to perform identical functions within the system shall be mechanically and electrically interchangeable. Standard commercially available equipment and material from multiple sources shall be used where practicable. All wayside equipment shall be secured and protected by the use of tamper-resistant covers. Where deemed appropriate by the Designer, further protection shall be provided with intrusion detection devices. All cables and wires shall be suitably protected. Conduits shall be provided under tracks, along bridges and through roadways, to meet AREMA recommendations. All material and equipment furnished shall be new and standard products of manufacturers regularly engaged in the production of like equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.15.2	EQUIPMENT LOCATION													
3067	Performance Criteria		Signal equipment shall be located along the wayside only where necessary. All other equipment shall be located on the outer edge of the right-of-way, in easily accessible equipment housings. Signal masts, grade crossing gates, flasher masts, cantilever signal masts and all concrete signal structures shall follow CPUC GO 75 and City requirements for these structures.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.15.3	EQUIPMENT HOUSINGS													
3068	Performance Criteria		All signal equipment housings shall include all required environmental controls to facilitate maintenance and operation, including any necessary heating, ventilation and air conditioning. As a minimum, air conditioning and forced air ventilation shall be provided at every enclosure. Heat load calculations shall support any heating, ventilation and air conditioning (HVAC) installation. The signal equipment shall be capable of operation in the event of a failure of any environmental control subsystems. Houses, cases and junction boxes shall be steel or aluminum. Signal houses and cases containing electronic equipment shall be coated with reflective paint. All equipment-housing openings shall be screened or sealed to prevent entry of animals and insects to the extent practicable. All entryways shall be sealed following installation of cables and wiring entering the housing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3069	Performance Criteria		All insulation material used to line the interior of equipment housing walls, doors and roofs shall be flame retarding and non-electrically conductive, and shall not introduce a hazard of any type. All equipment housings, including component rack (card files, backplanes) shall be designed to accommodate possible future expansion of equipment space by 30%. Signal housings shall be provided with a fire detection system. NFPA 2001 Compliant Clean Agent Fire Extinguishing System shall be installed in the housings containing vital microprocessor equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.15.4	SECURITY OF EQUIPMENT													
3070	Performance Criteria		All signal equipment housings, cases, junction boxes, switch mechanisms, and signals shall be secured with an appropriate security device. Provide intrusion detection in all rooms, bungalows and cases housing train control equipment. Doors of housing shall be capable of being secured by a standard electric lock with mechanical key bypass and equipped with a weatherproof seal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.15.5	TRAIN CONTROL LOGIC SECURITY													
3071	Performance Criteria		Whenever microprocessor logic is used, both for vital and non-vital train control purposes, implement security procedures to prevent unauthorized access to, modifications to and operation of such.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.15.6	MAINTAINABILITY													
3072	Performance Criteria		The signaling equipment shall be designed and constructed to facilitate quick and easy troubleshooting and module replacement. The design shall require a minimum of testing following module replacement. Built-in indicators or meters shall be provided for routine maintenance, testing, and diagnostic purposes. The use of plug-in devices, such as laptop computers for the downloading of data from devices, including microprocessor interlockings, shall be allowed in addition to a basic set of fault indicators. As a minimum, LED indicators shall be provided for circuit boards to indicate the health status of a circuit board. A failed indication shall signify to a maintainer that the board should be replaced.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.16	TIME SYNCHRONIZATION													
3073	Performance Criteria		Internal clock of all microprocessor-based signaling equipment, including event recorders, shall be synchronized to a stratum-1 time source.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.4.6.17	GROUNDING													
3074	Performance Criteria		All at grade wayside equipment and housings shall be individually grounded to their own individual ground rods. Each ground rod shall have a separate hand hole for maintenance and inspection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.5	**COMMUNICATIONS - GENERAL**													
		9.5.1	INTRODUCTION													
3075	Performance Criteria		This section describes the criteria for design of the communications system and associated subsystems, including specific requirements of all subsystems and their relationship to other communications subsystems and other systemwide elements of the LRT and HRT System Projects.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3076	Performance Criteria		The communications system shall provide the necessary subsystems to support the total operational requirements of the LRT and HRT System. The following subsystems and/or functions shall be considered part of the communications system and its design; including certain requirements related to expanding the subsystems to fulfill future needs: • Radio • Telephone (TEL) • Transit Passenger Information System (TPIS) including Public Address (PA), Visual Message Signs (VMS) • Closed Circuit Television (CCTV) • Cable Transmission System (CTS) • Supervisory Control and Data Acquisition (SCADA) • Intrusion Detection and Controlled Access • Central Control Consoles and Displays/Rail Operations Control (ROC) • Gas Monitoring • Seismic Detection • Fire Alarm • Facility and Emergency Management (F&EM) System • Communications Power System	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3077	Performance Criteria		The above subsystem design requirements are detailed in the following sections of this document. Communications requirements for any communications based Train Control System are not contained herein. The Rail Operations Control (ROC) will contain the necessary displays, control consoles, communications apparatus and the operating personnel responsible for the overall safety and security of passengers and the daily operations of the trains, stations and all supporting wayside apparatus. The ROC will serve as the focal point from which all Rail Transit System operations will be supervised, regulated and controlled. Yard Control shall contain the necessary displays, control panels, communications apparatus and personnel to manage train movements and consists within the Yard. Maintenance Control will be responsible for vehicle, personnel, and inventory control within the shop, personnel, maintenance equipment and inventory control within the LRT and HRT System, and communications between the shop and operations facilities, including Central Control and Yard Control. In addition, it will have maintenance-oriented management information services including vehicle and other system apparatus histories inventory analysis, and maintenance forecasting.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3078	Performance Criteria		The Communications system shall consist of voice, video, and data circuits connecting the ROC with stations and other areas within the LRT and HRT systems. These functions shall be provided by communications network elements: radio; telephone; transit passenger information system; closed circuit television; cable transmission; supervisory control and data acquisition; intrusion detection and access control; gas monitoring and seismic detection; fire alarm; facility and emergency management; ROC and other subsystems equipment. All materials and equipment delivered and or installed under this contract shall be new and be the standard products of a manufacturer regularly engaged in the production of the materials and equipment that qualify for the manufacturer warranty. Offers with used, refurbished, or "grey" market products will NOT be accepted. These elements are described in the following paragraphs.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3079	Performance Criteria	A	Radio transmission shall provide the primary voice communications services for all areas. Two-way voice communications via radio shall serve trains and maintenance vehicles and portables with channels provided for operations, maintenance, security and fire/police emergency functions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3080	Performance Criteria	B	The telephone service shall include emergency, maintenance, administrative telephones, and passenger assistance intercom at passenger stations, wayside, the ROC, and the Yard, served by Metro telephone system. In keeping with regulatory practice, all emergency and patron assistance telephone communications shall be recorded.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3081	Performance Criteria	C	Transit Passenger Information System (TPIS) includes Public Address (PA) and Visual Message System (VMS). PA services shall provide a fully supervised PA subsystem at each passenger station, the Yard and Shop buildings with access and control from various locations. The PA subsystem at the Yard and Shop buildings shall allow announcements from designated Yard and Shop phones to be directed to any one or multiple simultaneous zones. VMS, compliant with ADA Accessibility Guidelines requirements, shall provide safety and operations related messages to the traveling public at selected locations. The Transit Passenger Information System (TPIS) shall provide multi-media communications at each passenger station and other selected locations. The TPIS shall integrate PA and VMS with full-color flat panel displays to provide routine announcements, emergency warning, advertising and other non-interactive multi-media audio-visual information in full compliance with applicable fire and ADA regulations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3082	Performance Criteria	D	Closed Circuit Television (CCTV) shall provide means of surveillance of passenger stations, the vehicle storage area, and other areas as required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3083	Performance Criteria	E	The Cable Transmission System (CTS) shall provide the primary means of information transmission between the ROC, passenger stations, wayside facilities (as required), and the Yard and Shop. Signals, Traction Power and Communications Systems shall each be considered stand-alone infrastructure only sharing the project duct bank. Each system shall utilize separate cable and ducts within the duct bank. When there is a requirement for localized inter-system communications a dedicated cable shall be utilized. Radio-on-fiber shall be on its own dedicated fiber optic cable. One dedicated radio-on-fiber cable with minimum 96 strands shall be provided for each tunnel/track. Diversity routing shall be employed using fiber optic (FO) cables routed on both tunnel bores or track ways to prevent a single FO cable failure from affecting radio operation in any location.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3084	Performance Criteria	F	The Supervisory Control and Data Acquisition (SCADA) subsystem shall provide a master control station at the ROC and wayside interfaces for remote monitoring and control of train operations, traction power, station and wayside facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3085	Performance Criteria	G	Intrusion Detection and Controlled Access Intrusion Detection and Controlled Access shall be the Metro Enterprise solution that is in service at the time of signing the contract. The current system is Sielox 1700. The Sielox Pinnacle software is the Master station located at Metro Union Station Gateway HQ building. Sielox AnyWare Browser Based Access Control shall be installed and configured at the ROC for authorized staff to manage Rail Operations specific doors and alarm points with additional Alert Status System monitoring stations as required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3086	Performance Criteria	H	Rail Operations Control (ROC) The ROC subsystem shall provide unique equipment to support other systems, such as traction power, train control (TC), and the Environmental Control System (ECS). Included in this location are data processing equipment, control consoles, radio support interface equipment, Metro telephone system, network equipment for CTS, voice logging recorders, video monitors and recorders, data recorders, displays, and control panels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3087	Performance Criteria	I	Gas Monitoring system (For underground systems) A fully supervised gas monitoring subsystem shall be installed as required by results of soil sample test conducted during station construction and compliance with the Environmental Impact Study (EIS). Gas monitoring controller equipment, integrated with the station fire alarm system and ROC SCADA, shall be located in the train control and communications (TC&C) room and communicate with sensor heads installed at designated locations as necessary for the detection of the presence of specific gases at alarm concentrations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3088	Performance Criteria	J	Seismic Detection System The Seismic Detection Subsystem shall provide event detection alarms to the ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3089	Performance Criteria	K	Fire Alarm System The Fire Alarm system shall provide alarm annunciation to the Fire Alarm Control Panel (FACP), Emergency Management Panel (EMP) and ROC as well as fan and damper shutdown, elevator control, fire suppression activation, and evacuation by zone (all, as applicable). The fire control panel will typically be located in the TC&C Room.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3090	Performance Criteria	L	Facility and Emergency Management (F&EM) System The Facility and Emergency Management System includes high availability F&EM PLC, Emergency Management Panel (EMP), Auxiliary Emergency Management Panel (AEMP), and CCTV jack box. EMPs shall be provided in underground and aerial stations in accordance with Fire/Life Safety Criteria. These panels shall provide access to intrusion alarms, remote graphical fire annunciation, telephone, public address, elevator, emergency ventilation controls, and CCTV monitoring in a single panel to permit their use as a consolidated command post in event of emergency conditions in stations/tunnels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3091	Performance Criteria	M	Communications Power System All Communications system equipment shall be powered from Uninterruptible Power Supplies (UPS) or floating battery systems. (See Facilities - Electrical criteria for additional requirements to supplement the criteria listed herein). All communications equipment shall be capable of start-up following a power outage without reinitialization and with full status memory and process recall, with power from battery or from inverter sources.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.5.2	GENERAL DESIGN CRITERIA													
3092	Performance Criteria	A	General	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3093	Performance Criteria	A1-4	**1.** Standard commercial devices shall be used when such apparatus, software and materials meet the stated design criteria. Equipment assemblies, where required, shall be constructed using only standard off-the-shelf equipment. **2.** Within each Communications subsystem for each segment, like functions shall be performed by identical units. In no case shall the apparatus or hardware used in one portion of a segment's subsystem be different from that used in another portion to perform the same function under similar operation and environmental conditions. Due to technological advancements, parts availability and other restrictive factors functional equivalent equipment may be used between segments. **3.** Modular design shall be employed. Electrical and mechanical components shall be organized in cabinet-mounted plug-in assemblies. The mixing of equipment associated with two subsystems in one plug-in assembly shall not be permitted. Apparatus serving similar functions shall be in the same relative location in all cabinets, wherever practicable. **4.** Cabinets, racks and battery racks shall be protected to seismic codes of the State of California as applicable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3094	Performance Criteria	A5-6	**5.** All communications equipment located in the passenger stations, wayside, ROC and the Yards and Shops shall be powered from un-uninterruptible power sources or DC back-up battery systems. The uninterruptible power sources shall be designed to operate within the factory specifications and able to withstand the conditions that they are subjected to e.g. heat, moisture, humidity, dust and wind tunnel effect in order to maximize system longevity. **6.** CIC enclosures or any enclosure housing active equipment shall not be used as a junction box for thru routing of cables. Only those cables that terminate in the enclosure shall enter the enclosure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3095	Performance Criteria	A7	All communications equipment shall be clearly labeled such that the nomenclature is visible from the front with the normal operating covers on the devices.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3096	Performance Criteria	A7a-e	**a.** All fiber optic patch panels, fiber splice trays, power supplies, frame blocks, protector blocks, shall be labeled in a manner that is visible to a person standing in front of the device. **b.** All cross-connect panels shall be clearly labeled. **c.** All fiber optic patch panels and main distribution frame shall be clearly labeled on the non removable portion of the shelf and on the front cover whether removable or not as to the cable number, the route, and where the cable goes or distant end. **d.** All other equipment, as a minimum, shall be labeled on the front cover as to what the device is. **e.** All cable terminations shall have cable tags identifying the cable number, the number of copper pairs or fiber strands in the cable, the distant end (where the cable goes). To label the cablings, follow ANSI/TIA-606-B standard or the latest revision at the time of signing the contract. Cable identification shall match with the as-built drawings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3097	Performance Criteria	A7f-h	**f.** All punch down or cross-connect blocks and protected terminal blocks shall be labeled on the front of the blocks with the cable number, the number of pairs in the cable, the distant end (where the cable goes) and the route. **g.** All Communications Interface Cabinets, located outside of TC&C room or C&S room, shall be mounted and bolted to 6" height reinforced concrete pad which is poured above ground. **h.** In addition to Item a through Item g above, all racks at the Central Control communications equipment room shall have identification at the top of the rack as to what LRT and HRT line the equipment is associated with. At any location where communications equipment from different Metro Transit Systems reside in the same room, all racks shall have line or project identification at the top of the rack.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3098	Prescriptive Spec	A8-11	**8.** External communications conduits shall stub up 4" above the floor in a single concentrated area or enter from a single cable vault. Cable entry shall be directly adjacent to and terminate at a building entrance block with protectors adequately rated for each utilized conductor. **9.** All fiber optic Ccables running in cable tray shall be protected by corrugatedsplit innerducts. Indoor/Outdoor rated armored fiber optic cables are required for all Metro projects.Non-ruggedized fiber optical cable shall be inside the innerduct in cable tray. Outdoor ruggedized cables are required to use for outside plant. **10.** Innerducts shall be corrugated, 1-1/4" nominal ID, orange in color. The innerduct shall be rated appropriately for the location of installation e.g. outdoor, riser or plenum rated. Pull rope shall be installed in every innerduct. Install maximum number of innerducts up to 70% filled in a conduit. **11.** Software for systems shall be an integration of commercially available off-the-shelf (COTS) products. Custom software development shall only be considered where there exist no available COTS solution is available and shall be approved by Metro.													

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3099	Prescriptive Spec	A12	**12.** Each station shall have an interface to the local telephone carrier. The interface includes the 2"two 4" GRS conduits (one for spare) and pull ropes conduits from a designated location e.g. telephone pole or manhole to the station minimum point of entry (MPOE). There mustshall be a 2 4" conduit (GRS) and one 5025-pair cable from the MPOE to the location where the communications equipment is located e.g. TC&C Room. The 5025-pair cable shall be terminated on the 66M Blocks at both ends.													
3100		B	Electromagnetic Compatibility													
3101	Performance Criteria	B1	Electromagnetic compatibility (EMC) control shall insure that all Communications subsystems operate in their intended electromagnetic environments without either causing or suffering harmful interference because of electromagnetic emission or response. A primary objective shall be to develop signal levels, apparatus, components, and installation parameters to assure an electromagnetically compatible system. This objective shall be achieved through coordination of Communications system apparatus selection, design and installation with other electromagnetic equipment, such as the communication equipment (radio, CCTV, etc.), traction power system, AC power distribution system, vehicle propulsion apparatus, train control system, and other nearby facilities. The approach to implementation of EMC shall include control of: **a.** Conductively coupled interference **b.** Interference coupled through common impedance **c.** Interference coupled through radiated electric fields **d.** Interference coupled through radiated magnetic fields.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3102	Performance Criteria	B2	The control of electromagnetic interference shall employ, but not be limited to, the following methods: **a.** Shielding **b.** Grounding **c.** Balancing **d.** Filtering **e.** Isolation **f.** Separation and orientation **g.** Circuit impedance level control **h.** Cable design **i.** Frequency management **j.** Power level	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3103	Performance Criteria	C	Grounding	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3104	Performance Criteria	C1	Safety and Facilities Grounding	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3105	Performance Criteria	C1	Ground electrical equipment enclosures in accordance with NFPA 70 requirements and to achieve a maximum of 5 ohms to earth resistance. Per the requirement of Art. 645 in the NEC the grounding of communications equipment shall be completed in accordance with Art .250. When grounding communication equipment shall consider proper operation as well as safety from electric shock. Communications equipment shall comply with the NEC and all other safety requirements. Equipment shall be grounded as shown in Figure 9.5.1 and ground loops shall be avoided. Radial grounding shall be implemented. Each piece of equipment shall be fed separately and radially from the source and grounded by means of metallic raceway, a green-wire ground, or any other grounding conductor to a single communication equipment ground point, noted as "G" in the diagram, at the source or distribution point. In situation where the communications facility is co-located or relatively nearby a high voltage facility e.g. Traction Power Substation (TPSS) and the facilities are linked directly via metal conduits, cable sheaths, phone lines, utility feeders etc., designer shall follow IEEE Standard 80-2000. Follow Motorola R56 Standards for the grounding system for communications equipment and facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3106	Performance Criteria	C1	NOTE: Cabinets and racks shall be electrically insulated from floor, mounting channels, cabinets, racks, cable trays and the building structures. Each cabinet shall be provided with a ground terminal and connected to a common ground system. Interdependent cabinets and racks may be mechanically and electrically connected to facilitate interconnect wiring. **a.** Each cabinet and rack shall contain a hard drawn copper bus bar, 1 in. by 1/8 in., running the width of the cabinet or rack, having a conductivity of 98 percent of the International Annealed Copper Standard. **b.** Minimum No. 4/0 AWG insulated, soft-drawn, stranded copper wire shall connect the cabinet or rack bus bar to a copper bus bar, which shall be extended over all cabinets and racks in each lineup. This bus bar shall be bare No. 4/0 AWG or equivalent copper bar. **c.** The ground bar for the main distribution frame shall span the length of the frame and shall be a bare No. 4/0 AWG copper wire or a copper bar equivalent. **d.** Cabinet and equipment grounding shall conform to NFPA 70, Section 250, as a minimum. **e.** Cabinet and equipment grounding shall conform to requirements of Single Point Grounded System.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3107	Performance Criteria	C2	High Performance Ground The designer shall be responsible for including a separate high performance communications ground as required for proper and noise free operation of systems. Performance ground shall achieve a maximum of 5 ohms to earth resistance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3108	Prescriptive Spec	D	Underplatform Duct Banks **1.** General **a.** The Underplatform Duct Bank will consist of the following elements: **1)** Embedded conduits in concrete duct banks to the Cable Turning Room (CTR). Pulling irons are required in every CTR. One group of conduits comes from each duct bank of embedded conduits to a common CTR for underground stations. **2)** Conduits in the platform from the CTR to both the TC&C room and the CTR at the opposite end of the station. **2.** All conduits shall be embedded in concrete duct banks. Two conduits, one from each duct bank to the CTR and then to the TC&C room shall be GRS. All others may be PVC. Spacers are required for PVC duct banks at 6-1/2 feet in longitudinal spacing. **3.** Duct banks extending the length of the platform shall be uninterrupted and as straight as possible, bends shall be gradual sweeps (factory sweeps) and shall not exceed 180 degrees of bend, for the entire length of the cable run. **4.** Conduits from the guideway cable troughs to the CTR or TC&C rooms shall be uninterrupted and as straight as possible, bends shall be gradual sweeps (factory sweeps) and shall not exceed 180 degrees of bend, for the entire length of this cable run. **5.** Exposed cable trays shall include protective metal covers. Use of exposed trays shall be minimized.													
3109	Prescriptive Spec	E	Station Conduit Routing Subsystem devices of the same system within a station area shall be grouped and routed to an Area-Junction Box. From this Area-Junction Box, all wires of that subsystem will share an adequately sized common conduit for wire routing to the designated Communications Interface Cabinet (CIC). **1.** Conduit routing of subsystem devices shall be configured as to reduce the quantities of single conduits runs from devices to a CIC or to the TC&C room. **2.** Subsystem Devices located in close proximity to the TC&C room may be grouped and routed directly into the TC&C room. If these conduits enter the TC&C room from overhead, they shall be located 11'-6" above the finished floor or 6" above the room cable tray. **3.** Conduit routing shall be configured to provide the routing path with the fewest changes of direction.													
3110	Prescriptive Spec	F1-3	Radio Antenna Sleeves and Conduit (For Subway Use) Radio Antenna Sleeves consist of one and one-half inch (1-1/2") inner diameternonmetallic sleeves through walls. These sleeves shall be utilized for routing of leaky coax (radio antenna) cables, which are part of the distributed radio antenna system. **1.** Sleeves shall be provided through walls, into all rooms or areas accessible to the general public, and LRT and HRT operating or maintenance personnel. Wherever penetrations are made for running Communications conduits shall be sealed properly to make it water proof and fire proof. **2.** Sleeves shall be located as far above the finished floor as practical without causing the antenna to interfere with any equipment on either side of the wall. 3. Four (4) two inch (2") GRS conduits from the TC&C room to each trackway shall be provided, total of eight (8) conduits. When the TC&C room is located on other than the platform level, these four conduits shall extend to the outside of the trainway.													
3111	Performance Criteria	F4-5	**4.** Two inch (2") sleeves shall be placed vertically from the TC&C room through the ceiling to above grade to accommodate antenna cable for off air interfaces. At least two spare sleeves shall be provided. **5.** For those locations requiring off-air repeaters for Radio Services, required size GRS conduit shall be provided between the TC&C Room and each surface antenna location. Routing shall be determined on a site-by-site basis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3112	Prescriptive Spec	H	Closed Circuit Television Conduits Conduits used to housefor the cabling for the Closed Circuit Television (CCTV)cameras shall be GRS, minimum of 1", and maximum filled of 40%. Conduits shall be routed directly from the junction boxes to the TC&C room and/or CIC.													

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3113	Performance Criteria	I	Fire and Emergency Management Conduits Fire and Emergency Management Conduits shall be embedded GRS conduit for various types of detectors, sound powered telephones and emergency annunciation cabinets/panels. **1.** Embedded or concealed GRS conduits shall be provided from all fire system detector junction boxes to the appropriate CIC or to the TC&C room. Conduits shall be a minimum of one inch (1"). No other types of circuits may be shared in a fire system conduit. **2.** Junction boxes for detectors shall be embedded and located nine feet above finished floor in a wall. (The Systems Contractor will extend the circuit via surface mounted conduit to the ultimate detector location). **3.** 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. **4.** The Auxiliary EMP (Subway System only) shall be provided with two (2) two inch (2") conduits which shall run directly from the CP to the TC&C room.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.5.3	TUNNEL CONDUIT/TRAY ROUTING													
3114	Performance Criteria		Subsystem devices of the same system within tunnel area shall be grouped and routed to an Area-Junction Box. From this Area-Junction Box, all wires of that subsystem will share an adequately sized common conduit or tray, for wire routing to the designated Communications Interface Cabinet (CIC).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3115	Performance Criteria	1	Conduit or tray routing of subsystem devices shall be configured as to reduce the quantities of single conduits or tray runs from devices to a Communications Interface Cabinet (CIC) or to the station or tunnel area TC&C room. The designer shall submit tray loading calculations (CDRL).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3116	Performance Criteria	2	Subsystem devices located in close proximity to the station or tunnel TC&C room may be grouped and routed directly into the TC&C room. If these conduits enter the TC&C room from overhead, they shall be located 11'-6" above the finished floor or 6" above the room cable tray.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3117	Performance Criteria	3	Conduit or tray routing shall be configured to provide the routing path with the fewest changes of direction. Conduit routing shall meet NFPA 130 for emergency circuits.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3118	Performance Criteria	4	Subsystem devices, conduits, trays, distributed antenna cables and other fire/live safety communication installations CANNOT be mounted in the proximity or the train dynamic envelope and passenger emergency egress, such as safety walks and emergency exits. For example, subsystem devices, conduits, trays, distributed antenna cables and other fire/live safety communication installations cannot be mounted anywhere directly above the LRV pantograph.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3119	Performance Criteria	5	Subsystem devices, conduits, trays, distributed antenna cables and other fire/live safety communication installations shall be not conflict with other tunnel installations and shall not come closer than 6 inches to the vehicle dynamic outline at any point in the tunnels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.5.4	COMMUNICATIONS POWER SYSTEM													
3120	Performance Criteria		All stationery systems equipment shall be powered from stationary battery/rectifier or UPS plants, as applicable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3121	Performance Criteria	A	Batteries Batteries in TC&C (C&S), yards and ROC battery rooms shall be gel sealed batteries, non outgassing storage type of long-duration/low-rate.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3122	Performance Criteria	B	Rectifiers Rectifiers shall be dual and load-sharing, with each rectifier capable of supplying full equipment load while recharging a fully discharged battery.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3123	Performance Criteria	C	Battery Racks Battery racks shall be not larger than two-tier configuration, and shall be constructed with seismic bracing in accordance with the CBC Requirement for Seismic Zone Four.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3124	Performance Criteria	D	Voltages Battery/rectifier plant voltages shall be as follows: Battery voltages for communications equipment shall be compatible with the equipment requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3125	Performance Criteria	E	Sizing Battery sizing shall provide full load for a minimum 4 hours of main AC power outage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3126	Performance Criteria	F	Recharge Time The recharge time of a battery plant shall not be greater than four times the discharge time period, e.g., discharge 4 hours, recharge 16 hours.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3127	Performance Criteria		Refer to Electrical Section 7.10.13 for additional requirements to supplement the criteria listed herein for Uninterruptible Power Supply (UPS) design requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.5.5	INTERMEDIATE DISTRIBUTION FRAME (IDF) AND COMMUNICATIONS INTERFACE CABINET (CIC)													

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3128	Prescriptive Spec	A	Within a station or yard, IDF shall be used to house communications equipment. **1.** Minimum size of IDF shall be 8'x10' room to accommodate a minimum of three rack spaces of 27"x27"x72" (LxWxH). **2.** The controlled temperature in the IDF shall be at 75 degrees Fahrenheit with full rack occupancy. The capacity of the HVAC shall include the 40% provision for future expansion. **3.** The IDF shall be connected to the Main Distribution Frame (MDF) or Main Communications Room that is usually located at the TC&C or C&S Room via 48-strand SM fiber optic cable.													
3129	Performance Criteria	B	At the cross-passages and uncontrolled environments	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3130	Prescriptive Spec	B1	For wall-mounting application, the communications equipment shall be installed in the CIC with the followings requirements: **a.** The CIC shall be made of 304 stainless steel, rated Nema 3X with dual fan ventilation. **b.** The minimum dimensions of the CIC shall be 24"x20"x48" (WxDxH) **c.** Service LED lighting and 120 VAC, 15A convenient outlets													
3131	Prescriptive Spec	B2	For floor-mounting application, the communications equipment shall be installed in the CIC with the followings requirements: **a.** The CIC shall be made of 0.125" Alumiflex rated Nema 4X **b.** Removable front and back door with louvers and removable filter panels **c.** Dual fan thermostatic controlled **d.** Dimensions are 46.25"x25.5"x30" (HxWxD) **e.** 12" base pedestal **f.** Service LED lighting and 120 VAC, 15A convenient outlets													
3132	Performance Criteria	B3	The CICs shall be connected to the the Main Distribution Frame (MDF) or Main Communications Room that is usually located at the TC&C or C&S Room via 24-strand SM fiber optic cable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.6	**RADIO SYSTEM**													
		9.6.1	GENERAL													
3133	Performance Criteria	1-3	**1.** The radio system shall provide the primary medium for voice transmission between the ROC, Yard*, maintenance facilities, wayside and rail line passenger vehicles along the alignments. * The Yard and Maintenance Facilities channel is for train yards use and is not required at stations. The train mobile radio, however, shall be capable of operating on the yard frequency. Yard maintenance and rail operation channels shall have radio coverage in the shop building and office areas. **2.** The radio system shall also provide facilities to support emergency response, e.g., fire, law enforcement agency, police agency, or security, etc., for all sections of each rail system. **3.** 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.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3134	Performance Criteria	4-6	**4.** 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. **5.** The radio system shall support subscriber vote scanning to optimize radio service connections. Repeater system based receive voting and multi-cast transmitting shall be used to optimize uplink and downlink signal communications across the strongest signal available. **6. a.** Digital Metro VHF and UHF Base Station and Repeater System equipment shall be compliant with TASC monitoring system including alarm monitoring and event notification for message status and alerts to the ROC. **b.** The TASC network monitoring system hardware and software both in remote locations and central locations shall be upgraded to accommodate any added rail project Metro radio channel requirements or warranted system enhancements to validate complete system operation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3135	Performance Criteria	7	Radio Coverage Radio coverage shall be based on talk-back originating from portable and vehicle radios in the underground sections and along the at-grade and aerial above-ground sections of the rail systems. For the purpose of coverage calculation, the underground and above-ground sections shall be considered separately. Talk-back coverage from rail vehicles and talk-out coverage to portable and rail vehicle radios shall be not less than talk-back coverage from portable radios. An RF signal coverage test shall be conducted to demonstrate that the radio system meets the requirements. Calculations shall include the affect of body shielding and in-train-cab shielding. Use IEEE and industry's acceptable values for the shielding factor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3136	Prescriptive Spec	8	System Assurance Program For the Radio System Equipment, the following required Reliability (minimum MTBF) and Maintainability (maximum MTTR) values in hours are established per each typical unit equipment set: **a.** Base Station Radio Assembly MTBF (HRS) – 25,000 MTTR (HRS) – 1.0 **b.** Channelized Repeater Amplifiers Assembly MTBF (HRS) – 50,000 (RF only), 40,000 (fiber-fed) MTTR (HRS) – 1.0 **c.** Amplifiers Assembly MTBF (HRS) - >100,000 (RF only) MTBF (HRS) - >70,000 (fiber-fed) MTTR (HRS) – 1.0 All system, sub-systems, components, and parts shall be designed such that no single failure shall cause an unsafe condition. This requirement shall apply for all phases of the design, including in-service support, warranty, retrofit, and field modifications. The designer shall establish and maintain an effective reliability program throughout the design, manufacturing, installation, testing, and operations activity.													
3137	Performance Criteria	9-12	**9.** The failure of any active component within or supporting the radio system shall not cause the loss of radio on more than one band. **10.** No single point of failures shall be allowed within the radio system architecture. **11.** Ethernet to 4-wire converters shall be provided for analog radio components. **12.** All new radio systems shall be equipped with manufacturer specific network management system hardware and software for remote access and reporting.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3138	Performance Criteria	13-15	**13.** Radio Recorder/Playback Unit: A dedicated computer with specialized application software shall be used for the radio channels and talk group telephone lines audio recording and the instant recall/playback of all recorded activities. Existing ROC radio system audio IP logger/recorder equipment shall require both hardware and software upgrades to accommodate any newly added rail project Metro radio channels **14.** Network controlled DC power distribution panel shall be provided for Metro VHF and UHF base station systems. **15.** Existing ROC radio network management systems (NMS) shall require both hardware and software upgrades to accommodate the integration of any newly added radio equipment infrastructure applicable to the existing NMS platforms.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.6.2	UNDERGROUND AND TUNNEL RADIO SYSTEMS													
3139	Performance Criteria	A	General	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3140	Performance Criteria	A1	The radio system is a mission-critical communications system and shall be protected at all times. A fault-tolerate deployment architecture shall be designed with fiber diversity, redundancy and automatic fail-over capabilities. Multiple radio equipment head-ends configured as primary and hot-standby site shall provide system redundancy, location diversity, resiliency to failure and signal coverage requirements. The radio subsystem shall encompass the ROC, wayside, passenger station, passenger vehicle, Yard, mobile and portable equipment. The radio subsystem shall provide two-way radio communications over channels in the 160 MHz band for Rail Operations and Maintenance, and channels in the 450/460 MHZ band for Transit Police. When underground facilities are located within City of Los Angeles jurisdiction, channels shall be provided in the 460/500/700 MHZ band for the Los Angeles Police Department (LAPD), Los Angeles County Sheriff Department (LASD) and Mutual Aid Channel(s), and in the 800 MHz band for the Los Angeles City Fire Department (LAFD). When underground facilities are located outside City of Los Angeles jurisdiction, channels shall be assigned and provided as required by local jurisdiction. Note that channels from local jurisdiction could be expanded into the City of Los Angeles or vice versa. Each new project shall have project specific number of radio channels and its frequencies as required by the end users. Designer shall be responsible to coordinate with all related 3rd parties and finalize the number of radio channels, frequencies, and compatibility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3141	Performance Criteria	A1	Limited radio channels shall be permitted to enter the underground stations and tunnel area to reduce the possible intermodulation generation. Intermodulation studies for frequencies are to be included in the radio system design. Within segments of the radio system, each identical function shall be performed by interchangeable units. In no case shall the equipment or hardware used in one portion of the radio system be different from that used in another portion to perform the same function under identical operating and environmental conditions. Design of equipment performing like functions shall be standardized.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3142	Performance Criteria	A2	Equipment Accessibility **a.** The design shall insure the proper size of self retaining fasteners for cable and surface wiring. Latch hold open devices shall be provided when applicable. The shelf and cabinet mounted equipment shall be easily accessible by maintenance personnel. **b.** Human factors insuring changeability and accessibility shall be provided in accordance with MIL-STD-1472.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3143	Performance Criteria	A3	Equipment Arrangement Normal testing shall not require disassembly of the equipment under test or of any other equipment. The design shall include test panels to provide access to monitor uplink and downlink signals without causing disruption to the circuit. Equipment arranged in cabinets shall be designed for air cooling, such that no modules/assemblies shall operate with surface temperatures in excess of manufacturers' recommendations or 110 degrees F, whichever is lower. Fans or air condition units shall be provided in cabinets where necessary to meet this requirement. Crosspassage radio equipment shall be mounted in secured RF bulkhead cabinets that is secured to the floor. No wall-mounted radio equipment is allowed. Radio equipment, UPS battery back-up equipment, and equipment enclosures installed at the cross passages shall be designed to withstand the extreme conditions that are prevalent within these locations. Heat, moisture, humidity, and wind tunnel effect must be accounted for in the design of the equipment to maximize system longevity. These requirements shall supersede those specified in Section 9.5.5.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3144	Performance Criteria	A4	Wiring Wires distributing AC and DC power shall be continuous from the power distribution point to the equipment power input terminals. Power feeds to equipment cabinets shall be in conduits. Terminations and associated identifications shall be installed permanently to maintain their original positions. Terminations shall be sealed to prevent moisture penetration into cables. Where necessary, cables shall be supported or secured to prevent the transfer of damaging mechanical stresses to terminations, equipment or structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3145	Performance Criteria	A5	System Configuration:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3146	Performance Criteria	A5a	Frequency Allocation: The radio system equipment design and configuration shall be such that any present or potential transmitter intermodulation will not cause interference on other radio channels in the system. During different design stages and during testing a detail description of design measures and equipment shall show the mitigation of harmful intermodulation product frequencies from causing radio interference. Each Project shall perform intermodulation study to determine the compatibility and constructability of the proposed frequencies. An RF signal intermodulation test shall be conducted to demonstrate that the radio system meets the requirements stated above.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3147	Performance Criteria	A5b	Radio System Operation: All underground Metro channels and Transit Police Channels shall be operated from base station repeaters linked back to and controlled by equipment in the ROC. As an option, Transit Police Channels may be used with off-air head-end equipment pending approval from Metro. The system shall employ built-in voting function, so an external voter device is not required. In that the voting equipment at ROC will select the signal from the base station receiving the strongest transmission from portable, or train radio and retransmit this signal over all base stations in the underground portion of the system. The operators at ROC transmit over all base stations when they wish to make transmission. Mobile/portable radio shall provide multicast voting function for downlink communications.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3148	Performance Criteria	A5c	Equipment Compatibility: The equipment to be installed in all segments must be operationally compatible with the equipment Metro installed. It should be noted that the existing equipment may not interface with another manufacturer's equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3149	Performance Criteria	A5d	Underground Antenna System Configuration: The underground antenna system shall consist of distributed antennas, radiating coaxial cables, fiber optic cables or combination of technologies (to be approved by Metro) designed to meet the performance level for the environment in which they will be utilized. Dual antenna system, one for receiving, one for transmitting shall be used to extend reception and transmission of radio signals in the underground areas. The selection of antenna technologies shall be part of the intermodulation, power budget, coverage and architectural design. The radio system shall be design to meet the coverage requirements. Low profile free space antennas are preferred in stations passenger areas where aesthetic considerations and/or design criteria warrant their use. If radiating coaxial cables are used in passenger areas, they shall be concealed by a cover. The cover shall match the color of the wall or have a decorative stripe. Signal loss caused by these covers, if used, shall be considered in the power budget computations. Radiating coaxial cables shall be used throughout the train tunnels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3150	Performance Criteria	A5d	Underground, below ground, and tunnel location distributed antenna system (DAS) shall consist of one uplink radiating cable and one downlink radiating cable. The uplink and downlink radiating cables within tunnel and station shall maintain a minimum 9 feet separation. Wherever the antenna system design calls for active devices such as amplifiers, within the tunnels, these devices shall be installed in tunnel cross passages or other areas that during maintenance will not cause train movement interruption. If the radio signal level within a cross passage with no radio equipment installed is equal or greater than -92.8 dBm for all bands, the radiating cables are not needed at that cross passage. This is an effort to avoid the splitting of the main tunnel cable trunks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3151	Performance Criteria	A5d	High quality active devices (amplifiers, etc.) and passive devices/ components (splitter, couplers, connectors, etc.) shall be provided throughout to insure intermodulation products are minimized. At no point in the antenna system shall the ratio of overall desired signal carrier to undesired intermodulation products be less than 43+10logPc (Pc=Watts Carrier). It is recognized that use of lower loss cables may affect the quantity, types and/or spacing of signal booster devices (amplifiers) required to meet the performance specifications of radio coverage and intermodulation products in the tunnels. A continuous cable route, with a minimum number of splitters/dividers is preferred. If the antenna cables must be split to cover a specific area, the splitters shall be installed above the false ceiling, or where there is no false ceiling, concealed by a suitable aesthetic cover. The antenna system shall not have physical and electrical characteristics altered by exposure to ambient conditions. Cable splices/connections shall be made only with suitable connectors that ensure a sound mechanical and electrical connection. Connectors with precious metal (gold) center pin conductors shall be used to ensure low loss at connections. Connector shells shall be stainless steel or other non-ferrous material. The cables shall be supported by noncorrosive supports at designated support points. The base station receive antenna cable shall be on the tunnel side wall mounted to unistruts / anchors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3152	Performance Criteria	A5d	At the end of each transmitting antenna cable span, the cable shall be routed down the side wall of the tunnel to a point approximate five (5) feet above the walkway level. A cable termination device and sampling port shall be installed at this point. As approved by Metro, Ffree space antennas may be used in lieu of radiating coaxial cable to provide communications within passenger stations. This is to include the platform, mezzanine, corridors, fire exits, and other areas of the passenger station. The antenna(s) must be capable of transmitting and receiving 160 MHZ, 450/500 MHz, 700 MHz Public Safety Band, and 800 MHz frequency bands for Maintenance Personnel, Operations, Transit Police, LASD, LAPD, Mutual Aid Channel(s), LAFD (or other first responders in local jurisdiction) services, and others as required by the specific Project. Free space antennas that replace the radiating cable shall be concealed by aesthetically pleasing covers. The covers shall have minimum RF signal loss. Any cover loss shall be considered in the power budget computations. The underground ground radio system block diagram is shown in Figure 9.6.1.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3153	Performance Criteria	A5d	All coaxial cables and fiber optic cables are plenum rated, with low smoke, low fume, non-halogen producing outer jackets. Radiating cables in tunnels are supported on standoffs, which support the cables approximately 3 inches from the tunnel walls. Standoffs are installed along the entire length of the tunnels at intervals based on manufacturer's specifications for the particular cable type and size as required by manufacturer for tunnel environment. Anchors and fastener are provided in tunnel walls, station walls/ceilings and other areas as required for mounting antenna cables and associated radio antenna hardware. Anchors, fastener, mounting studs and other mounting hardware shall use stainless steel or high temperature heat resistant material. Radio cable and hanger systems shall comply with the latest NFPA-130 standard for total smoke release and low toxicity. The design plans including loading calculations for tunnel cable mounting system shall be signed and sealed by a California licensed Structural Engineer. There shall be two RF splitter/divider cabinets at each station location. One cabinet shall be dedicated for radio cabling at the tunnel side and one for the radio cabling at the station side.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3154	Performance Criteria	A6	Coverage requirements:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3155	Performance Criteria	A6a-c	**a.** The voice signal quality shall be not less than CM-4 or DAQ 3.4 with a coverage requirement of 10098% probability of communications along 100% of the tunnel, emergency exits and public areas locations. The radio signal quality shall be 18 dB SINAD or better. At station entrances, emergency exits, and portal areas, 95% probability of communications at 95% area coverage are required. **b.** The voice signal quality shall be not less than CM-4 or DAQ 3.4 with a 95% coverage probability at 100% of auxiliary locations such as equipment rooms. The radio signal quality shall be 18 dB SINAD or better. **c.** This 95% requirement cannot be met by averaging coverage over the system; i.e., one station with 90% and the next with 100%. Each station or area of the station shall stand alone as an entity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3156	Performance Criteria	A6d	RF Power Budget The design shall be based on power budget computations based on the equipment and final design being proposed. The RF power budget shall be analyzed for the frequencies bands. All computations are outbound or downlink from the radio head-end equipment location to a portable or mobile radio unit in the tunnel as well as inbound or uplink traffic from a portable or mobile unit in the tunnel to the radio head-end equipment. RF amplifier requirements shall be determined from the power budget analysis. Templates for power budget calculations are provided in Appendix C at the end of this section. Parameters shown in template are minimum required parameters to be used in power budget analysis. An RF signal coverage test, shall be conducted to demonstrate that the radio system meets the requirements stated above.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3157	Performance Criteria	A6e-g	**e.** Test Transmitters Sets of Test Transmitters, compatible with remote control equipment already installed at the first responder authority's dispatch center and center control desk shall be part of the radio system. Test transceivers shall be end-to end native Ethernet based and compatible with the DFSI (Digital Fixed Station Interface) standard. **f.** Maximum test points shall include the location at 100 feet distance at any evacuation or maintenance walking surface area and in the train. **g.** The Contractor's design shall be such that the minimum margin calculations shown in the power budget template provided in Appendix C shall not be less than 10 dB throughout of the entire system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3158	Performance Criteria	A6h-j	**h.** The Contractor shall provide as part of the deliverables the predicted coverage maps of the radio system for Metro to review and approve at 60% design timeline. prior to the completion of the design. In order to ensure proper uplink and downlink coverage as well as predictive Time Delay Analysis (TDI) off-air coverage, testing shall be performed at all head-end antenna sites, portals, open trenches, station entrances and emergency exits. TDI computer simulation data shall be submitted as a reference. Using both the coverage test results and simulation data TDI areas shall be designated and proper TDI mitigation measures shall be employed to limit or negate any coverage issues. **i.** Contractor shall provide NXDN Bit Error Rate (BER) field testing coverage mapping after the field testing. **j.** All downlink and uplink signal levels at any location within the below ground radio system shall be greater than -92.8dBm and minimum of DAQ 3.4 or better. Uplink signal shall be measured at the head-end uplink input cable to the cross band coupler. Downlink signal shall be measured at the test radio and/or spectrum analyzer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3159	Performance Criteria	B	Functional Requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3160	Performance Criteria	B1	The radio system for operations and maintenance shall operate on 160 MHZ triplex radio channels where there are two (2) different downlink radio channels with one (1) uplink radio channel per associated triplex radio channel. Also, 450/460 MHZ duplex voice analog channels with narrow band 12.5 KHz shall be provided for transit police security. Radio transmitting and receiving equipment shall be provided at all passenger stations where required, and in crosspassages between stations if necessary. Base station radios shall provide services for the Operation and Maintenance of the transit system, and Transit Police channels. As an option, these channels may be used off-air radio equipment pending Metro's approval. The base station sites for LAPD and LAFD or other first responders in local jurisdiction shall be based on the Single Carrier Amplifier (SCA).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3161	Performance Criteria	B1	Fiber-fed amplifiers implemented in a star or radial topology from the radio head end to separate array of amplifiers for each tunnel via dedicated single mode fiber cables. This applies as well to stations that house BDA's. In underground areas where there is only one tunnel area, redundant amplifiers are needed to provide backup if the primary units should fail. Cross passages, remote tunnel or underground areas, and stations shall be supplied with a full set of band specific uplink and downlink radio amplifiers for each tunnel bore or underground track way Metro passenger station RF signal distribution shall be evenly split between the independent amplifier sets to prevent full station signal loss in the event of an amplifier failure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3162	Performance Criteria	B2	Radio communications between mobile and portable radios shall be possible through base stations. Below ground communications shall be via a distributed antenna system (radiating cables/free space antennas). Base station transmissions shall be broadcasted simultaneously at all base station locations to enable users on the voice channels throughout the system to hear all control center, train, and portable radio transmissions on their respective channels. The above ground antennas shall be installed at a height to provide the required signal propagation and reduce any possibility of vandalism. Antenna site tower structures shall be located in secure fenced or walled locations. Those antennas shall provide signal strength to ensure reception of radio signal from distant transmitters and receivers to achieve the required coverage requirements. Off-air pickup/donor antenna sites shall be engineered to provide viable RF links to both primary and backup Metro and Public Safety donor sites. In addition, the antennas must be covered with an aesthetic covering that fits into the décor of the station. Contractor shall secure all pertinent permits, studies, and licenses required to construct the antenna tower structure(s).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3163	Performance Criteria	B2	Base stations, uni-directional amplifiers, bi-directional amplifiers (fiber-fed and coaxial-fed) and SCAs shall be solid state devices rated for full continuous duty and shall meet or exceed the requirements of all applicable EIA and FCC standards. The base stations, uni-directional amplifiers, bi-directional amplifiers and SCAs will include, but not be limited to, transmitters, receivers, power supplies, control circuitry, service and maintenance test panels, and intercom modules. Base stations, SCAs, uni-directional amplifiers, bi-directional amplifiers and associated equipment at the TC&C room, and other locations that require environmental control, shall be mounted in suitable enclosed cabinets. The base stations shall include meters for monitoring transmitter and receiver performance. Meters and the associated function switches shall be contained within the equipment cabinet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3164	Standard Criteria	B2	Separate, self-contained base station shall be installed for the Metro Rail Operation and Maintenance, and Transit Police channels. Table 9.6.1 below shows minimum technical requirements for base station repeaters. The SCA shall be single channel assembly type with the minimum technical requirement stated in Table 9.6.2. The Fiber Fed BiDirectional Amplifier (FFBDA) requirements are listed in Table 9.6.3.The SCAs shall be Class A narrowband amplifiers and the uni-directional amplifiers, bi-directional amplifiers shall be Class B broadband. All radio equipment shall have Ethernet/LAN interface for remote programming and monitoring.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3165	Standard Criteria	B2	The Single Carrier Amplifiers (SCAs) provided for interfacing and repeating LAPD, LAFD, or other local jurisdiction's radio service underground shall employ hi-gain antennas (one for 460/500 MHZ and one for 800 MHz). The design for these services shall be based on receiving on off-air signal strengths of -50 to -89 dBm at the antennas locations. The same requirements shall be applied to the 700 MHz radio frequency band. The SCAs shall be equipped for remote ON-OFF Control via the SCADA system. Return path transmissions from LAPD/LAFD (or other first responders in local jurisdiction) portable radios in underground stations/tunnels shall be transmitted via the underground antenna system SCAs, uni-directional and bi-directional amplifiers for subsequent retransmitting via above ground antennas. These SCAs and antenna gains should be set so that the effective radiated power shall be approximately +37 dBm for LAPD channels, +34.8 dBm for LAFD channels. Narrow band RF unidirectional amplifiers shall be used in the tunnels and stations as required to meet the coverage requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3166	Performance Criteria	B2	Crossband couplers/filters shall be required at the amplifier locations. The indicated crosspassages will have AC power to power amplifiers (or SCAs, where used in lieu of amplifiers). Four hours backup battery power supplies and charges for the amplifiers/SCAs shall be part of the system. The Base Stations, SCAs, uni-directional and bi-directional amplifiers shall have summary alarms to indicate a failure. The summary alarm shall be routed to the TRACS system for reporting to the ROC. Parameters to be monitored and controlled include: - An alarm for the transmit and receive voice audio lines for each radio base station. - A summary alarm for each LAPD and each LAFD off-air repeater or other first responders in local jurisdiction. - An alarm for each RF amplifier. - Crosspassage backup power system alarms. - SCAs, and uni-directional and bi-directional amplifiers ON-OFF Controls.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3167	Performance Criteria	B3	All radio equipment supplied shall be the 160 MHz very narrow band (6.25 KHz) for Metro Operation and Maintenance, and 450/460 MHz analog narrow band (12.5 KHz) for Metro Transit Policey radio system. **a.** Mainline Operations Six (6) triplex channels (Talk-out) shall provide the normal operations radio links for the wayside. **b.** Transit Police Three (3) duplex analog channels with narrow band 12.5 KHz (Talk-out) shall provide the transit police radio links for the wayside. **c.** Channel control shall be provided in the Train Dispatch, Communications, and Supervisors Consoles. All personal portable radio and mobile radio units shall be equipped to communicate over these channels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3168	Performance Criteria	B4	All radio equipment shall support following calling features in digital conventional mode operationally and functionally compatible with Metro's existing very narrow band (6.25 KHz) Digital Rail Radio System that operates in the 160 MHz frequency band.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3169	Performance Criteria	B4a-c	**a.** Selective call, group call and talk group ID The radio system shall allow to call individual or group users. The radios shall automatically send their own ID number when the PTT button is held down. The radios shall memorize minimum 500 of both individual/group ID numbers and alias names in the table. The alias name or individual/group ID is displayed on the LCD while receiving a message allowing user to identify who is calling. **b.** Talk back function and call mode selection When the talk back function is enabled, the radio shall automatically select the received talking group or individual ID to reply to the received call, while the talk back timer remains. After the talk back timer is exceeded, the radios shall set to an initial call mode depending on programming which is either talking group or individual call or retain the previous user call mode selection. **c.** Digital voice scrambler When secure communication is required, the radio system shall provide a digital voice scrambler using a 15-bit key (about 32,000 codes) as standard. This shall be added security to the digital modulation/demodulation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3170	Performance Criteria	B4d-f	**d.** Emergency call functions When the emergency button is pushed an emergency signal shall be automatically sent to the dispatcher or another radio. Other emergency features are a man down feature and a lone worker function. A remote radio monitor function shall allow the dispatcher to turn on the PTT button from a remote location and transmit anything the microphone hears for a preprogrammed time period. **e.** Status message The radio system shall allow a set up to 100 conditions such as "on duty", "at lunch" or "in route". This message shall be sent each time the PTT button is pushed until the status message feature is turned off. Also, the user shall be able to request another unit to send their status and receive it. **f.** GPS position reporting When the radio is used with built-in GPS capability for the handheld radio or an external, third-party GPS for the mobile radio, the user shall be able to transmit current position information to another radio or the dispatch. Three different sending intervals can be programmable: on PTT; when polled; or at periodic times. When connected to a PC that has mapping software installed, the dispatch shall know the activity of the fleet members (when radio last sent position or when it was polled).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3171	Performance Criteria	B4g-i	**g.** Radio shut off, stun and revive The radio shut off function disables a lost or stolen radio over the air, eliminating security threats from undesired listeners. When the radio stun command is received, all functions shall be temporary locked out until the revive command is received or the user password is entered. The radio shall also send radio stun, kill and revive commands. **h.** RAN (Radio Access Number) for digital code squelch The RAN (Radio Access Number) code is the digital equivalent of CTCSS for accessing a radio repeater or digital squelch function. **i.** Short Data Message capability Radio shall be able to send and receive short data messages of up to 12 characters between the radios or from the remote communicator.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3172	Performance Criteria	B4j	Other features Radio check function shall allow to verify if another radio is within communication range Call log displays the received call history Call alert function notifies receiving party that a call is coming with a beep sound and blinking icon Base station operation for repeater Late entry: the radio shall decode the received ID and show group ID, unit ID or alias name on the display even when turned on during a conversation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3173	Performance Criteria	B5	IDAS Multi-Site Conventional (Voting) for Metro Operation & Maintenance Radio System IDAS Multi-Site Convention Blue (Voting) is a method of providing single group wide area coverage with a focus on optimal subscriber reception by the system. Combined with subscriber "Vote Scan" IDAS Blue can be a complete replacement for legacy simulcast system. It offers seamless coverage and no need for the subscriber equipment operator to "change channels" regardless of location. IDAS Blue can be offered with essentially unlimited number of system receivers and more system transmitters. In either configuration, when initiating a call, the subscriber unit will transmit on the common RX frequency, shared by all the receive sites on the network. One or many of the sites may receive this transmission. These receive signals are transported, via the IP network as packets, to the IDAS voting comparator (which is a standard FR5000 configured as a voting unit). This card determines the best received signal via the RSSI information contained in the IDAS packets.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3174	Performance Criteria	B5	The packet with the best RSSI figure is then routed to multiple site transmitters for Multi-Cast transmission. Where there are multiple site transmitters, the operator of the subscriber units need not change channels to select the optimal transmitter for his area. In this case, "Vote Scan" is activated on the subscriber unit in addition to "beaconing" on the system side of things. Functionally, the "Vote Scan" and "beaconing" systems work together. Periodically, the IDAS site transmitters generate a beacon pulse. These pulses are received by the subscriber units and are analyzed for the strongest RSSI. The subscriber unit then listens for traffic from the site that has generated the strongest beacon pulse as received. Thus the subscriber radio is always monitoring the strongest available site for traffic. The subscriber units are always monitoring the transmitters, and will automatically change to the strongest site. No channel changing is required by the user. A full suite of console services and a complete integrated solution to radio system shall be provided by Avtec.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3175	Performance Criteria	B6	Performance Criteria	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3176	Performance Criteria	B6a-c	**a.** Radio Equipment (General) Radio base stations shall be located as needed to provide coverage. Fiber Optic transmitters, where used, shall be at the ROC, and shall have a capacity to accommodate all radio receiving equipment, and shall be of the type that gives priority to the receiver on each channel having the audio signal with the best signal-to-noise ratio. The transmitters shall be such that once an initial receiver selection has been made, continuous voting shall take place such that the best quality signal shall always be presented to the radio operator at the console. The apparatus shall also be capable of locking onto the initially selected receiver throughout the transmission. **b.** The service shall be designed such that the stated grade of service prevails over the entire mainline area. **c.** All radio equipment to be installed in locations having environmental control shall be mounted in relay-type equipment racks. Equipment to be installed in locations with hostile environments shall be mounted in suitable weatherproof cabinets (NEMA 4 type enclosures).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3177	Performance Criteria	B6d-g	**d.** All radio repeater equipment shall be linked to the ROC for the remote control and supervision of transmit and receive functions. **e.** Transmitter frequency shall be of sufficient stability to support the subsystem requirements herein and to prevent the appearance of extraneous audio tones. All combinations of base stations shall be capable of concurrent operation without harmful interference between any channels (intermodulation). **f.** Radio repeaters shall be rated for continuous duty and shall be capable of continuous transmit operation. **g.** Radio equipment shall be furnished with indicator and alarm circuits for: **1)** Base station Function disable **2)** Low or no RF power with "transmitter turn on" **3)** Base station failure **4)** Loss of AC power **5)** Loss of DC power	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3178	Performance Criteria	B6h-l	**h.** Base stations shall be furnished with transmitter power monitor and alarm circuit. Reduced power output shall alarm at ROC via SCADA. All active radio system equipment i.e. pre-amplifiers and FO/RF transceivers etc. shall be alarmed to SCADA and if applicable the particular radio system network management system. **i.** Each radio equipment installation at a station shall be powered from Un-Uninterruptible Power Supplies (UPS) or floating battery systems. **j.** Class B Booster Amplifiers shall not be used for surface transmissions. Rather, the usage of Class A Booster Amplifiers, per the Federal Communications Commission CFR 47 part 90.219, shall be used for all surface/above ground transmissions. **k.** All components making up the RF communications shall be FCC type accepted for its manufacturer intended usage. **l.** Due to the operational characteristics of the existing Metro Radio system, there shall be two (2) downlink channels per one (1) uplink channels as each of the two (2) downlink channels are installed in alternative transmit zones. Stated in alternative means, there are two duplex channels with two different downlink channels and the same uplink channel i.e. a triplex channel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3179	Performance Criteria	7	Mobiles and Portables Equipment Mobiles shall be provided in operator cab of each passenger vehicle dependent pair. Mobiles and Portables shall comply with the following criteria: **a.** Use synthesized frequency-determining circuits to provide stable oscillator frequencies for both the transmitter and the receiver. **b.** Power for the mobiles shall be furnished from the passenger vehicle low voltage power supply. Vehicle-generated electrical noise shall be mitigated by filtering and other EMI preventive methods and shall not affect radio subsystem operation. **c.** Mobiles shall be controllable from the energized operation cab by a remote control unit that will be installed in each operator cab. **d.** Shall be equipped with RAN (Radio Access Number) code for accessing a radio repeater or digital squelch function. **e.** Provide a POWER ON indication to the remote control unit. **f.** Mobiles provide an audio output for use with a separate speaker in the operator cab. **g.** Mobile and Portable VHF radios shall be functionally and operational compatible with the ICOM IDAS mode at 6.25 KHz digital modulation. Vote-Scan shall also be provided on the Mobile and Portable radios.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3180	Performance Criteria	8a-c	Antennas a. The repeater antennas and transmission lines shall conform to applicable EIA Standard RS-329 and shall be designed to meet the performance levels for the environment in which they will be utilized. Lightning protection shall be provided on antennas, where applicable. **b.** Distributed antenna shall: **1)** Be the primary radiating and receiving element in tunnels, subway passenger stations, and ancillary rooms. Supplemental space antennas may be used in these areas to provide additional coverage where necessary. **2)** Not have physical and electrical characteristics altered by exposure to ambient conditions. **3)** Be spliced only with connectors that ensure a sound mechanical and electrical connection. **4)** Be capable of passing UL 83 and UL 1685 flame resistance tests (outer jacket). **c.** Supplementary below-ground antennas shall be suited to the frequency bands indicated and be appropriate for the specific site and usage. The antennas shall have the gain, bandwidth, and pattern required to provide the specified grade of service.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3181	Performance Criteria	8d	**d.** At Grade Antennas for Off Air Use 1) Low profile panel antenna type. 2) The antennas shall be single band rated at the required 450/500 MHZ and700 MHz Public Safety Band at 806-896 MHz band. 3) The antennas shall be of a high gain type (12 to15 dBi). 4) Technical specification of antennas shall be submitted to Metro for approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3182	Performance Criteria	9	Electromagnetic Compatibility Control Program	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3183	Performance Criteria	9a, b	**a.** An electromagnetic compatibility (EMC) Control Plan shall be implemented throughout the design to ensure that the Radio System will operate in its intended electromagnetic environment without earlier causing or suffering unacceptable interference due to electromagnetic emission or response. The Control Plan objective is to provide equipment and installation parameters that will assure an electromagnetically compatible system. **b.** The implementation of EMC shall include control of conductivity coupled interference, interference coupled through common impedances, and interference coupled through radiated electric and magnetic fields.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3184	Performance Criteria	9c	Analysis: The plan shall identify the techniques to be employed for ensuring the adequacy of specific aspects of the mechanical, electrical, and electronic design, including electromagnetic radiation. Identify equipment for which existing analyses and data document EMC in identical or similar applications. Identify any potential issue areas, and outline appropriate measures to be implemented to control EMI. Shield circuit wires and twisted pairs in cables shall be to minimize electrostatic and electromagnetic coupling. Consideration shall be made to the electromagnetic environment to which the wayside and vehicle-borne Communications System equipment will be exposed and special techniques to eliminate interference with operation of this equipment. Consideration shall be made to the RF environment where amplifiers and SCAs are exposed. Unitization of double shielded/rigid coaxial lines to couple input/output ports and ancillary devices such as couplers, splitters, etc. to prevent self oscillation. Power levels in wires within a common bundle or harness shall not exceed a 30 dB spread. Shields must be electrically continuous and grounded at one end only.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.6.3	ABOVE GROUND RADIO SYSTEM													
3185	Performance Criteria	A	Communication System Description The Radio Communications System for the above ground coverage shall use two-way radio communications in the 160 MHz Frequency Band for Rail Operations and Maintenance, and the 450/460 MHZ Frequency Band for Transit Police. The above ground Radio System consists of several elements as the following	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3186	Performance Criteria	A1	The Radio System The voice radio system consists of a multi-site, multi-channel 160 MHz band utilizing ICOM NXDN protocol and very narrow band 6.25 KHz radio channels for Metro Operation and Maintenance. And Metro Transit Police radio system utilizing 450/460 MHz bands with analog narrow band 12.5 KHz radio channels. At grade and aerial coverage shall be 100% with no exceptions and include the area extending not less than 500 feet each side of the right-of-way, the main and satellite yard, ancillary rooms/bungalows, and the Central Control Facility external areas. Yard and rail operations channels shall have coverage in the shop buildings and offices.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3187	Performance Criteria	A2	Dispatch Console Equipment Radio control equipment shall be provided for light rail line Transit Operations Supervisor (TOS), communication controller and ROC supervisor console positions. The equipment shall be capable of monitoring and accessing all of the talk groups in the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3188	Performance Criteria	A3	Mobile, Portable, Control Station and Repeater Station Equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3189	Performance Criteria	A3a	Mobile, portable and control station equipment shall be provided to operate as part of the 160 MHz radio system. The mobile radios shall be two-piece construction, with a RF control head connected by a cable to the transceiver unit. The RF control head shall contain the usual functions such as speaker volume, talk group select, talk group display, power, MDC-1200 ANI features and transmit indicators. In addition, trainborne mobile radios shall be equipped with train interface connections for input audio, output audio, PTT leads and emergency trigger. Finally, all mobile, portable, and control station radios shall operate with the ICOM NXDN protocol at 6.25 KHz with Vote-Scan enabled.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3190	Performance Criteria	A3b, c	**b.** Each portable radio shall have a connector for a speaker-microphone. **c.** Control stations will be used at specified yard, ROC and office facilities and commercial power mains. ROC based control stations shall be connected to the ROC's UPS. A mobile radio control station and antenna system shall be supplied by Metro and installed by the contractor to provide radio coverage within communication, electrical, and maintenance bungalows or buildings where the Metro above ground radio system does not provide adequate in-building coverage. The control station shall be connected to an existing or standalone UPS system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3191	Performance Criteria	A3d-f	**d.** Radio equipment shall be furnished with indicator and alarm circuits for: **1)** Repeater Function disable **2)** Low or no RF power with "transmitter turn on" **3)** Repeater failure **4)** Loss of power **e.** Repeater stations shall be furnished with transmitter power monitor and alarm circuit. Reduced power output shall alarm at ROC via SCADA. **f.** Each radio equipment installation at a station shall be connected to back-up power such that operation is possible in event of a commercial power outage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3192	Performance Criteria	A4	Backhaul communications Each remote base station will require wide area network connectivity to the ROC through the either the fiber optical or microwave radio communications backbone.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3193	Performance Criteria	A5	Emergency Trigger Alarm **a.** Each portable radio shall be equipped with an emergency button. Once the emergency button, hereafter designated the Emergency Trigger, is depressed, the system shall automatically assign the highest priority to that portable. **b.** Mobile radios installed in light rail passenger vehicles shall include a means for external, remote activation of the Emergency Trigger. For mobile units installed in the existing MBL passenger rail vehicles, connection shall be as directed by Metro. **c.** Mobile radios installed in maintenance, highway and high rail vehicles shall have an emergency trigger in a readily accessible location but protected from accidental activation. **d.** At the System Communications Controller Console in the ROC the emergency condition shall be audibly and visually annunciated. The System Communications Controller Console and both systems control terminals shall be able to reset an emergency alarm.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3194	Performance Criteria	A6, 7	**6.** Automatic Base Station Identification Automatic International Morse Code station identification shall be provided for the radio system. Operation of the automatic station ID shall be in accordance with FCC Rules and Regulations 90.647(b)) for radio systems. **7.** Adding Additional Sites to the System The Contractor shall build out radio communications site(s) in order to provide the required radio coverage of the Metro VHF and UHF bands at the new rail expanded area. The new radio equipment/site shall be compatible with the existing system and meet the criteria found in Section 9.6.3. The new radio site(s) shall be compliant with FCC, local, state and federal government agencies and/or Acts	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.7	**TELEPHONE SUBSYSTEM**													
		9.7.1	GENERAL													
3195	Performance Criteria		**A.** An IP Telephony System with an interface to the existing Metro telephone system shall be installed to provide telephone services to the public and the ancillary areas of the rail system. **B.** Included in the telephone system shall be: • Administrative telephone (ATEL) • Emergency telephone (ETEL) • Passenger assistance telephone (PTEL) • Maintenance telephone (MTEL) • Gate (fare) telephone (GTEL) • Elevator Telephone (LTEL) **C.** Equipment failure alarms from each telephone subsystem at each location shall be provided to the SCADA subsystem at each station. All ETELs shall be provided with line status monitoring. **D**. All phones will report their locations to the ROC or other places requested by Metro. **E.** All telephones must have a dedicated line (no party line). **F.** ADA push plate shall be provided to the base of the elevator interior wall to activate elevator telephone, refer to Architecture MRDC Section 6.15.3.C for detail location.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.7.2	IP TELEPHONY SYSTEM													
3196	Performance Criteria		**A.** IP Telephony System will be a network based Voice over Internet Protocol (VoIP) telephony system. Call control and messaging server clusters to be designed to fail over to geographically diverse servers. IP Telephony system includes: **1.** IP network to be configured for Quality of Service to give voice traffic priority. **2.** IP telephones shall be configured to encrypt voice traffic. **3.** Adequate IP network security shall be provided. **4.** Gateways and VoIP routers geographically diverse for redundancy.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3197	Performance Criteria	B	IP Telephony System Design	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3198	Performance Criteria	B1-4	**1.** The IP Telephone System shall be designed for console-less operation with dial service from telephone sets, auto ring down service from ETELs, and public address access from telephones with keypads. **2.** The equipment shall be digital solid-state, modular design, utilizing the same Unified Communications Manager with the latest hardware and software technologies. **3.** Existing Communications Servers are to be used if already in place in Metro's network. Metro's intent is to build a primary Communications manager cluster to provide call control and messaging for the entire system with one or more remote clusters for redundancy and to support continuity of operations in the event of disasters. **4.** The hardware and software design shall be such that incremental increases in telephone lines, and modifications of user data (adds, moves, or changes) may be easily accomplished without affecting service to any existing lines.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3199	Performance Criteria	B5-6	**5.** Dial-up service: The system shall provide station to station direct dialing, capable of processing calls to/from any point in Metro's telephone system. IP telephony users shall be able to go off-hook and dial any network number, regardless of location or serving IP Telephony system, and the system shall automatically complete the call to a system telephone set or route it over network lines for switching by the existing main PBX system, whichever is applicable. **6.** The system components include an integrated router-voice gateway with an integrated Ethernet module for rail stations and a stand-alone router and separate voice gateway for rail yards and other facilities. Provide analog voice gateways for analog phone lines. Analog and IP telephone instruments are used throughout the rail stations, right-of-ways, yards and other facilities. Separate Ethernet switches connected to the router via multi-mode fiber optic cables may be used to extend the Metro Enterprise Network in underground stations and are required in yards when IP phones or other Enterprise Network equipment are more than 100 meters from the router. All IP telephones instruments shall be powered by using Power-Over-Ethernet Plus (POE +) IEEE 802.3 at compliant data switches.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3200	Performance Criteria	C	IP Telephony Servers and Gateways Requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3201	Performance Criteria	C1-2	**1.** The router-voice gateway and when possible the analog voice gateways shall be dual-power with each power supply connected to separate electrical circuits. All equipment shall be powered from the communications UPS. The equipment shall be rack mountable inside a communications equipment cabinet. Physical dimensions, construction, mounting data (wall and/or floor), and enclosure locking mechanism shall be submitted. **2.** Employ a five-digit dial plan compatible with Metro standards. The software must determine if the number dialed is within Metro's IP network or off net. No access level (e.g. "9") shall be required to dial any network number.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3202	Performance Criteria	C3-4	**3.** The Router-Voice Gateway shall be configured to provide alternate emergency calling via telephone company lines in the event that the Metro Enterprise Network connectivity is disrupted. **4.** Analog voice gateways provide telephone lines for analog phones, including emergency telephones and dial-up public address system. They convert analog traffic from/to IP and are under the control of the centralized communications manager. Analog voice gateways shall be 96-port high-capacity dual-powered when more than 24 analog lines are required, 24-port medium capacity or 4-port low capacity devices. All ports on high and medium-capacity analog voice gateways shall support long loop lengths (long-range analog lines).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.7.3	ADMINISTRATIVE TELEPHONE (ATEL)													
3203	Performance Criteria		The ATEL group shall be multi-line IP phones with displaying, hold, conference, and transfer capabilities. They should be installed in TC&C rooms, Staff/Security Offices, Operator (conductor) rooms or booths, Security Kiosks, and similar rooms in underground and aerial stations, in Security Kiosks and conductors' rooms or booths on or near stations, and at the ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.7.4	EMERGENCY TELEPHONE (ETEL)													
3204	Performance Criteria		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. ETELs shall be fault supervised, with alarms reported by SCADA.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3205	Performance Criteria		Telephone instruments in the ETEL group shall be one of three types, to be determined by the instrument location and function as follows: **A.** Hands-free with single-button activation, used at public locations such as in elevators and on public platforms and mezzanines, and requiring no further user action after initial activation. See Provisions for ADA Accessibility Guidelines (ADAAG). (Refer to ADAAG 4.30, DOT 49 CFR parts 27, 37 and 38 and the CalDAG-California Disabled Accessibility Guidebook for guidance). These phones will ring down to CCTV observers at the ROC. Elevator Telephone (LTEL) is the ETEL installed in elevators. **B.** Standard black wall phone (2554 with G6 handset or equivalent), used in ancillary and Motorman Platform locations. These phones will be programmed to ring down to ROC controllers. **C.** ETELs at parking lots and parking structures shall have the blue LED light mounted atop in order to provide high visibility. The blue LED light shall remain always list and will begin to flash throughout the duration of a telephone call.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3206	Performance Criteria		ETEL service shall be provided at each passenger station, along the trainway, and at maintenance/train storage facilities. ETEL, as a minimum, specific telephone locations shall include: • Public mezzanines • Public platforms • Fire hose cabinets • Emergency Management Panels (2 per EMP), provided with outside dialing capability • Elevators • Sprinkler valve rooms • Tunnel cross passages • Emergency fan rooms (next to fan controls) • Emergency equipment rooms • Emergency hatches (emergency exits from underground stations) • Emergency exit corridors • Emergency exit stairs • Blue Light Station (BLS) boxes • Parking lots and parking structures • Motorman Platforms	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.7.5	PASSENGER ASSISTANCE TELEPHONE (PTEL)													
3207	Performance Criteria		The PTEL group shall provide priority point-to-point telephone service from all station fare collection areas and any other designated public location to the CCTV observers at the ROC. Instruments in this group shall be identical electrically and physically to the Type "A" ETEL, except for distinctive activation buttons and signage to differentiate them from ETEL instruments. See Provisions for individuals with Disabilities for ADA requirements. PTEL shall be installed next to each group of TVMs and other locations as specified by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.7.6	MAINTENANCE TELEPHONE (MTEL)													
3208	Performance Criteria		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 "B" Type ETELs – standard black wall phones (2554 type with G6 handsets or equivalent). As a minimum, specific telephone locations shall include: • TC&C buildings or cabinets • Signal bungalows or cabinets • TPSS building or rooms • Auxiliary power rooms • Electrical rooms • Elevator machine rooms • Cross passages • Staff security rooms • Mechanical rooms • Emergency fan rooms • Custodial rooms • Ejector rooms • Sump pit rooms • Cable turning rooms • Fan rooms	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.7.7	GATE TELEPHONE													
3209	Performance Criteria		Gate Telephones (GTELs shall be provided on both sides of fare barriers to obtain assistance from Metro personnel remotely monitoring station fare gate arrays. Refer to Section 9.2.2.F.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.7.8	INSTALLATION AND NUMBER OF TELEPHONES													
3210	Performance Criteria		ETELs and MTELs installed in ancillary rooms should be within 15 feet of room entrances, and all must have a 25 feet handset cord. If the room is larger than 30 feet, there shall be an additional MTEL. TC&C rooms in underground stations shall have an ATEL and sufficient MTELs so that all equipment is within reach of a telephone. All phones must have independent lines. ETELs in public areas and ancillary emergency egress routes shall be placed in accordance by code for manually activated alarm-initiating devices (NFPA 17.14).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8	**TRANSIT PASSENGER INFORAMTION SYSYSTEM (TPIS)**													
3211	Performance Criteria		TPIS shall function as a combination of Public Address and Visual Message Signs subsystems providing audio and video information to the passengers and Metro personnel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8.1	PUBLIC ADDRESS													
3212	Performance Criteria		The public address (PA) subsystem shall provide for general announcements, alerts to existing or pending hazards or emergency warning information to single and multiple zones within individual and multiple passenger stations, yards, shops and central control with access and control from various locations and from the Metro telephone system. The PA subsystem shall also provide for prerecorded announcements and paging via the Metro telephone system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3213	Performance Criteria	A	Functional Requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3214	Performance Criteria	A1-3	**1.** The PA subsystem shall provide an effective sound-masking system which utilizes loudspeakers strategically placed to produce uniformly distributed audio throughout the passenger stations, yards and shops and central control areas. Uniform audio in both tonality and sound level, at 5 feet elevation above the walking area, so that normal moving does not result in 5 dB changes in the sound level. The audio inputs shall be prioritized in accordance with Table 9.8.1 **2.** The power amplifiers shall be on hot standby on a one-to-one basis, being switched to active by a PA supervisory subsystem. The amplifiers shall drive speakers in backboxes in the station, office, ancillary and low bay areas; and horn type speakers in the yard and high bay areas and in station high noise areas such as mechanical rooms and emergency fan rooms. Level of the power amplifier output based on the ambient noise shall be automatically adjusted for the track areas, shop areas, mezzanine and station areas. **3.** The PA subsystem shall be fully supervised with failure annunciation of all major system components such as controller, power amplifiers, supervision tone generators and detectors, power supplies, and speaker wiring. Failure reporting shall be via SCADA to ROC using dry contact.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3215	Performance Criteria	A4-6	**4.** The primary means of access to the ROC and Yard/Shops PA systems shall be through the local Metro telephone system via maintenance telephones and digital administration desk sets. Zone selection shall be accomplished using the Dual Tone - Multi Frequency (DTMF) keypad to select any one or all zones for broadcast of audio from the telephone microphone. **5.** The primary means of access to the station PA systems shall be from PA consoles located at the ROC. 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. **6.** All station PA equipment shall be powered from the communications UPS. Yard and ROC PA systems shall be powered from the facilities UPS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3216	Performance Criteria	B	Design Criteria	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3217	Performance Criteria	B1	The PA subsystem shall comply with NFPA 72 and shall be compliant with listing requirement of the California State Fire Marshall wherever used as part of a combination fire system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3218	Performance Criteria	B2	Technical Characteristics	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3219	Performance Criteria	B2a-g	**a.** Active Components: Solid-state devices. **b.** Power Output: As required. **c.** Headroom: Sufficient to allow a minimum increase in output of 12 dB, without increase in hum, noise, or total harmonic distortion. **d.** Frequency Response: **1)** End-to-end Station amplifier to speaker frequency response: 1.5 dB from 100 Hz to 10 kHz, 3.0 dB10 kHz to 15 kHz. **2)** 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. **3)** Live microphone audio shall be encoded and delivered at a minimum of 22 kHz, 8-bit. **e.** Total Harmonic Distortion: Not greater than 1 percent at full rated output. **f.** Distribution: 70 V nominal, transformer isolated. **g.** Power Source: Un-interruptible Power supply.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3220	Performance Criteria	B2h, i	**h.** Overload Protection: All amplifier outputs shall be protected with automatically resetting thermal overload, short circuit and current limited protection. **i.** PA subsystem shall maintain a uniformly distributed sound level at least 10 dB above ambient station operating noise level measured at 5 feet above floor for indoor stations. Outdoor stations shall be not less than 60 dBA plus or minus 30 degrees off axis, 4 feet above the floor, at vehicle ambient noise level. The minimum sound level at any point 5 ft. or lower, above the floor sound level shall be: **1)** Mezzanine: 70 dBA minimum **2)** Platform: 78 dBA minimum **3)** Yard and High Bay Areas: 78 dBA minimum **4)** Ancillary: 70 dBA minimum **5)** Low Bay, ROC, and Offices: 70 dBA minimum **6)** Horn speakers' frequency response shall be in the range of 150 Hz to 15 kHz.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3221	Performance Criteria	B3	Supervision and Alarms **a.** The PA subsystems shall be fully supervised with failure annunciation. **b.** A local annunciator/alarm panel shall: **1)** Indicate individually the failure of any supervised circuit or equipment, **2)** Annunciate the transfer to a standby power amplifier, **3)** Upon failure of standby power amplifier, activate the appropriate annunciator or alarm.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3222	Performance Criteria	B4	System Input Priorities Up to five levels of prioritized inputs shall be selected from various sources at the stations, Yard and the ROC PA subsystems. Microphones shall be provided at the EMP/CP and the PA equipment racks to access the station PA subsystem. Prerecorded voice announcements shall be activated either locally or by remote control from the ROC for information or emergency announcements. Inputs 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 following inputs shall be provided:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8.1.2	REMOTE ACCESS													
		9.8.1.2.1	TELEPHONE ACCESS													
3223	Performance Criteria		Remote access via the telephone subsystem to PA subsystem shall be provided from both the communications and the 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. 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 telephone Dual Tone-Multi Frequency (DTMF) sequence and shall allow access to 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 of a hang-up DTMF code (whichever occurs first).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8.1.2.2	CONSOLE ACCESS													
3224	Performance Criteria		Remote access via TPIS graphical user interface consoles shall be provided at the ROC. **A.** Consoles shall allow selection of one or more stations and zones or announcement groups for broadcast of live or pre-recorded announcements. **B.** It shall be possible to select broadcast destinations using a map-based graphical display or a sort-able tabular style display. **C.** Consoles shall allow system maintainers to define announcement groups for quick selection of broadcast destinations. The system shall include the following pre configured groups: **1.** Systemwide, all stations and all zones **2.** Systemwide, all station platforms **3.** All stations and all zones (one group for each rail line) **4.** All station platforms (one group for each rail line) **D.** Consoles shall include a maintenance display that indicates the following information: **1.** Status of each remote TPIS station control unit **2.** TPIS server status **3.** Status of each TPIS console	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8.1.3	PRE-RECORDED ANNOUNCEMENT DEVICES													
3225	Performance Criteria		**A.** Station Control Unit (SCU) shall be used in all stations for local automatic messages initiated by local contact closures. **B.** Equipment at the ROC shall be capable of recording and storing new announcement. **C.** Equipment shall be provided to allow recording and storing of new announcements on local SCU. **D.** Provision shall be made for ROC Initiation and Selection of prerecorded voice announcements from the ROC console. **E.** The station EMP shall be able to broadcast an emergency evacuation message from the local SCU.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8.1.4	PA ZONES													
3226	Performance Criteria		**A.** 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, mezzanine and ancillary areas. Shops and yard areas have typically nine zones and ROC has typically four zones. **B.** Zones for the ROC PA subsystem shall be uniform and provide a sound pressure level of 70 dBA measured on axis of speakers at a point 4-feet above the floor and not less than 60 dBA plus or minus 60 degrees off axis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8.1.5	STANDBY AMPLIFIERS													
3227	Performance Criteria		Hot-standby power amplifiers shall be provided on a one-to-one 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.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8.1.6	SPEAKER BY LOCAL MICROPHONES													
3228	Performance Criteria		Provision shall be made to reduce output level of speakers in close proximity of local microphones to prevent acoustic feedback.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8.1.7	NOISE-OPERATED LEVEL ADJUSTMENTS FOR POWER AMPLIFIERS													

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3229	Performance Criteria		**A.** Automatic Gain Control (AGC) 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. **B.** 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 the surface. **C.** Independent automatic gain or level control shall be provided at each passenger station for the public areas. Automatic level control shall also be provided, independently, for the high-bay machine shop areas and the outdoor track area in the Yard and the high-bay machine shop in the Maintenance-of-Way-Building. Automatic level control will not be required for office zones or equipment rooms. **D.** Noise sensing device for each controlled area shall be mounted in each individual enclosure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8.2	VISUAL MESSAGE SIGNS													
		9.8.2.1	GENERAL													
3230	Performance Criteria		The Visual Message Sign (VMS) System is a subsystem of TPIS shall provide visual information at selected locations in passenger stations and auxiliary areas. The display of the visual information shall be in compliance with the ADA Accessibility Guidelines (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 Disabled 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 areas of all stations, at fare vending areas, and at underground entrances. The VMS shall provide centralized message generator (including message creation, storage and selection), and dispatch functions at the ROC for individual stations, groups of stations, and all station sign activation and display. Each passenger station VMS/TPIS shall accept message inputs from both a centralized processing unit located at the ROC and from local passenger station inputs. Passenger station inputs consist of pre programmed messages emulating the pre-programmed public announcements activated from the passenger station's Emergency Management Panel and from train control/signaling system equipment. All station message sign units shall be:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3231	Performance Criteria	A	A. For LRT 42" (diagonally measured) LCD monitors or LED signs shall be environmentally housed to prevent damage from moisture, dust, and vandalism. LCD monitor shall have 4K or higher resolution. 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. At a minimum, LCD or LED monitors shall be provided as follows: **1.** For underground LRT stations, 42" LCD monitors shall be installed in the following areas: above map case; near fare collection ticketing machines; along the edge of the platform; above the fare gate group; at grade level entrance; other area required by Metro **2.** For aerial and at-grade LRT stations, 42" LCD monitors shall be installed at the same locations as underground LRT stations except: LEDs shall be provided at both ends of the station platform to provide better visibility. However infrastructure shall be designed to accommodate both LED and LCD monitors should Metro decide to replace the LED with LCD monitors in the future.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3232	Performance Criteria	B	For HRT 46" (diagonally measured) LCD monitors shall be environmentally housed to prevent damage from moisture, dust, and vandalism. LCD monitor shall have 4K or higher resolution. The LCD monitors should be installed in the following areas: above map cases; near fare collection ticket vending machine; along the edge of the platform; at grade level station entrance; areas as required by Metro All signs shall have a minimum character size lettering compliant with the ADA Accessibility Guidelines (ADAAG). Refer to ADAAG 4.30, DOT 49 CFR parts 27, 37 and 38, and the CalDAG-California Disabled Accessibility Guidebook for guidance. The character and number height shown on VMS versus viewing distance shall be shown as Figures 9.8.1 and 9.8.2. Message display shall include fixed position message, left to right scrolling, rolling and flashing functions. Other unique display capability such as special character set generation and top to bottom rotation of messages are acceptable. The orientation of the LCD/LED mounting shall be adjusted properly for best viewing by passengers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8.2.2	SYSTEM REQUIREMENTS													

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3233	Performance Criteria		The VMS/TPIS System shall be configured using a standard computer system. Passenger station display signs shall be remotely accessed by the ROC-located computer via the cable transmission system. Data transmission to and from the ROC VMS computer and each passenger station display sign shall be transmitted over Ethernet. Note that the VMS computer system may be a shared device, part of the PA system. All interfaces between the passenger station VMS system and other systems shall be accomplished in the train and control communications room or communications signaling building. Interfaces include train control or signaling system and public address system activation switches to the station Emergency Management Panel. Power for VMS system equipment located in the train control and communications room or communications-signaling building shall be from the uninterruptible communications AC power distribution system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.8.3	TRANSIT PASSENGER INFORMATION SYSTEM AUTOMATIC ANNOUNCEMENTS													
3234	Performance Criteria		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). (Refer to ADAAG 4.30, DOT 49 CFR parts 27, 37 and 38 and the CalDAG-California Disabled Accessibility Guidebook for guidance). 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:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3235	Performance Criteria		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. Information on service interruptions or delays such as “The approaching train is not in service, please stand clear” Emergency instructions such as “Evacuate Station” Prohibitive instructions such as “No Smoking, Eating, or Drinking” News, sports, weather Commercial advertising Day, Date, and Time synchronized to a master clock at the ROC Other pre-recorded messages to be determined by Metro The software shall generate arrival messages as described above.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.9	**CLOSED-CIRCUIT TELEVISION**													
		9.9.1	FUNCTIONAL REQUIREMENTS													
3236	Performance Criteria		The Closed Circuit Television (CCTV) system should be designed for every day safety and security requirements as well as revenue protection, anti crime and anti terrorist applications requiring the identification of unknown people and objects depicted within images. Stations will generally function unattended. The CCTV subsystem shall provide visual surveillance of designated passenger platform areas, and intersections near platforms, elevators and escalators to aid in safety, security control and assistance to patrons. The subsystem shall provide monitoring capability of all cameras at the ROC. The CCTV subsystem shall provide video recording of all cameras in the transit system. Street level access shall be available to the CCTV and Network system for all subway stations (not for elevated and at-grade) by way of a laptop hook-up.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3237	Performance Criteria	A	Passenger Stations IP Pan/Tilt/Zoom (PTZ) cameras shall be installed to permit monitoring of the station, platform, and plaza areas: 100% coverage should be 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). TVM/SAV equipment and areas (front side of equipment) including passenger assistance telephone (PTEL) and gate telephones (GTEL), and the Paid Areas. For fare collection barrier system requirements see fare collection Section 9.2. Passenger loading/unloading areas on platforms Entrances from public areas to authorized ancillary areas. Additional corridor specific locations (e.g. intersections at entrances to stations, emergency exit areas, security sensitive areas, etc. as required by the transit security design consideration. As described in Section 12) Pull-out areas adjacent to platforms As a minimum, camera placement should be one per 75’-0” of viewing area. 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”. The entire plaza level, including bike-parking areas should be covered. All cameras shall be equipped with video level driven auto-iris lens. Cameras shall view a subject area free of facility impairments such as building columns, signs, and lighting fixtures. All CCTV camera signals at passenger stations shall be transmitted to the ROC for viewing. The locations include the security sensitive areas as required by transit security design considerations which are described in Section 12.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3238	Performance Criteria	B	Parking Structures and Lots CCTVs shall be provided for specific locations in parking lots, parking structures. **1)** PTZ camera should be installed to provide full coverage in parking lots. **2)** PTZ cameras should be installed in parking structures in the following locations: **a.** Elevators, **b.** Elevator lobbies (on each level), **c.** 100% coverage of parking areas, **d.** Enclosed Stairways, **e.** Entrances and exits. Provision shall be provided for future Automatic License Plate Recognition (ALPR) cameras to be installed at the vehicle entrances and exits. Conduits shall be provided from CCTV hub location to all public and employee parking structures and lots associated with LRT or HRT passenger stations for 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.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3239	Performance Criteria	C	Wayside PTZ cameras shall be installed to monitor all intersections where the trains are in street run, and intersections where an interlocking is located, the cross passages, tunnel portals, bridges, yards, and other areas required by Section 12, Safety, Security and Systems Assurance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3240	Performance Criteria	D	Elevators and Escalators Dedicated fixed cameras shall be grip free vandal proof corner mounted that give full coverage and field of view of the cab interior and elevator entrance. Dedicated IP fixed cameras should cover elevator cab with door opening on one side of the cab. For each elevator cab with doors on both sides of the cab, two cameras shall be corner mounted. Dedicated IP PTZ cameras shall be used to monitor elevator entrance areas from the outside of the elevator on plaza, courtyard or platform (etc.) areas. Dedicated IP PTZ cameras shall be used that monitor each escalator at each landing (both top & bottom areas).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.9.2	DESIGN CRITERIA													
3241	Performance Criteria	A	General	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3242	Performance Criteria	A	• The CCTV system shall be TCP/IP based video transmission network system. • IP PTZ cameras with high definition 1080P (1920x1080) or higher resolution shall be used in CCTV system design to identify a person and objects depicted within images. Optical lens capability 4.7mm to 94mm, 20X optical zoom minimum. • The CCTV picture characteristics shall be as follows: - NTSC color format - The CCTV subsystem shall be capable of supporting to following video resolutions and shall be user adjustable at the ROC console: o Up to 30 fps (user selectable 5 and 30) at 1080P (1920x1080); - Minimum monitor resolution shall have 4K or higher resolution.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3243	Performance Criteria	A	• The minimum illumination requirement of the camera shall be 0.4 lux @ F1.6 at 1/30 second at 50 IRE for color mode. • Minimum Ambient Illumination: One foot candle when emergency lighting is activated. • The IP PTZ cameras shall be powered by using Power over Ethernet (PoE), IEEE 802. 3at-2009 compliant. • Augmented Cat 6 (Cat 6A) shall be used to deliver signal and power to the CCTV cameras. CCTV systems shall be configured in a hub and spoke arrangement with local recording being undertaken and images compressed then being transmitted back to the ROC via a CTS or possibly wireless network.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3244	Performance Criteria	B	Cameras	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3245	Performance Criteria	B	? Elevator Camera shall be Vandal resistant, IP66 (ingress protection) rated and corner mount color CCD type that gives full coverage and field of view of the cab interior and elevator entrance. ? Elevator camera housing shall be constructed of stainless steel with polished stainless steel finish. ? It shall be suitable for surface/corner mounting in an elevator cab. ? The IP PTZ cameras shall have smoked glass. ? The IP PTZ cameras shall not have make or model number visible on the camera housing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3246	Performance Criteria	B	? Cameras shall be compatible with the picture characteristics and shall, in addition: - Be housed in corrosion-resistant, vandal-resistant environmental enclosure with reflection inhibiting, shatterproof glass or polycarbonate viewing port. Enclosures shall be rated IP66 or better. - Be equipped with sunshades when used outdoors as required to prevent unwanted reflections into lenses. Consideration to object/target clarity will be evaluated when applying sunshades to camera housings. Cameras located in an environment that is subject to rain shall be sealed to prevent moisture infiltration and build-up. - Camera housings and mounting apparatus shall use anti-corrosive (rust-proof) material. - Lenses: Focal length and Fields of View (FOV)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3247	Performance Criteria	B	? The selection of lenses will be dictated by the field-of-view to be covered by each camera, as well as by the size of the camera's detector. For cameras placed to record images at a point of transactions, such as a front of fare machine or parking approach , the area of interest (e.g., face, license plate) should cover approximately 15 percent or more of the camera's field-of-view (based on the recommended minimum resolution). Examples: 1. For an average human head that is six-inches wide, a three-foot-wide field-of view will meet this guideline. 2. For a license plate width of approximately 12 inches, a six-foot-wide field-of view is sufficient. • The focal length necessary to achieve an approximately three-foot-wide field-of view for a given detector size and camera-to-subject distance is provided in Table 9.9.1 below. The camera must be in focus at the position of this subject.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3248	Performance Criteria	B	Differences in the units used to describe these resolution recommendations are due to the differences in the industry recommended practices used to describe them. PTZ cameras by their natures are adjustable and these calculations should be considered for a “home” or “cage” position. Cameras that provide overviews of interior and exterior locations should have their focal lengths selected so as to meet the field-of-view requirements of the facility. However, exit cameras should have sufficient depth-of-field of at least three to four feet for walking pace objects to ensure that subjects exiting the facility will be in focus. Field of view (FOV) relates to the size of the area that a camera will see at a specific distance from the camera. The field of view is dependent on lens focal length and camera format size.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3249	Performance Criteria	C-E	**C.** Camera Mounts Manual adjustable mounts shall be provided for each camera. Positive position locking shall be provided. Cameras shall be located unobtrusively and at as high an elevation as possible to maximize field of view and reduce vandal access, but low enough to access using an eight foot ladder. If cameras are located higher than this, fall protection must be installed per OSHA guidelines. **D.** Camera Identification 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. **E.** Wayside Transmission Video transmission between each passenger station and the ROC monitoring areas shall be by Fiber Optical Cable Transmission (FOCT) system. Each passenger station and TC&C room shall be serviced with sufficient supporting equipment capacity to add 40% additional cameras for expansion. (Example: Nine cameras plus 40% equals 13 cameras total.) The fiber optic network for the CCTV system shall provide equipment at each station/location for multiple CCTV camera inputs. The optically transmitted signal shall be recreated at the ROC for distribution to the various monitors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3250	Performance Criteria	F, G	**F.** Interface The CCTV system shall be interfaced with ETEL, LTEL, GTEL, and PTEL such that activation of ETEL, LTEL, GTEL, 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 CCTV Observer 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 ETEL, LTEL, GTEL, and PTEL call(s) is terminated. After that the event monitor should display the last camera image prior to call-up event. **G.** SCADA Alarms CCTV individual alarms shall be transmitted from each station to the CCTV or SCADA console in the ROC. The alarms will be based on the CCTV system, its alarm capabilities, and the project needs. The alarms, at a minimum, shall include: - Power failure - CCTV communications equipment failure (transmission equipment) - CCTV cable failure - Video loss	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3251	Performance Criteria	H	Video Recording System • All CCTV camera signals shall be recorded in real time at the station network video recorder. The selected camera signals can be controlled and routed from remote sites to the CCTV observer consoles in ROC.. • A CCTV management system shall control and record the selected CCTV video images into the network video repository server in ROC. The playback provision shall be able to display recorded images. Contractor shall supply the software license for every CCTV camera installed plus 40% spare for future expansion. The CCTV management software/application shall be in its unmodified state from its original manufacturer and interface seamlessly with Metro existing system, Video Insight.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3252	Performance Criteria	H	• The station network video recorders (NVR) shall have a video output for the console monitor to monitor recorded images. Controls for the NVR shall be provided at the console in ROC. The station NVR shall be compatible with the CCTV subsystem and shall have the following characteristics: - The video recorder shall be able to record images seen on all CCTV monitors in following resolutions and shall be user adjustable at the ROC console: o Up to 30 fps (user selectable between 5 and 30) at 1080P (1920x1080) o Recording Time: as recommended by Transit Security Design Considerations but in no event less than 30 days at 30fps at 4CIF - Operating Temperature: 40•F to 140•F - Audio Dubbing: Required - Controls: o Record o Playback - Image search by date and time o Stop o Pause - Other (as recommended by Transit Security Design Considerations)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.9.3	OPERATION: CONTINUOUS DUTY													
3253	Performance Criteria	A	CCTV Monitors Individual monitors of minimum diagonal length of 21" mounted at each CCTV Console. CCTV wall displays shall be provided for full-screen sixteen way split (sixteen images), and quad format viewing of selected camera pictures. It shall also be able to apply time and date stamp on each recording. All monitors shall display images in color and recording devices shall record images in color.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3254	Performance Criteria	B	Digital Signatures In order to digitally sign a file, all data/video file, which is to be protected, should passed through hashing function. The hashing function should produce a large checksum value for the file, which should be then encrypted using the private key. The two most recognized and acceptable by Metro hashing functions could be used for digital signature technologies are MD5 and SHA-1. The American Bar Association (Digital Signature Guidelines: http://www.abanet.org/scitech/ec/isc) describes digital signatures as using public key cryptography and a 'hash function' derived from the message itself. The hash function is an algorithm created from enough of the message data to ensure that it could only be created from those data. The message and the hash function are then encrypted with the sender's private encryption key to make a digital signature which is unique. The receiver decodes the message with a related version of the encryption key previously given to the intended recipient by the sender (or held by a trusted third party). The message is verified by computing the hash function again and comparing it with the original. Watermarks cannot be used for traceability of video evidence.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.9.4	TRIGGERS/VIDEO ANALYTICS (ANALYTICAL VIDEO SYSTEMS - AVS)													
3255	Performance Criteria		In some situations, systems may include triggers that lead to the recording of images at a variable rate, or in a sequence, that differs from the normal operating mode. An example of this would be to change from a low resolution recording mode to real-time mode when triggered by an alarm. (15 fps to 30 fps or better). Another example would be to create an alert from an otherwise unmonitored camera if motion was detected in the field-of-view of that camera using AVS. Test recordings should be made to ensure that activation of the triggers, trip wires or other AVS based alarms and subsequent operation of the incident recorder, does not have an adverse effect on the quality of the recorded images and meets a minimum playback resolution of horizontal resolution stated in the section 9.9.2A. Video Analytics (VA), or Analytical Video Systems (AVS), are increasingly being used within Metro to aid operators and controllers. Where numerous screens are used within an ROC, VA systems aid operators to direct their attention at areas of interest depending on how and what type of VA is employed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3256	Performance Criteria		Passive infrared detectors can be added to a systems network and tied to individual or groups of cameras that can get the attention of an operator when triggered. There are manual triggers and automatic triggers. The manual triggers initiated by AVS generally more reliable although much simpler in operation as they are fed back to the ROC separately on the network and then "paired" with a group of cameras at the ROC. AVS, or software based VA, is increasingly becoming more advanced for detecting abnormal behavior as well as triggering events based on intrusion. Automatic VA systems are usually housed at the ROC on separate servers having camera feeds directed into them. Software based analysis is then performed on these feeds and alerts generated. Metro will define what features to detect or monitor based on the project specific. Metro will ensure that these can be "measured" and "tested" in some way to ensure that false alarm rates are kept to a minimum. VA is not a substitute for processes and procedures that must be put into effect when a VA alarm or alert is generated.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.10	**CABLE TRANSMISSION SYSTEM (CTS)**													
		9.10.1	GENERAL													
3257	Performance Criteria		The Cable Transmission System (CTS) shall incorporate both the backbone fiber optics transmission system and communications metallic cable distribution within the confines of the yard, wayside/guideway, passenger station area, control center, etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3258	Performance Criteria	A	Backbone System The backbone CTS shall be an optical fiber-based system to mitigate electrically induced interference to the communications system, and shall provide all voice, data, and CCTV video transmission circuits between the ROC and all fixed locations on the LRT and HRT System (as applicable). Fiber optic cable and terminal equipment shall be equipped for 1:1 protection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3259	Performance Criteria	B	Functional Requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3260	Performance Criteria	B1-3	**1.** The system shall operate in a ring arrangement, with self-healing equipment in event of a fiber optical cable 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 not drop any active telephone call. 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, each CTS backbone ring shall consist of two fiber cables with 144 single mode OS2 fiber strands. Each CTS backbone ring shall have an alternate routing loop back to ROC to avoid a single point of failure. **3.** Voice, Data, and CCTV video on the CTS shall operate on the fiber optic transmission service at a bit rate capable of transmitting the type and quantity of signals required without impeding the operation of the LRT or HRT system. The CTS shall provide voice grade channels for telephone, public address audio, radio audio and control, and data channels for the SCADA, UFS, TPSS, Train Control and other subsystems, and video grade channels for CCTV subsystem. Bandwidth and quality of service shall be allocated in accordance with the specific subsystem requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3261	Performance Criteria	B4-8	**4.** The CTS network shall be configured to maximize reliability and will feature redundancy in the event of equipment or cable failure. Inbound and outbound traffic at every node shall have fiber and equipment 1:1 redundancy. **5.** The Metro telephone system shall have dual paths within the cable transmission system. Loss of a fiber optic line or repeaters shall cause the remote multiplex unit to switch to the redundant transmission link. **6.** Full featured CTS management tools shall be included that allow system configuration and alarms to be managed from a single remote location in ROC. Maintenance and diagnostic capabilities shall be provided at each local node. **7.** The CTS equipment shall be capable of multiple service types including E Line, E-LAN and E-Tree. **8.** All E-Line and E-LAN services shall be protected by G.8032 Ethernet Ring Protection Switching.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.10.2	DESIGN CRITERIA													
3262	Performance Criteria	1	The CTS shall consist of, but not be limited to, the following components: **a.** Transmission Lines (metallic cable and fiber optic cable) **b.** Transmission Line housing **c.** Transmission line termination apparatus **d.** Transmission line supervision with automatic transfer apparatus may be either internal or external optical equipment. **e.** The CTS Equipment with the following MINIMUM functions: **1)** Common Logic Redundancy **2)** Power Supply Redundancy **3)** Output Redundancy (Either Constant or Hot Standby for optical equipment). **4)** Remote Alarm Annunciation **5)** At ROC, dual redundant nodes shall be provided. **f.** Mounting Racks and Cabinets **g.** Duct Liners **h.** Patch Panels **i.** Fiber Optic Patch Panel **j.** Network switching and routing equipment **k.** Modular 66M Blocks	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3263	Performance Criteria	2-5	**2.** 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. **3.** All local distribution cables shall be placed in galvanized rigid steel conduit or totally enclosed raceway. Other Materials are acceptable only for backbone cable in main duct banks when encased in concrete or buried under a minimum of 24 inches of cover. **4.** All outside plant and tunnel metallic distribution cables shall be surge protected at all main and subsidiary distribution frames and at all cable terminals. Protection shall be by 3-electrode fail-short gas tube or electronic protectors. **5.** Optical Cable All outside main backbone optical fiber cable shall be gel-filled and armored for rodent protection. Sufficient fiber strands shall be provided to support the CTS subsystem plus future extensions and 25% spare. Safety-critical signals will be backed up by another independent transmission path or means. All backbone optical fiber cable (144-strand) shall be continuous, without splices, from source to system components location, terminating at the fiber distribution panel at each end	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3264	Performance Criteria	6	Backbone and Local Distribution - Metallic Pairs Local CTS distribution for voice, data, and CCTV video circuits shall be Unshielded Twisted Pair (UTP) Augmented CAT 6 (Cat 6A) with guarantee of 625 Mhz bandwidthand data rate of 10 Gigabits per second. Cat 6A shall be terminated (EIA/TIA 568-A compliant) to the patch panels and RJ-45 ports at the equipment and device sides. The total cable length including all patch cords from the equipment to the devices shall be less than 300 feet. One-manufacturer solution shall be implemented for end-to end Cat 6A Cabling system in order to receive a 25-year warranty offer by the manufacturer at no additional cost to Metro. All installation shall be done by manufacturer certified installers. 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%. No outside plant cable shall be less than 12 pairs.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3265	Performance Criteria	6	All main riser cables shall be 22 AWG minimum, and shall meet REA PE-22 o PE-89. No cable shall be less than 12 pairs. Inside wire from distribution terminals to instruments shall be 22 AWG minimum, and have a characteristic impedance of 105 ohms + 15%. All telephone instrument and jack appearances shall be served with one Cat 6A per instrument. The RJ-45 port on the patch panel located at the equipment side that is designated for telephone shall be extended via Cat 6A patch cord from the patch panel to the 66M Modular Blocks. Termination shall be EIA/TIA 568-A compliant. All outside main and riser-paired cables shall be shielded. REA PE-39 cables shall not be used as a substitute for PE-22 or PE-89 cables.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3266	Performance Criteria	7	Data Network Equipment All data network equipment shall be managed type and supports VLAN Trunking Protocol (VTP), Cisco Discovery Protocol (CDP), Enhanced Interior Gateway Routing Protocol (EIGRP) and Hot Standby Router Protocol (HSRP). No media converters and Ethernet extenders shall be allowed. Small Form Pluggables (SFP) shall be of the same manufacturer as the data equipment. All end devices shall be connected to data switches and/or routers. At locations where the distance exceed 100 meters, install CIC or IDF to support these end devices. Data switches and routers shall be eligible for SmartNet service contract. All data switches must be multi-layer. Equipment installed in the CIC and uncontrolled environment shall be hardened industrial grade with operating temperature between -40C to +75C.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.11	**SUPERVISORY CONTROL AND DATA ACQUISITION**													
		9.11.1	GENERAL													
3267	Performance Criteria		The Supervisory Control and Data Acquisition (SCADA) subsystem shall provide supervisory control of the Train Control (TC) system, auxiliary and traction power, the Environmental Control System (ECS), facilities, and other systems and subsystems as required for safe and effective remote supervision and control. Status reporting, information storage and retrieval, alarm processing, trending and incident and operations reports shall be provided via overhead displays, ROC consoles, archive media drives and hard disc storage. As a part of initial system sizing, the SCADA system shall be provided with the processing capability and memory required for Rail Projects, including communication circuits, application programs, database, displays, and logs. The system shall permit database generation and changes, as well as the compiling, debugging, and integration of new software. Schematic, one-line, pictorial, and alphanumeric displays shall be generated, altered, or deleted on-line by use of interactive programs and LCD terminal keyboards. All application programs shall be implemented with the capacity for all Rail Projects. The SCADA system shall be designed for ease of expansion and alteration in an economical and efficient manner, to facilitate future Rail Projects. The maintainable system life of the SCADA system shall be at last 25 years.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.11.2	FUNCTIONAL REQUIREMENTS													
3268	Performance Criteria	1	The SCADA subsystem shall facilitate the transmission of indications and alarms from the remote terminal units (RTUs) to the ROC and the transmission of controls from ROC to the RTUs. All transmissions shall be through the CTS. The SCADA transmissions shall include: **a.** Traction power alarm, indication and control signals **b.** Train control alarm, indication and control signals **c.** Mechanical equipment, load shed control signals and auxiliary power alarms **d.** Gas alarm signals **e.** Tunnel ventilation alarm, indication and control signals **f.** Communications alarms **g.** Miscellaneous electrical/mechanical system status and alarms. **h.** Any other interfaces and capabilities required for safe, efficient, and effective remote operations. **i.** All Communications systems control, status/indications and alarms **j.** Passenger station subsystem alarm, indication and control **k.** Fire suppression summary status indicators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3269	Performance Criteria	2-5	**2.** Remote terminal units (RTUs) – See Appendix A - shall be provided to interface local and remotely located devices with the SCADA subsystem. Analog input, discrete inputs, discrete output and local subsystem communications interfaces shall be provided. The RTU shall provide isolation between the signal source and the CTS units. The preferred design is IP based communications (See Appendix B). **3.** Redundant server processors shall be provided and configured in a primary/backup mode to support automatic fail over to the backup processor upon failure of the primary processor. **4.** Signal transmitted from the RTUs to the processors at the ROC shall be processed to provide monitoring information for all subsystems listed above, generate commands to be transmitted back to the RTUs, provide information for displays and alarm processing at the control consoles and store information and historical data for future processing. **5.** The SCADA subsystem shall provide monitoring of the seismic detectors and gas sensors and generate commands for emergency operation procedures for the control of ventilation fans and dampers. Communication shall be provided via RTUs on the CTS for data exchange between the ROC and the equipment located in the passenger station TC&C rooms, yard, shop and maintenance areas. The detail requirements of SCADA RTU are described in Appendix A and B.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.11.3	DESIGN CRITERIA													
3270	Performance Criteria	1	Equipment and associated peripherals for the SCADA subsystem shall include, but not be limited to, the following: **a.** Redundant server processors **b.** Data storage peripherals: Disc drives and archive media drives **c.** Hard copy printers: High-speed gray scale and color printers **d.** Control consoles consisting of: Dual head, flat screen monitors Keyboard Computer interface Cursor positioning devices.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3271	Performance Criteria	2-6	**2.** SCADA server CPU usage does not exceed 90% for more than ten seconds at any time. The CPU usage shall normally average less than 40%. **3.** Remote and ROC RTUs shall operate in a full duplex mode with each continuously scanning and reporting the changes of status of indications and commands. The RTUs shall utilize reliable, error detecting communications protocols. Capability shall be provided to scan each data point at an assignable rate, selectable between one second and 30 seconds per scan cycle. **4.** A computer platform consisting of redundant server processors shall perform the real time data acquisition processing, generation of supervisory control commands, alarm generation, database management, execution of diagnostic and maintenance programs. **5.** Offline simulation and playback functions shall be provided. **6.** Hard copy peripherals (e.g. printer) shall interface with the ROC computer. In addition to the generation of reports, these hard copy peripherals shall be capable of printing out all alarms that are stored in redundant databases, including the date and time at which they occur.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3272	Performance Criteria	7-10	**7.** Alarm displays shall be designed with latching circuitry. An annunciator shall sound an initial alarm and the visual indication shall be illuminated. The audible alarm shall have a silencer function. The visual indications shall remain latched until the alarm is cleared and the indication is reset. Both audible and visual reset provisions shall be provided on a graphical display on the SCADA console. **8.** Multi color displays with direct manual access to the cursor shall be used for English language alphanumeric display of status indications, alarms and controls and graphic display of the schematic diagrams and plans. **9.** An emergency condition shall immediately be displayed on the operating displays to permit monitoring of device actions by the operator. In the event that a sequence of actions has been initiated, the appropriate devices shall flash until the sequence has been completed. **10.** A horn/strobe device shall be activated by Fire/Life Safety critical alarm indications as the SCADA also serves as a remote fire alarm annunciator.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.12	**FACILITY AND EMERGENCY MANAGEMENT SYSTEM**													
		9.12.1	GENERAL													

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3273	Performance Criteria		Facility and Emergency Management (F&EM) System consists of high availability logic controller, Emergency Management Panel (EMP), Auxiliary Emergency Management Panel (AEMP), and Remote CCTV Jack Box. An Emergency Management Panel (EMP) shall be provided at designated locations at underground and aerial stations, trench structures, and mid-line vent structures (Reference: Fire/Life Safety Criteria). Each EMP shall be equipped with controls, alarms, and status indications, as applicable, for: • Emergency Ventilation System • Fire Detection and Suppression Monitoring • Gas Detection • Intrusion Detection • Seismic Detection • Public Address System • Escalators • Elevators	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3274	Performance Criteria		EMP shall include a local SCADA human machine interface (HMI) panel for indication and control of station ventilation and seismic detection, a local CCTV workstation for CCTV cameras monitoring and control, an Intrusion Detection System (IDS) annunciator panel for indication of intrusion alarms, and a remote graphical annunciator for fire alarm and trouble indications. Information shall be graphically overlaid on top of station schematics as well as in tabular data format. Each EMP shall be equipped with the following communications circuit access: • Priority Access to local PA system • Two ETELs (wall phones with outside dialing) • Evacuation system activation • Capability for facilitating evacuation of patrons, including controls for homing of elevators, and releasing fare gates • Intrusion detection alarm • CCTV monitoring and control • Remote annunciator for the fire alarm control panel	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3275	Performance Criteria		An EMP shall be located in the vicinity of the underground station entrance at mezzanine level un-paid area to which the fire department will respond. Locations shall be approved by the Fire/Life Safety Committee (FLSC). Auxiliary Emergency Management Panels (AEMP) shall be provided at underground and aerial passenger stations which have a secondary entrance not readily accessible to the EMP and shall be used to augment the functions of the EMP. The AEMP shall contain: • Emergency telephone (ETEL) • Capability for facilitating evacuation of patrons, including controls for homing of elevators, and releasing fare gates • PA system access • Intrusion detection alarm.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3276	Performance Criteria		A remote CCTV jack box shall be provided outside of the station at-grade level at underground stations 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. The locks for the EMP, AEMP, and CCTV box need to be compatible with the Metro keying scheme. Appropriate locks and keys need to be coordinated with the Metro keyshop, and need to be the same as existing EMP keys.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.12.2	OPERATION													
3277	Performance Criteria		When activated, the EMP shall have control priority over central control of the emergency ventilation. Alarms and indications shall be reported to the EMP and to central control regardless of which entity is in control. Underground EMP shall have the capability of controlling multiple ventilation zones served by separate F&EM PLCs. Only one EMP or ROC shall have control over a ventilation zone The following requirements shall be met as far as the EMP/ROC controls and interfaces:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3278	Performance Criteria	a-e	**a.** Each and every EVOP (Emergency Ventilation Operational Procedure) scenario shall have a pre-determined fans/dampers configuration, to be implemented upon activation of a single, discrete command from either ROC or anyone 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.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3279	Performance Criteria	f-h	**f.** 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. **g.** In case of failure of any local controller, the respective EMP will have its controls relinquished, and send an alarm to SCADA. **h.** If the F&EM PLC detects that the EMP is offline, then control shall revert to the ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3280	Performance Criteria		The location of EMPs and their ventilation zone assignments shall be coordinated with the local Fire Department having jurisdiction.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.12.3	DESIGN CRITERIA													
3281	Performance Criteria		The EMP shall be the intuitively operated touch screens (with back-up keyboard/mouse) used to monitor and control emergency events in an underground or aerial 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. Emergency ventilation controls and indications shall be graphically accessed, and may show the complete ventilation area. 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 followings: **1.** Emergency Ventilation Operating Procedures (EVOP) **2.** Emergency Gas Operating Procedures (EGOP) **3.** Emergency Seismic Operating Procedures (ESOP)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3282	Performance Criteria		Emergency ventilation controls and indications shall be graphically accessed, and shall show the complete ventilation area. EMP shall have the capability of controlling multiple ventilation zones served by separate SCADA RTUs. EMP shall have the features to monitor and control CCTV cameras at the station. The location of EMPs and their ventilation zone assignments shall be coordinated with the local Fire Department having jurisdiction. The design of the EMP will be coordinated with Metro, who will provide screen shots of EMPs currently in use. F&EM PLC requirements: **1.** Redundant CPU, **2.** Redundant power supply fed from separate circuits, **3.** Continuously supervised redundant remote IO data links.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3283	Performance Criteria		EMP Cabinet: The EMP cabinet shall house the following equipment: **1.** Telephone panel with two emergency telephones **2.** One public address panel with microphone and selector panel **3.** One HMI workstation supervised by the F&EM PLC and alarm to SCADA on loss of communications, One CCTV workstation for CCTV monitoring and control, two 21" flat-screen rack mounted color graphic monitors (LCD), with drawer slides for extension of LCDs out of EMP cabinet for maintenance purposes. One screen is for SCADA HMI, and another one if for CCTV monitoring. **4.** One fire /gas alarm graphic annunciator and an EVAC microphone interfaced with the FACP **5.** One IDS graphic annunciator **6.** Cooling slots at top and bottom of cabinet for ventilation. **7.** Conduit entry and wiring space at back of cabinet. **8.** Wiring terminations secured at back of equipment openings.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3284	Performance Criteria		In addition, each EMP should have keys necessary for access to all areas of station in nearby lockbox and a designated space for EMP as-built map books and emergency ventilation procedure books (as applicable). The design of the EMP should be coordinated with Metro, which will provide screen shots of EMPs currently in use. Future EMPs could be designed similarly; however, it is possible that advances in fire/gas products may result in a graphical alarm screen being available from the fire/gas panel manufacturer. If this is the case, fire and/or gas could be shown on a separate (fully fire rated) screen, while other functions would remain on the touch screen monitors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.13	**INTRUSION DETECTION AND CONTROLLED ACCESS**													
		9.13.1	GENERAL													
3285	Performance Criteria		The Intrusion Detection and Controlled Access (IDCAS) shall be provided for designated rooms and areas at passenger stations, yard and shops and ROC facilities, and facilities/equipment. Detection of authorized and/or unauthorized intrusion shall be reported to Union Station Gateway (USG) Plaza via the Cable Transmission System (CTS) for recording and to the station EMP. Any intrusion along the right of way including fences/tunnel portals shall be reported to ROC via station SCADA/RTU and to the station EMP. In general the intrusion detection is considered to be composed of two systems; ancillary intrusion detection and Right of Way (ROW) intrusion detection. Ancillary (and facilities) intrusion detection is intended to control access to and monitor intrusion of secure non-public areas. Monitoring is primarily a transit security / law enforcement function. ROW intrusion is intended to monitor unauthorized access to the running rails. Monitoring is primarily a safety function performed by Rail Operations Control and may be interfaced directly to train control and traction power systems for automatic actions as determined by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.13.2	DESIGN CRITERIA FOR ANCILLARY SPACE													
3286	Performance Criteria	A	Functional Requirements Detection of entry into specific rooms shall be reported to IDS server at USG Plaza.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3287	Performance Criteria	A1a	**1.** Intrusion detection devices shall provide continuous indication of door movement of 1 in. and greater from the fully closed and latched position. As a minimum intrusion detection shall be provided for the following rooms and areas: **a.** Passenger stations: **1)** Traction power substations **2)** Rolling grilles when provided at station entrances **3)** Auxiliary power rooms **4)** Train Control and Communications rooms **5)** Communications and Signaling rooms and buildings **6)** Sprinkler valve rooms **7)** Electrical cable rooms **8)** Electrical equipment rooms **9)** Emergency exits and platform end gates **10)** Emergency exit hatches. **11)** Agent office **12)** Battery rooms **13)** Corridor doors leading from public areas to ancillary areas **14)** Mechanical rooms **15)** Emergency fan rooms **16)** Elevator equipment rooms **17)** Cable turning rooms **18)** Other ancillary room doors, as needed	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3288	Performance Criteria	A1a	Card key access also shall be provided for 1) through 5) above listed facilities. Roll-up grilles will require two card readers; one on each side of the grille. Card key access shall also be provided for 13) to suppress alarms for authorized entry. Intrusion for 7), 8), 11), 12) and 18) shall be recorded as an event only for historical reporting and shall not trigger an intrusion alarm when the area perimeter is also secured by IDS. An intrusion concept should be developed for large facilities (like underground stations) so that the premises are protected, but not over-protected (too many alarms may result in the system not being utilized). Attention should be given to protecting the perimeter – all of those doors that are dividing the public from non-public areas. In any case, the doors requiring card readers will remain the same. The system shall be designed to minimize false alarms. A combination of key bypass switches and extra card readers, or other technology which keeps alarms from being sent when a key is used to unlock a door, should be used so that all alarms are valid alarms, not employees going about their daily business.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3289	Performance Criteria	A1b	**b.** Yard and shop facilities and central control: **1)** Communications equipment rooms **2)** Data processing rooms **3)** Operations control rooms **4)** CCTV observation rooms **5)** Operations computer rooms **6)** Yard control Towers **7)** Train control rooms/building. **8)** Electrical equipment rooms **9)** Mechanical rooms **10)** Traction power substations Central Control facilities shall also have card key access.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3290	Performance Criteria	A1c-f	**c.** Intrusion alarms shall be indicated to the SCADA RTU, the IDCAS server/workstations at USG and at the EMP. Intrusion indication to the SCADA RTU shall be from an auxiliary output contact of the local door control unit. **d.** Local audible alarms with configurable automation timed resets shall be provided for intrusion detection at emergency exit doors. **e.** Request to exit devices shall be installed to inhibit intrusion alarms during egress from the secure side of any monitored entrance. Internally wired request to exit hardware integrated into doors/frame shall be provided for equipment rooms. **f.** All train control cases, signal houses, or any location that houses the train control equipment shall have intrusion detection system and card reader access	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3291	Performance Criteria	A2	The controlled access (CA) subsystem shall include card key readers and validating terminals. Card readers' installations shall be inconspicuous and not easily identifiable to the general public.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3292	Performance Criteria	A2a-d	**a.** The key card shall contain a machine-detectable code indicating unique security classification number (SCN). When an employee uses a key card to activate a card reader adjacent to a controlled door, the subsystem shall release the electric lock if access is authorized for the specific card, based upon door number, time of day, and day of the week. **b.** The subsystem shall maintain a record on magnetic disk. The record shall include intrusion alarms, diagnostic alarms, all card reader events and authorization status. The date, time, location, card identification, card holder's name, department badge number and SCN shall be recorded with each record. These records shall be retrievable via both computer and hard copy. Functions for archiving and restoring records shall be provided, **c.** The IDS server at USG shall be a pair or computers operating in primary/standby configuration with automatic failover. All system configuration and alarm/event data shall reside on RAID protected shared disk memory. **d.** If the subsystem fails or is out of service due to a communications loss with the IDS server, its functions shall transfer to a backup mode of operation. While the backup mode is in effect, access to a door shall be granted when a zone code ascribed to the SCN on a card coincides with the zone code assigned to the door where the card is presented.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3293	Performance Criteria	A2e-h	**e.** If both the subsystem and its backup mode fail, door releases shall be effected 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 preselection of the appropriate failure mode, be it locked or unlocked, for each specific door. **f.** Local audible alarms with configurable automation timed resets, magnetic switches, passive infrared (PIR) detectors, key bypass switches, and Emergency Hatch PLC-based Controller shall be provided for intrusion detection at emergency hatches. The emergency hatch doors shall have both active pneumatic and mechanical assisted system to assist in the opening of the doors (refer to Architectural Standard drawing AS-036 and Electrical Directive drawings ED-430, ED-431, ED-432 and ED-433). The active pneumatic system shall have the capability to be monitored via SCADA at ROC. **g.** Local audible and visual alarms with configurable automation timed resets shall be provided for intrusion detection at platform end gates. Key by-pass switches shall be provided so that employees can use the gates without setting off alarms. **h.** The controlled access or intrusion detection system shall not inhibit egress.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3294	Performance Criteria	A2i-k	**i.** The subsystem shall provide the capability of authorizing and voiding a single SCN or a group of SCNs. The subsystem shall provide the capability of assigning employee names, department, badge numbers and zone codes to each SCN. The subsystem shall provide the capability of authorizing combinations of door numbers, SCNs, times of day, and days of the week. The subsystem shall prevent alterations of the data by unauthorized persons and provide capability for changing access codes and validations on a real-time basis. **j.** Emergency exit doors shall have local audible alarms that sound on the public side, with configurable automation timed resets. They shall be provided with card reader on the public side, and request to exit devices on the emergency stair side. **k.** The subsystem shall provide selection capability to print out authorized access and/or print out only rejected access attempts	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3295	Performance Criteria	A2l-n	**l.** Encoding terminals shall be provided for the encoding of key cards with employee name, department, badge number, SCN and zone code. Encoding terminals shall encode key cards singly or in multiple. **m.** Encoded key cards shall be impervious to magnetic fields, dirt, water, oil, embossing, laminating and damage by scratching. **n.** Vandal-resistant, weatherproof, proximity type card readers shall be located at traction power substations, passenger station public areas, main entrance rolling grilles to the passenger stations, TC&C rooms, communications equipment rooms, Yard Control Towers, auxiliary power rooms, electrical rooms, sprinkler valve rooms, and station auxiliary power rooms.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.13.3	DESIGN CRITERIA FOR OPEN SPACE (RIGHT OF WAY)													
3296		A	Functional Requirements													
3297	Performance Criteria	A1	Wayside Intrusion Detection System (WIDS): The WIDS shall be installed along the perimeter fencing and the bridges along the right-of-way, wherever it is directed by Metro, (or other Metro approved areas) to warn ROC controller of unauthorized entry into the restricted areas. **a.** The WIDS shall be 24 hr x 7 days, failure rate be less than 1%. **b.** The WIDS shall be a fiber optic intrusion detection system (or other Metro approved means) utilizing a fence-mounted fiber optic vibration sensor cable. The sensor cable shall be an outdoor-grade fiber optic cable rated for aerial and duct installations with a UV-resistant medium-density polyethylene jacket. **c.** CCTV cameras may need to be added as part of the WIDS system. These cameras should feed back into the station CCTV system, as well as being an integral part to the WIDS system. **d.** A wayside intrusion alarm signal shall be transmitted to the ROC via the SCADA system. The alarm signal shall identify the zone in alarm on control consoles and CCTV observer consoles in ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3298	Performance Criteria	A2	Tunnel Portal Intrusion Detection System (TPIDS): The TPIDS shall be provided at tunnel portal entrance areas to warn the train operators and ROC controller of unauthorized entry into the tunnels. Infrared transmitter/receiver beam motion detectors (or other Metro approved method) shall be provided at the tunnel portal entrance along with intrusion warning signals for train operators and intrusion alarm for the ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3299	Performance Criteria	A2	**a.** CCTV cameras shall be installed as part of this system, and will feed back into the station CCTV system. **b.** An intrusion alarm signal shall be transmitted to the ROC via the SCADA system. The alarm signal shall identify the zone in alarm on control consoles and CCTV observer consoles in ROC. **c.** The alarm signal shall cause the CCTV camera screen for the camera viewing the tunnel portal zone in alarm to be highlighted, or other Metro approved means of gaining ROC operators immediate attention. **d.** Intrusion warning signals within the tunnel zone in alarm shall be activated to flash alternately on-off at 1 second intervals (or other Metro approved means) to warn train drivers of an unauthorized entry into the tunnel. These signals shall be installed at both ends of every zone and strategically positioned to provide sufficient advance warning to approaching trains. **e.** Intrusion alarms, CCTV highlights, and train driver warning signals shall remain active until remotely reset by an operator at the ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3300	Performance Criteria	A3-5	**3.** The subsystem shall be immune to EMI, RF emissions, and lightning. **4.** The subsystem shall be capable of automatically generating both visual (through CCTV) and audible alarms to Personnel at ROC. **5.** Local audible alarms with configurable automation timed resets shall be provided for intrusion detection for emergency exit hatches, cross passage doors, platform end gates and any other emergency access to dedicated right of way. An auxiliary intrusion contact shall also be provided for future interface of ProTran warning system by others.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.14	**FIRE ALARM SYSTEM**													
		9.14.1	GENERAL													
3301	Performance Criteria		The fire alarm system shall generally consist of a fire control panel, smoke & heat detectors, monitor modules for water flow and valve tamper switches, monitor, relay, and control modules, and audible and visual notification devices. If there is a fire, the fire alarm system shall provide alarm annunciation, and as applicable, automatic fan and damper shutdown, elevator recall and shunt trip, fire suppression activation, and evacuation by zone.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.14.2	DESIGN OF THE FIRE ALARM SYSTEM													
3302	Performance Criteria	A-C	**A.** Fire alarms, supervisory alarms, and trouble alarms shall be monitored at the Fire Alarm Control Panel (FACP) in TC&C room and Central Supervisory Station in ROC through the CTS system. **B.** FACP shall provide dry contact summary alarm, summary trouble and summary supervisory interface to the SCADA PLC for system redundancy. **C.** At aerial and underground stations, the fire alarm system will also report to the Emergency Management Panel, where it will have a remote graphical annunciator with a graphical and tabular display which will guide first responders to the location of the alarm.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3303	Performance Criteria	D, E	**D.** There shall be two evacuation zones per station (at the underground and aerial stations) – an all evacuation zone, and an ancillary area only zone. The fire system will be programmed so that any one smoke or heat detector activation in the ancillary area will evacuate only the ancillary area. Any smoke detector in the public area will evacuate the entire station. Any two smoke or heat detectors anywhere in the station will evacuate the entire station. Any water flow alarm within the station will evacuate the entire station. Water flow or smoke detect alarms outside of the station will not evacuate the station. **E.** Underground stations shall have two deluge systems – one for each track. Activation of the deluge system shall cause the power on the affected track to be removed. This removal of power should occur in two ways – one through the deluge button being pushed, and one through the flow switch that senses the deluge water flow through the FACP.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3304	Performance Criteria	F-H	F. All TC&C rooms and buildings , C&S rooms and building, TC rooms and buildings (signal bungalows) shall be protected with an approved non-water based special extinguishing system (such as an inergen system or equivalent), that does not damage or affect the performance of installed equipment. **G.** Elevators shall be recalled through the FACP by activation of an elevator lobby smoke detector, or elevator equipment room detector. Alternate floor recall will be required as needed. **H.** Elevator equipment rooms shall be shunt-tripped through the FACP by activation of a heat detector in the elevator equipment room (present code requires a heat detector within 18 inches of each sprinkler head). The AC power used to shunt trip the elevator room must also be monitored. In addition, when the room is shunt-tripped, the battery lowering device must be disabled (also through a control or relay module from the FACP).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3305	Performance Criteria	I-L	**I.** Fans (except the Emergency fans) over 2000cfm shall shut down through the FACP, and fire smoke dampers shall close. In an underground station, a shutdown scheme should be designed so that a fire detector or a water flow switch in that area will shut down all fans and close all dampers in that area. Fans should automatically restart after the fire panel has been reset; breakers should not be required to be reset. **J.** 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 fire alarm workstation located in the ROC. **K.** Fire system design shall minimize false alarms through the use of intelligent detectors, alarm verification, detector placement, and type of detector. **L.** In stations where a gas detection system is located, the fire alarm system may be used as the means of evacuating the station based on a high gas alarm (with AHJ approval). In this case, the notification devices must be marked “EVAC” and “Evacuation” instead of “FIRE”. Coordination with the gas system design will be required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3306	Performance Criteria	M, N	**M.** Upon activation of the Evacuations microphone at the FACP or EMP, the FACP shall suppress all active fire audible devices in the notification appliance circuits (NAC). **N.** 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 and EMP. **2.** ROC shall evaluate the alarm condition and select a pre-programmed scenario(s) developed and programmed. However, for rate-compensated heat detectors mounted on edgelight assembly of station platform shall automatically activate station emergency fans (exhaust mode) within 90 seconds. **3.** Annunciate both visually and audibly at the FACP, EMP, and the Metro's fire alarm workstation in ROC. **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 detectors. **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. **9.** Elevator fire recall/shunt trip (as applicable).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3307	Performance Criteria	O, P	**O.** All initiating circuits shall all be configured "Class A". **P.** All notification circuits shall all be configured "Class B", except in underground stations, where any notification devices in the public areas shall be configured "Class A".	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3308	Performance Criteria		Additional design may be required to accommodate changes in code.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.14.3	DEVICE PLACEMENT													
3309	Performance Criteria		At minimum, the design shall comply with the code requirements and shall include additional provisions required by AHJ. Devices should be placed as follows, at a minimum. Additional devices may be required (or may be deleted) per AHJ.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3310	Performance Criteria	A-E	**A.** Smoke detectors: • TC&C rooms and buildings • TPSS rooms and buildings • Signal and radio bungalows • All ancillary rooms • Elevator lobbies • Cross passages **B.** Heat detectors: • High voltage areas (such as TPSS's and Auxiliary power rooms) • Elevator equipment rooms **C.** Duct detectors shall be installed as required by code **D.** Audible and visual notification devices: • TC&C rooms and buildings • TPSS rooms and buildings • Signal and radio bungalows • Public areas in underground and aerial stations • All ancillary rooms • Stand alone TC&C, TPSS, and Signal buildings shall additionally have one strobe mounted outside the main entrance door. **E.** Remote graphical annunciation panel in EMP for monitoring and control of the FACP.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3311	Performance Criteria	F-H	**F.** Manual pull stations in standalone buildings: • TC&C buildings • TPSS buildings • Signal and Radio bungalows • Yard buildings **G.** Manual pull stations in Underground and Aerial Stations - at the AHJ's discretion, manual pull stations shall be replaced by ETELs. ETEL shall have fault reporting to SCADA. The ETELs may be installed in the following areas: • Public areas • Areas of egress (emergency stairs, corridors, and hatches) **H.** Additional requirements: Sequence of Operations must be posted at fire panel Fire Panel must have a document holder that contains final full size prints, and a USB drive with the FCP program Fire Panel must have labeling that indicates the location of the breakers feeding the FCP Breakers for Fire Panel circuits must be painted red, be clearly marked, and have clips installed that prevent them from being opened without removing the clips.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3312	Performance Criteria		The number and placement of all devices shall be determined by code. All devices must be accessible per Metro Fall Protection Policy 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 hook installed next to it or provide other means of access.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		9.14.4	POWER													
3313	Performance Criteria		Power supply and distribution for the fire alarm system shall be furnished in accordance with applicable NFPA Codes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.14.5	CENTRAL SUPERVISORY STATION													
3314	Performance Criteria		The Central Supervisory Station (CSS) shall be the primary means of annunciating, logging and managing fire alarms, trouble and supervisory information from the fire systems. The CSS shall be implemented with two or more workstations, each capable of performing all of the required functions. Alarm acknowledge shall only be required at one CSS workstation. It shall be possible to partition CSS workstations for monitoring of selected territories. The CSS shall be implemented using software listed to meet UL864. Communications from FACP's to the CSS shall utilize Ethernet via a dedicated service in each CTS system and shall employ means and methods to satisfy UL864 requirements for Transmission and Communications Paths and/or approved by Metro and the AHJ.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.15	**GAS MONITORING AND SEISMIC ACTIVITY DETECTION**													
		9.15.1	GAS MONITORING EQUIPMENT													
3315	Performance Criteria		In areas classified as "gassy" or "potentially gassy" by CAL/OSHA or when directed by the Fire/Life Safety Committee, permanent gas monitoring equipment shall monitor hazardous gases in the atmosphere of subterranean facilities. Each gas monitoring alarm shall be annunciated at Central Control and at the EMP in the station where the gases detected. Presence of an alarm shall initiate the appropriate Emergency Gas Operating Procedure (EGOP) which activates a pre-determined ventilation scenario to purge the gas. Unless otherwise directed by the Fire/Life Safety Committee, hazardous gases to be monitored shall be determined by review of subsurface conditions reports and other relevant data.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3316	Performance Criteria		**A.** The system shall initiate a minor alarm whenever methane is detected at 10% of lower explosion level (LEL), or hydrogen sulfide is detected at 5ppm. Low speed EGOP will be initiated automatically. **B.** The system shall annunciate a major alarm whenever methane is detected at 20% of LEL. High speed EGOP will be initiated automatically. **C.** The system shall annunciate an "evacuate" level alarm whenever methane is detected at 25% of LEL, or hydrogen sulfide is detected at 10ppm. High speed EGOP will be initiated automatically, and the station will be automatically evacuated. **D.** The gas system may have its own evacuation system (horns/strobes) or it can evacuate the station using the fire alarm system (with permission from the AHJ). In that case, coordination with the fire alarm design would be required or, it may be possible to use a fully combined fire and gas alarm system, if such a system can be shown to meet Metro's needs, with the concurrence of Metro and the AHJ.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3317	Performance Criteria		**E.** All alarms shall report to the EMP, both on a graphics display (showing exact location of the gas sensor in alarm) and by tabular alarm display. **F.** In addition, the current analog level of all gas sensors, trouble and calibration status shall show on the SCADA system at the ROC. **G.** All portions of the gas system shall be fully monitored by SCADA, and the system shall send trouble alarms additionally to the EMP. **H.** Gas monitoring equipment shall be accessible for maintenance. There shall be room for access with a ladder, and if a ladder over 8 feet is required, a fall protection hook must be installed next to the device or provide other means of access. Gas monitoring equipment shall not be installed over high voltage equipment. **I.** Gas control units shall not send gas level or limit alarms while in calibration mode. Calibration mode shall be indicated to SCADA and report a trouble to the FACP.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.15.2	SEISMIC DETECTION EQUIPMENT													
3318	Performance Criteria		Seismic switches shall be provided to advise of seismic event of sufficient intensity to cause potential damage to facilities. The devices shall be installed at intervals and locations to provide comprehensive coverage. The system shall report a self resetting minor alarm for events greater than 0.1G and less than 0.2G. The system shall report a latching major alarm for events greater than 0.2G. The system shall be fully supervised and report alarm and trouble to the SCADA RTU.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.16	**CENTRAL CONTROL APPARATUS**													
		9.16.1	GENERAL													

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3319	Performance Criteria		Apparatus at central control includes console equipment to support various manned positions, recorders, printers, displays and special processing components. Digital time clocks synchronized with a reliable, accurate time source shall be distributed throughout the facility. An access control system and continuously recording CCTV/Video management system shall secure the entire facility perimeter and designated rooms. Proximity card reader access shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.16.2	CONTROLLER AND CCTV OBSERVER CONSOLES													
3320	Performance Criteria		Train dispatcher consoles shall have powered sit-stand lifts to independently position the workspace and monitor surfaces. Consoles shall be suitably arranged and include adequate surface area, communications capabilities, workstations, displays and other equipment, equipment cabinets, environmental conditioning, wire management and lighting as necessary to support the assigned supervision, control, communications and administrative functions in an ergonomic manner. Communications equipment such as radio, public address, VMS, intercom, and telephone shall be integrated to the greatest extent that is possible while maintaining high availability and reliability requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.16.3	VOICE RECORDING													
3321	Performance Criteria		Multi-channel voice recording equipment shall be installed in the communications equipment room to provide continuous archival records of designated voice communications. Recording channels shall typically include one channel for each radio voice channel, one channel for composite audio for each console operating position, and one channel for selected managers'/assistant managers' office phones. The individual composite console position channel shall record the position headset/handset audio and include all ATEL, ETEL, PTEL, MTEL, intercom, public address and radio circuit activity at the position.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.16.4	PRINTERS													
3322	Performance Criteria		Color and black/white high volume printers shall be provided as necessary to support the rail operations and administrative functions. Sharing of printing resources shall be utilized to the greatest extent possible without compromising system security or performance requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.16.5	SYSTEM STATUS DISPLAY SUBSYSTEM													
3323	Performance Criteria		Large overhead flat panel displays shall be arranged throughout the control room to provide an overview summary status of rail operations and facilities. The displays shall permit each train dispatcher and management personnel to view the position and ID of every train on the system, status of every switch, signal and track and summary alarm status of every subsystem. The position and arrangement of the status display shall permit comfortable viewing from each control console position.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.16.6	CCTV WALL AREA													
3324	Performance Criteria		A CCTV wall shall be provided in the CCTV observers' area to provide continuous viewing of all station platforms and designated high security areas. The wall shall be constructed as an arrangement of large flat panel displays of multiplexed live video.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.16.7	DATA PROCESSING ROOM													
3325	Performance Criteria		**A.** The data processing room shall house all data processing and data storage apparatus for central control, including computers associated peripherals, Metro telephone server, process controllers and other equipment requiring strictly-regulated temperature and humidity. **B.** Consoles shall be provided as necessary to support the following functions: **1.** Network monitoring and management **2.** System development and simulation **3.** Application monitoring **4.** All SCADA functions available to the rail operations control. **5.** Support Rail activation testing **C.** Each console position shall be provided with an ATEL. **D.** Designated console positions shall be provided with radio, public address/VMS capabilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.16.8	GENERAL													
3326	Performance Criteria		The communications equipment room shall contain all ancillary central control equipment not requiring regular access for normal operations. The room shall be located adjacent to the data processing room. Maintenance desks with convenience power outlets, ATEL and radio access shall be included and located as necessary to provide workspace and documentation storage as necessary for proper on-site maintenance of equipment. MTELs shall be installed at each end of designated equipment racks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.16.9	BATTERY ROOM													
3327	Performance Criteria		The battery room shall contain provisions for housing batteries for communications battery/rectifier plant and UPS Module/battery system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.16.10	YARD CONTROL TOWER EQUIPMENT													

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3328	Performance Criteria		Provide a train dispatcher console in the Yard Control Tower identical to the train dispatcher console at central control with the following services available: **A.** Yard operations radio channel. **B.** Emergency operations radio channel. **C.** Transmit amplifiers and receive amplifiers, if required, shall be provided in the Yard Control Tower communications equipment room. **D.** Supervision, base station disable, voting control, patching, and other radio facilities management control shall be performed by the communications controller at central control. **E.** Remote annunciator panel for the FACP.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.17	**YARD COMMUNICATION**													
		9.17.1	GENERAL													
3329	Performance Criteria		The functionality of the various communications subsystems is described in other sections of this document. Only the specific application of subsystems to the Yard and its buildings is described in this subsection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.17.2	COMMUNICATIONS EQUIPMENT ROOM													
3330	Performance Criteria		The Communications Equipment Room shall be located in the vehicle maintenance shop building. All terminal equipment for communication circuits to, from and within the Yard shall be installed at this location. All communications Yard duct banks and Yard-to-mainline transitional communications duct banks shall terminate in a cable vault under or adjacent to the Communication Equipment Room and have at least 20% separate conduit capacity.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.17.3	CABLE TRANSMISSION SYSTEM (CTS)													
3331	Performance Criteria		The fiber optic and CTS terminals for the Central Control/Yard backbone line shall be located in the Communications equipment room (reference Cable Transmission Systems Backbone System). Local distribution throughout the Yard and associated buildings shall be by fiber optic and metallic cables as outlined in Cable Transmission Systems Backbone and Local Distribution - Metallic Pairs. Main feeder cables shall be provided to major buildings, e.g., \Maintenance of Way, when they are present.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.17.4	TELEPHONE SERVICE													
3332	Performance Criteria		All Yard telephone service (ATEL, ETEL and MTEL) shall be provided from the appropriate Yard Metro telephone system. Functionally, all services shall operate as described in the telephone system with the exception that ETEL circuits within the Yard complex shall ring to the Yard control room. Additionally, if the call is not answered after three rings, the call shall be automatically forwarded to the central control emergency reporting position.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.17.5	PUBLIC ADDRESS													
3333	Performance Criteria		The Yard PA system shall be provided in accordance with Public Address System (PA). Primary paging zones in the yard shall be: • Yard Track Area • Vehicle Maintenance Shop • Maintenance of Way • All Call.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.17.6	SCADA													
3334	Performance Criteria		The SCADA subsystem shall provide remote monitoring of Yard alarms at central control. Among the alarms to be monitored are: • Selected traction power alarms • Fire detection and suppression • Selected communications subsystem alarms In addition, operating parameters of selected Yard systems may be monitored and/or controlled at central control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.17.7	INTRUSION DETECTION													
3335	Performance Criteria		All Intrusion detection in the Yard area shall be annunciated at central control.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.17.8	FIRE DETECTION AND SUPPRESSION MONITORING													
3336	Performance Criteria		All fire detection and suppression monitoring devices in the Yard area shall be annunciated locally at the associated remote annunciator in the lobby, or other agreed upon point of entry, and remotely at central control and in the Yard control room. A map associated with the remote annunciator is required to show the yard and shops layout, with all the information necessary to find an annunciated alarm location. All buildings within the yard should report to the yard and shops FACP. There should be a strobe on the outside of each building to guide the fire department to the location of the fire.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.17.9	CLOSED CIRCUIT TELEVISION (CCTV)													
3337	Performance Criteria		The CCTV system shall be compatible with the Metro CCTV system. It shall include 100% perimeter coverage, 100% parking lot coverage, and other cameras depending on design of the yard. Yard control should be able to either physically see, or see on CCTV, all train movement.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.18	**TRACTION POWER AND DISTRIBUTION SYSTEM**													

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		9.18.1	GENERAL													
3338	Performance Criteria		The following criteria apply to the Traction Power and Distribution System that supplies power for the operation of the trains on Metro Rail Lines. Power to the trains shall be supplied at a nominal voltage of 750VDC provided by Traction Power Substations (TPSSs) located along the alignment of each line.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3339	Performance Criteria		The TPSSs shall step down and rectify the high voltage 3-phase AC power received from the local Utilities to the nominal 750VDC required to run the trains. The positive polarity of the DC system shall be distributed to the trains from the TPSSs through feeder cables connected to a Third Rail for Heavy Rail Systems, or an Overhead Catenary System (OCS) for Light Rail Systems. Power from the Third Rail shall be transmitted to the vehicles through special collecting shoes installed on bottom part of the vehicles. Power from the OCS shall be transmitted to the vehicles through pantographs installed on top of the vehicles. The negative polarity of the DC system shall follow a return path from the vehicle wheels along the running rails and back to the TPSS through negative return cables. For underground stations and tunnel portals, the TPSSs shall also distribute high voltage 3-phase AC power to Auxiliary Transformers that shall provide 480VAC to a low voltage distribution system. When feasible and convenient, TPSSs shall also provide low voltage power to at-grade stations through auxiliary transformers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		8.18.2	SCOPE													
3340	Performance Criteria		The following major components comprise the traction power and distribution system: **A.** Traction Power Substations-TPSSs **B.** Wayside Distribution System **1.** Feeder and Return Cables **2.** Third Rail **3.** OCS **4.** Running Rail **C.** Sectionalization and Emergency Trip System-ETS **D.** Trainway Feeder and Emergency Back-up Power Supply - EBPS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.18.3	CODES AND STANDARDS													
3341	Performance Criteria		The design of the Traction Power and Distribution System shall comply with the latest applicable requirements set forth by the following organizations, in addition to other applicable requirements not here listed: National Fire Protection Association (NFPA) Electronics Industries Association (EIA) Cities and the counties in which the transit system will operate American National Standards Institute (ANSI) National Electrical Manufacturers Association (NEMA) Institute of Electrical and Electronics Engineers (IEEE) Insulated Cable Engineers Association (ICEA) California Public Utilities Commission (CPUC) California Occupational Safety and Health Administration (CAL-OSHA) California Electrical Safety Orders, Title 8 American Society for Testing and Materials (ASTM) Underwriters Laboratories (UL) California Building Codes (CBC) IEEE/APTA Rail Transit Standards National Electrical Code (NEC)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.18.4	EQUIPMENT STANDARDIZATION													
3342	Performance Criteria		The design, major equipment, and components of similar TPSS and of the Wayside Distribution System shall be standardized and interchangeable between TPSSs and along the alignment of a line or construction segment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.18.5	TRACTION POWER SUBSTATIONS													
3343	Performance Criteria	A	Locations, Capacities, and Other Requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3344	Performance Criteria	A1-3	**1.** The TPSS shall be sized and located along the alignment at suitable intervals based on computer simulation studies taking in consideration all the determining factors, such as track alignment, distribution system electrical parameters, vehicle propulsion, and operational requirements, among others. Preferably, the TPSS shall be located at, or near, passenger stations to minimize voltage drops in the distribution system during train acceleration. **2.** The TPSS shall provide 750VDC nominal voltage at 100% load and operate in a range from 500VDC to 950 VDC for Light Rail Lines and in the range from 450 VDC to 950 VDC for Heavy Rail Lines. **3.** The TPSS locations, capacities, and all other characteristics shall be determined in order to meet the service requirements on the respective line, including vehicle loads, composition size, frequency of trains, and others, without degradation of service even with any one of the TPSSs out of service, providing a minimum voltage of 525 VDC for Light Rail Lines and 450 VDC for Heavy Rail Lines to any train at any location of the line.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3345	Performance Criteria	A4, 5	**4.** The system shall be designed, and shall be tested, for the allowance of the simultaneous acceleration of two AW2 loaded full train compositions –one on each direction - at the substation from which the adjacent substations are furthest apart, under the following scenarios: **a.** Acceleration of the two trains close to the selected substation while it is on service and the furthest apart substation is out-of-service; **b.** Acceleration of the two trains to the selected substation while it is out of-service and the two adjacent substations are on service. **c.** The system shall assume line current limit or similar control mechanisms under reduced line voltage conditions, as specified by Metro Rail Fleet Services for each type of vehicle and in accordance with the assignment by Operations of the type(s) of vehicle(s) to operate on each specific line. **5.** The negative to ground voltages shall be maintained below 50V - at any point of the line and at any time during normal operation with all substations on service, and below 70V with any one substation out-of service.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3346	Performance Criteria	B	Utility Incoming Switchgear **1.** Utility Incoming Metering Switchgear, as well as all incoming power connections, shall be provided in accordance with the specific Utility requirements. Adjacent substations shall be supplied from separate utility substations or from separate buses of the same utility substation, as practically possible. Isolation means shall be provided outside the TPSSs to enable the utility company to disconnect the high voltage incoming supply from the TPSS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3347	Performance Criteria	C	High Voltage Switchgear High Voltage Switchgears shall receive power from the Utility Incoming Switchgear and distribute it to the individual Transformer-Rectifiers and, when applicable, to the various Auxiliary Transformers of the Stations. The 34.5 kV circuit breakers shall consist of SF6 insulated assemblies. Lower voltages circuit breakers may be of conventional vacuum type.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3348	Performance Criteria	D1, 2	Transformer-Rectifier Units **1.** Rectifier transformers shall be indoors, ventilated, dry-typecast-coil, self cooled, class AA, configured as required to power the rectifier units further described. The 34.5kV transformers shall be of cast coil construction. The lower voltage transformers may be conventional dry-type or cast-coil. **2.** Rectifier Units shall be solid state diode, indoors, air cooled, and self ventilated, configured for 12-phase operation (ANSI Circuit 31). Thyristors can be used in lieu of diodes, if technically and economically feasible and advantageous, with Metro approval. Each individual diode shall be provided with individual fuse protection. The rectifier shall maintain all its performance requirements even in N-1 operation with one diode out of service per rectification leg.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3349	Performance Criteria	D3-5	**3.** Each Transformer-Rectifier Unit shall provide the following overload capacities: a. 150% continuous overload for two hours, following continuous operation at 100% load with stabilized temperature. b. 300% overload for five one-minute cycles equally spaced within the two hour overload period. c. 450% overload for 15 seconds at the end of the two hour overload period. **4.** Internal regulation shall be 4.5% for both Light Rail and Heavy Rail. **5.** All wiring inside rectifier cabinet associate with snubber circuits and diode fuses, shall not touch the diode heat sinks and the wire shall be rated for 2kV insulation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3350	Performance Criteria	E	DC Feeder Switchgear **1.** DC Switchgears shall include all the feeder breakers to be connected to each individual section of the Third Rail and/or OCS. **2.** DC Switchgears shall also contain isolation means from the Rectifier Units, consisting of one positive breaker and one negative no-load switch, mechanically interlocked to prevent in any circumstances a configuration in which the positive cathode breaker is closed or being closed while the negative switch is open or being opened. **3.** DC feeder circuit-breakers shall be single pole, extra high speed, draw-out type, including an internal mechanical, direct-acting, bi-directional, instantaneous over-current device, and with sufficient short-circuit capacity to interrupt the maximum short-circuit that may occur in the system. **4.** DC feeder breakers shall have manual mechanical emergency trip means accessible on the front of their panels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3351	Performance Criteria	F	System Protection	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3352	Performance Criteria	F1-5	**1.** Protective relays and other necessary devices shall be provided and individually set in accordance with a detailed and comprehensive integrated AC and DC protection coordination study, in order to assure effective, safe, and selective isolation of faults at any point in the system in any operational scenario. **2.** Each AC high voltage circuit breaker shall be provided with the instantaneous, inverse time, and ground over-current relay, as well as, phase unbalance, and under voltage relays. **3.** Each DC feeder breaker shall be provided with over-current and rate of rise relays. The rate of rise relays shall be capable of discriminating any low level short-circuit currents from any train operational currents at any time and any point of the line. The associated DC breaker shall trip for a low level short-circuit and not trip for a normal operational current. **4.** All rectifier transformers and rectifier units shall be provided with over temperature protection. **5.** The DC feeders shall include Load Measuring Systems capable of testing the line for the presence of faults before allowing the closing of the associated feeder breakers. In the event of a trip of the respective breaker due to a short-circuit, three attempts shallwill be made to re-close it. In the case that the three re-close attempts fail, the respective breaker will be locked out. Automatic re-closing shall not be allowed upon tripping of the respective breaker by any ground protection relay.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3353	Performance Criteria	F6	The Rectifier Unit and the DC Distribution Switchgear shall be provided with DC ground protection of a high resistance type for the Heavy Rail TPSSsand a low resistance type for the Light Rail TPSSs. The Rectifier Cubicle and the DC Distribution Switchgears will be insulated at 1,000 V level from the floor. where they are installed and shall be respectively provided with separate individual ground relays. Ground faults on the Rectifier Unit shall trip the associated AC breaker, as well as the associated positive breaker. Ground faults on the DC Distribution Switchgear shall trip the respective AC breaker(s), positive breaker(s), and all its feeder breakers. Ground Protection relays shall have two independent and distinct functions: **a)** Detection of short-circuits between the protected DC enclosure and ground, through continuous current measuring of the single ground conductor between the enclosure and ground. This function shall trip and lock all the breakers required to isolate the fault, both inside the substation and also remotely in the adjacent substations. **b)** Detection of degraded insulation between the DC enclosure and ground, through its continuous supervision for detection of leakages. This function shall initiate alarm annunciations as required. The Transformer-Rectifier Switchgear shall be separate and insulated from the DC Feeders Switchgear. Each one shall have independent ground relay protection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3354	Performance Criteria	F7-10	**7.** The DC feeder circuit breakers of adjacent TPSS connected to the same OCS/Third Rail section shall be provided of a transfer trip system. Each breaker shall send transfer trip signal to the adjacent breaker whenever a fault is detected, including over-current, rate of rise, and ground faults. The over-current and rate of rise transfer trip signals shall allow the re-closure of the adjacent breaker, while the ground fault transfer trip signals shall lock out the adjacent breaker, without any re-closing attempt. **8.** A Negative Ground Device shall be provided to automatically connect the negative bus of each substation to ground, in case the ground to negative bus or negative bus to ground voltage to ground exceeds a pre-set value. **9.** Surge Arrestors shall be provided on the load side of each DC feeder breaker, and shall be connected with insulated cables to grounding rods independent from the main substation grounding grid. **10.** The positive breakers shall be provided with reverse current protection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3355	Performance Criteria	F11-13	**11.** All Substations shall be provided with a grounding grid with a minimum of 5 ohms resistance to ground. The grounding grids shall also meet the requirements of the Utilities and provide safe step-and-touch potentials according to the applicable Codes and Standards. All non-current carrying structures and equipment enclosures shall be solidly connected to the grounding grid, except the DC Enclosures for the rectifiers and DC Switchgears, as required by their specific method of grounding – low resistance or high resistance. **12.** The negative return of the Mainline and Yard traction power system shall not be grounded intentionally at any point, either at the substations, feeder cables, or at track level. **13.** The Shops shall have separate and independent TPSSs solidly grounded and isolated from the Yards on the positive side by non-bridging section insulators, and on the negative side by Rail Insulated Joints, properly aligned with the respective section insulators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3356	Performance Criteria	G	Substation Operation All TPSSs shall be designed for unattended operation and remote control by the Rail Operation Control-ROC. All circuit breakers shall be able to be both locally and remotely operated and a Local/Remote Switch shall be provided at each TPSS. Open/close commands and open/close indications shall be provided. All protective and supervisory devices shall be individually alarmed both locally and remotely. Voltage and current meters shall also be provided locally and/or remotely. A list of local and remote controls, indications, and alarms shall be for Metro approval for each specific TPSS design in order to provide its safe and reliable operation. The interface with the remote operation at ROC shall be coordinated d with the respective SCADA system connected to the Rail Operations Control-ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3357	Performance Criteria	H	Auxilliary Equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3358	Performance Criteria	H1	Lighting Indoor lighting shall be provided. Design shall provide for minimum maintained lighting levels of 30 foot-candles vertical, average. Such lighting shall be located so as to illuminate satisfactorily the vertical surfaces of equipment such as switchgear and transformer rectifier units. Locations of lighting fixtures shall be coordinated to avoid interference with overhead raceways or other major wiring and shall not be directly above switchgear, rectifiers, or transformers. Outdoor lighting shall be provided by energy efficient lamp fixtures with built-in photocell control. Design shall provide a minimum illumination level of one foot candle at ground level. The general lighting shall be controlled from switches located near each access door.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3359	Performance Criteria	H2	Emergency Lighting Substations shall be provided with emergency lighting from individual self contained, maintenance-free units, with one or more lamps mounted on the equipment and a relaying device arranged to energize the lamps automatically on failure of AC power. Batteries shall have 1-1/2 hour minimum cut-off capacity from fully charged state and shall have testing means accessible from outside. Sufficient fixtures shall be provided to illuminate egress paths as required by code(s).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3360	Performance Criteria	H3-5	**3.** Convenience Outlets Duplex convenience 20 amp outlets shall be located approximately 25 feet apart around the interior walls of the substations And within 10 feet of AC and DC protection relays (for testing equipment purposes). **4.** Auxiliary Equipment Other auxiliary equipment shall include, but not be restricted to, Batteries and UPSs for DC and AC control power and essential loads, AC and DC distribution panels, Local Annunciator Panel Annunciators- LAPs, Smoke Detectors and Fire Control Panel-FCP, intrusion detection system, and provision for stray current corrosion measurements and/ negative return drain connections. **5.** Emergency Portable Generator Outlet Provide an outlet on the exterior wall of the substation enclosure for connection of an emergency portable generator plug. The bottom of the outlet shall be at 48 inches above the finished grade. The outlet shall be compatible with Metro's generator plug.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3361	Performance Criteria	I	Construction and Equipment Arrangement **1.** Underground Substation rooms or outdoor housing shall have adequate area to permit placement of electrical equipment and ancillary components of any manufacturer. Relative spacing and positioning of each equipment unit shall permit the removal, replacement, or maintenance of such unit without the necessity of moving other units. The arrangement of the equipment shall permit doors to be opened, panels to be removed, and switchgear and transformers to be withdrawn easily and conveniently. **2.** In underground installations, ceiling heights and openings shall permit entry and removal of the largest components which will be installed in the room or housing. **3.** Ventilation and/or air conditioning of substation rooms or housings shall be provided to maintain the interior temperature within limits suitable for full operation of all substations power equipment. Air conditioning may be used if demonstrated to be cost effective. 4. Sites for at-grade Substations shall be chosen taking in consideration the proximity to Utility points of supply and environmental factors in relation to the area on installation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.18.6	SECTIONALIZATION, AND EMERGENCY TRIP SYSTEM - ETS													
3362	Performance Criteria	A	Sectionalization	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3363	Performance Criteria	A1-3	**1.** The Traction Power System shall provide means of isolating individual sections of the Third Rail and/or Overhead Contact System-OCS for maintenance purposes and/or for attendance to track incidents. **2.** Each track of Tthe line shallwill be sectionalized, as a minimum, at each TPSS location. The TPSSs shallwill have four feeders, two feeders per trackline, each one providing power to one side of the TPSS, so that a track section between two TPSS shallwill be dual powered by two feeders, one from each one of the breakers of the two adjacent TPSSs. **3.** By-pass switches shall be installed between two feeders to the same track from the same TPSS, when so determined in any part of the Scope Definition Contractual documentation for a specific project. In such case, when such by-pass switches are closed, the ETS trip and transfer trip signals received by one of the connected feeder breakers shall be by passed in order to trip the feeder breakers of the adjacent track section, hence assuring that the originally intended track section is effectively de-energized	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3364	Performance Criteria	A4-5	4. All underground stations shall be sectionalized such that sectionalization occurs at the normal exit end of the station. For stations that don't have a TPSS, the normal end of the stations shall be sectionalized by Load Break Switches-LBSs. 5. As a minimum, sectionalization shall be provided at the departure end of all underground passenger stations through load-break switches or dc circuit breakers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3365	Performance Criteria	B	Emergency Trip System-ETS An Emergency Trip System shall be provided for de-energization of specific sections of tracks under emergency situations, with the following requirements:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3366	Performance Criteria	B1-4	**1.** An ETS Blue Light Station-BLS shall be located at each tunnel at the ends of the platforms of underground stations; at the ends of platforms of elevated stations, as well as the ends of bridges along the alignment. A BLS per track shall also be located at each tunnel Portal. **2.** The BLS locations shall not be accessible to patrons under normal conditions. **3.** The ETS Blue Light Stations'-BLSs for underground stations and tunnel Portals shall remove power individually from the specific tunnel where they are located. **4.** The ETS Blue Line Stations for aerial stations and bridges shall remove power simultaneously from the two respective tracks	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3367	Performance Criteria	B5-7	**5.** An ETS BLS shall also be provided at each tunnel cross passage, one for each track, and shall remove power from the respective track. **6.** An ETS-F (fire emergency ETStrip) shall be located at each entrance of each at-grade TPSS. Each ETS-F will trip all the breakers internal to the TPSS both at High Voltage and DC voltage levels. In addition, it will trip the DC breakers of the adjacent TPSS that are connected at DC level with the TPSS in question. **7.** Each BLS and ETS-F shall be provided with a mechanical padlockable lock out, which shall prevent the closing of the associated breakers. These breakers shall only be allowed to reclose once the local lock-out is removed and after a reset command given by ROC.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.18.7	UNDERGROUND STATIONS POWER SUPPLY													
3368	Performance Criteria	A	Underground Stations within the Jurisdiction of the Los Angeles Department of Water and Power (LADWP)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3369	Performance Criteria	A1-3	**1.** Each TPSS providing power to underground stations within the jurisdiction of the Los Angeles Department of Water and Power (LADWP) shall have a separate and independent Incoming High Voltage Switchgear powered by a trainway feeder, in addition to the local Incoming High Voltage Switchgear directly powered by the utility. The trainway feeder shall consist of one set of High Voltage cables installed along the tunnels, and connected to all the involved TPSSs. **2.** The trainway feeder shall be able to be powered from the incoming utilities of two different TPSSs. One of these TPSS shall provide power to the trainway feeder under normal operation, while the other one shall be available as a back-up. **3.** The trainway feeder shall also be able to be powered by an Emergency Diesel Generator as part of the Emergency Back-up Power System – EBPS, described in the following section.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3370	Performance Criteria	A4-7	**4.** The three possible sources of power to the Trainway feeder – two different TPSSs and the Emergency Diesel Generator - shall be interlocked to assure that only one of them can be connected to the trainway feeder at any time. Such interlocking shall be hardwired with a fail-safe design. Fail safe design means that in the occurrence of any relay malfunction and/or open circuit in any part of the interlocking circuits, the configuration of the system shall not be allowed to change. **5.** Each underground station shall be able to have all of its loads fully powered by either its local incoming utility supply or by the trainway feeder. **6.** Independent auxiliary transformers shall be connected separately to each one of the alternative power sources – local utility and trainway feeder. **7.** Under normal operation, each one of these two power sources shall provide power to approximately half of the station loads as determined by the stations low voltage design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3371	Performance Criteria	A8, 9	**8.** In the event of loss of power provided by one of the two auxiliary transformers connected to the same loads, the system shall transfer the respective loads to the remaining transformer, through the closing of normally open tie breakers. **9.** The operation of the tie breaker described in the previous paragraph shall be either manual or automatic, as chosen through a manual-automatic switch. The tie breakers shall be interlocked in such a way as to prevent the connection in parallel of two different auxiliary transformers at any time. The automatic-manual switches shall be included in the interlocking and their operation at any time shall not allow the connection in parallel of the two transformers. This interlocking shall be hardwired and fail safe. Fail-safe means that upon the occurrence of any relay malfunction and/or open circuit in the interlocking circuitry, no change in the configuration of the breakers shall be allowed either in automatic or manual operation. The use of dual redundant PLCs for controls and interlocking of the system may be considered upon submission and approval by the Authority.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3372	Performance Criteria	B	Underground Stations within the Jurisdiction of Southern California Edison (SCE).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3373	Performance Criteria	B1-3	**1.** Each TPSS providing power to underground stations within the jurisdiction of Southern California Edison (SCE) shall be able to receive power from two SCE sources, each source being originated from two separate and independent SCE substations. One of the sources – named Preferred source - shall constitute the single power supply under normal operations. The alternative source – named Emergency source - shall become the single power supply whenever the Preferred source is unavailable. **2.** The transfer of power from SCE's Preferred source to SCE's Emergency source shall occur automatically through the operation of Automatic Transfer Switches (ATSs), provided, owned, operated, and maintained by SCE. **3.** A Trainway Feeder shall be provided interconnecting all Stations for the purposes of the Emergency Back-Up Power System – EBPS only. The Trainway Feeder shall be able to be powered by an Emergency Diesel Generator, when SCE's power from both their Preferred and Emergency sources are lost in all Stations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3374	Performance Criteria	B4-5	**4.** The Trainway Feeder shall be provided with appropriate interlockings to assure that it can only be energized by the Emergency Diesel Generator only when all breakers connected to the SCE Incoming Power Sources, at all Metro TPSSs, are open. Such interlockings shall be hardwired with a fail-safe design. Fail-safe design means that in the occurrence of any relay malfunction and/or open circuit in any part of the interlocking circuits, the configuration of the system shall not be allowed to change. **5.** The Stations Auxiliary Power shall be provided by Main Distribution Switchboards, with two separate busbars, each one receiving power from two separate transformers. These two separate busbars shall be interconnected by normally open tie breakers. These tie breakers can be closed when power from one of the transformers are not available and the transformer is isolated through the opening of its main breaker.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3375	Performance Criteria	B6	**6.** The operation of the tie breaker described in the previous paragraph shall be either manual or automatic, as chosen through a manual automatic switch. The tie breakers shall be interlocked in such a way as to prevent the connection in parallel of two different auxiliary transformers at any time. The automatic-manual switches shall be included in the interlocking and their operation at any time shall not allow the connection in parallel of the two transformers. This interlocking shall be hardwired and fail safe. Fail-safe means that upon the occurrence of any relay malfunction and/or open circuit in the interlocking circuitry, no change in the configuration of the breakers shall be allowed either in automatic or manual operation. The use of dual redundant PLCs for controls and interlocking of the system may be considered upon submission and approval by Metro.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3376	Performance Criteria	C	Emergency Back-up Power System - EBPS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3377	Performance Criteria		**1.** The purpose of the Emergency Back-up Power System – EBPS, shall be to provide power to the ventilation fans required to maintain a minimum air flow throughout the underground facilities, as established on Section 8-Mechanical of these Criteria. The EBPS shall also provide power to all Facilities and Communications UPSs at each station. The EBPS shall be operated in case of complete loss of utility power on all TPSSs at each section of the line powered by one of the trainway feeders. **2.** The EBPS shall supply power to the trainway feeder trough a 480 VAC Diesel Generator and a step-up transformer to the trainway feeder voltage level. **3.** The EBPS shall include the means of shedding all the loads that are not intended to remain in operation during its operation as above described. **4.** The EBPS shall be activated through a sequence of operations performed remotely at the Rail Operation Control – ROC. A complete procedure describing all the controls sequence for implementation of the EBPS shall be provided, as well as the procedures to re-establish the system to its normal configuration.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.18.8	WAYSIDE DISTRIBUTION													
3378	Performance Criteria	A	DC Power Cables, Supports, and Ductwork	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3379	Performance Criteria	A1-3	**1.** The traction power cables connecting the DC feeder breakers or wayside dc disconnect switches to the wayside distribution, and from the running rails to the negative bus shall be sized to accept maximum overload currents and a temperature rise not to exceed safe insulation design limits of the cables, based on a minimum insulation life of 40 years. **2.** The cables shall have sufficient conductivity to maintain traction power voltage levels within the limits defined, confining the major voltage drop to wayside distribution system, rather than permitting excessive voltage drop in the connecting cables. **3.** Traction power feeders for each power zone shall have cable capacity as required by the ratings of the associated DC feeder circuit breakers. These ampacities shall not be compromised by virtue of different types of raceway arrangements for various sections of the feeder.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3380	Performance Criteria	A4-7	**4.** Negative return cable shall be provided between the substation negative bus and the connection to each pair of running rails. **5.** Since both the contact rail and the OCS constitute a vibrating mass, provision shall be made in the design of all cable terminations to prevent cable failures. The design shall utilize standard stranding feeder cables with a transition to extra-flexible stranding cables being provided for the final connection to the wayside distribution system. **6.** Feeders shall be of a common conductor size, using multiple conductors for the different ampacities. **7.** Cables shall be insulated, non-shielded, single conductors suitable for use in wet or dry locations and rated 2,000 Vdc, 90oC conductor temperature for normal operation. The conductors shall be copper with class C or D stranding, conforming to ASTM B8, with EPR insulation and low smoke jacket.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3381	Performance Criteria	A8-10	**8.** Cables from the substation to the OCS/contact rail shall not be spliced. **9.** Traction power positive cables from the DC feeder breaker connections and negative cables from the negative bus connections shall be laid or run in appropriate raceways such as conduits, trays, cable trenches, or on racks through the substations. Such raceways shall provide an adequate cross sectional area to permit a neat alignment of the cables and to avoid crossing or twisting single layer. Positive and negative cables shall be run in separate raceways. **10.** On racks, porcelain insulators designed for such purpose shall be used in the supporting arms. Such supporting arms or racks shall be spaced to avoid excessive weight or pressures against the cableinsulation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3382	Performance Criteria	A11-14	**11.** The ends of all exposed conduits shall be sealed. **12.** All conduit stub-ups shall be protected against damage during construction operations. **13.** Feeder ductwork shall be buried underground and shall consist of polyvinyl chloride (PVC) conduit encased in concrete. Design of ductwork such as conduit size, design cable pull, maximum total angular turn, and minimum embedment depth below grade, manhole spacing and duct gradient shall be in accordance with NEC requirements. Feeder ductwork shall be identified by a yellow warning tape 6 inches wide marked "Warning - High Voltage", laid 12 inches above concrete encasement in backfill. **14.** Feeder ductwork shall be run as directly as practicable and shall be located to avoid interference with foundations, piping and other similar underground work. Risers consisting of PVC coated galvanized rigid steel conduit shall be provided at feeder connections to the wayside distribution.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3383	Performance Criteria	B	Contact Rail	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3384	Performance Criteria	B1	**1.** The contact rail shall be bi-metallic. The two metal components of contact rail shall be forced to make permanent contact by applied pressures from bolts or equivalent methods, and interfacing surfaces shall be well cleaned to minimize electrical resistance between the metals. Contact surfaces shall be tightly sealed to prevent ingress of polluting or corroding matter. The contact rail for the main line shall have an electrical resistance not greater than 0.002 ohms per thousand feet at 20˚C, and shall be capable of carrying 4,000 amperes DC continuously at a temperature rise not exceeding 40˚C over a 30˚C ambient in still air. The contact rail for the yard area shall have an electrical resistance not greater than 0.004 ohms per thousand feet at 20˚C, and shall be capable of carrying 2,000 amperes DC continuously at a temperature rise not exceeding 40˚C over a 30˚C ambient in still air.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3385	Performance Criteria	B2-7	**2.** Contact rail height shall allow sliding of current collector shoes on top of contact rail when the contact rail is seated upon support. The top wearing surface of the contact rail shall be at least 2 inches wide to lessen wear. **3.** The support insulator shall be centered below contact rail and the insulator base shall be sufficiently wide to provide a stable arrangement for the rail. The contact rail and support insulator shall withstand without permanent deformation the stresses caused by the maximum short circuit forces. **4.** Contact rail joints shall not have misalignment or roughness. Bolted butt joints shall be ground smooth for minimum wear and abrasion of collector shoes. **5.** Feeder connections to contact rail shall be suitably designed, located, and attached to provide permanent connection without excessive protrusion from the side of the rail. **6.** The standard rail lengths shall be interconnected by means of bolted or welded joints. **7.** The relative position of the contact rail to the running rails shall be coordinated with the design of the vehicle current collector.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3386	Performance Criteria		8. The standard contact rail lengths shall not be less than 39 feet nor more than 60 feet plus or minus one percent. The rail shall have sufficient section modulus so that the maximum sag with a concentrated load of 30 pounds at midpoint between support insulators placed 10 feet apart shall not be more than 1/64 inch. 9. Protective cover shall consist of a curved insulating board covering the top of the contact rail. Side coverboard shall be provided where the contact rail is adjacent to safety or maintenance walkways in tunnel sections. Protective covers shall have adequate clearance not to obstruct movement of current collector shoes and to permit insertion of shoe paddles. **10.** The protective cover shall extend a minimum of 12 inches beyond the tip of the end approach. **11.** Contact rail through stations shall be located at trackside opposite the platform. **12.** Contact rail at-grade shall be located in the area between running tracks, except at the yard area, special trackwork and through center-platform stations. **13.** Contact rail anchors shall be provided at maximum 2,000-foot intervals at midpoint between expansion joints. Spacing of anchors shall be adjusted to provide an anchor near the middle of curved sections, with expansion joints at points of tangent.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3387	Performance Criteria		**14.** The contact rail shall be physically continuous between substations except at crosswalks and special trackwork locations where it is necessary to have separations in the contact rail. In addition, contact rail continuity shall be broken at wayside locations where further sectionalizing is needed to enhance operational flexibility. End approaches shall be provided at each separation to facilitate vehicle current collector shoe return to the contact rail without significant bounce. **15.** The design of the entire contact rail system shall ensure that, during normal operation, at least one current collector shoe of a two-car train is always in contact with the rail. **16.** The contact rail system shall be electrically continuous throughout the specific Metro Rail System. At crosswalk and special trackwork locations (or around expansion joints), electrical continuity shall be provided by jumper cables either bolted or welded to the contact rail. At substations electrical continuity shall be provided via DC switchgear, at wayside locations via motorized disconnect switches, connected to the contact rail by cables. The disconnect switches and cables shall provide conductivity that will not reduce the circuit capacity of the contact rail.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3388	Performance Criteria		**17.** Contact rail sectionalizing at substations and at the locations of the wayside disconnect switches (as required to provide definite traction power zones) shall be implemented by means of non-bridgeable-type gaps. The length of the non-bridgeable gap between power zones shall be such that it cannot be bridged by the front and rear shoes of a transit vehicle. In the vicinity of passenger stations, each non-bridgeable gap shall be located preferably in the normally decelerating zone. At stations where it is more economical to locate a gap in the normally accelerating zone, and at gap locations other than at stations, the gap shall be of special design to prevent interruption of power to trains during normal operation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3389	Performance Criteria	C	Overhead Contact System (OCS)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3390	Performance Criteria	1	General	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3391	Performance Criteria	1a-d	**a.** For light rail vehicle characteristics and dimensions see Sections 9.3 Rail Vehicle Interface in Systems and 4.1.3 Clearance Requirements in Track and Guideway. **b.** The OCS includes the Catenary system, the physical support structure and the associated feeder system. **c.** The Catenary system consists of the conductors, including the contact wire and supporting messenger (where used); in-span fittings; jumpers; conductor terminations; and associated hardware located over the track and from which the vehicle draws power by means of physical contact between the pantograph and contact wire. The Catenary system shall provide for satisfactory current collection under all operating conditions. See Section 10 Operations. **d.** The physical support structure consists of foundations, poles, guys, insulators, brackets, cantilevers, and other assemblies and components required to support the Catenary system in the appropriate configuration. The support system shall support the Catenary system in accordance with allowable loading, deflection, and clearance requirements. The supports throughout the system shall incorporate double insulation in accordance with the requirements of CPUC General Order 95. Structure grounding and bonding measures shall be provided in accordance with corrosion control and safety requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3392	Performance Criteria	1e, f	**e.** The feeder system consists of the feeder conductors, jumpers; disconnect switches, ductwork, and associated hardware that feed the power to the Catenary system. The feeder system in combination with the Catenary system shall provide for the supply of traction power to the vehicles within the allowable voltage limits. The design for all feeders and jumpers shall be sized; based on their respective current carrying capabilities, the wires to which they are attached, and the power requirements of the system. **f.** Electrical continuity shall be provided in the OCS from substation to substation. At the substations, the Catenary system continuity shall be sectionalized to provide isolation of each electrical section. An arrangement providing continuity and flexibility for sectionalization of the OCS while any mainline or substation is undergoing repair or maintenance shall be incorporated. This will be accomplished through the application of both electrically and manually operated outdoor and indoor types of disconnect switches as required for operations and maintenance. Between substations the continuity shall be accomplished by insulated or un-insulated Catenary overlaps with continuous jumper arrangements, or section insulators with jumpers and disconnect switches and jumper arrangements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3393	Performance Criteria	1g, h	**g.** The design of the overhead contact system shall be based on technical, operation and maintenance requirements, aesthetics, and economic considerations, and shall be in accordance with the standards and criteria specified herein. **h.** Two points of insulation is mandatory for all OCS assemblies including but not limited to, pole mounted disconnect switches, tunnel supports, under-bridge supports, OCR equipment, surge arresters, cantilevers, span wires, bridles, terminations, and any other pertinent equipment used to support the messenger or contact wire of the OCS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3394	Performance Criteria	2	Codes and Standards	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3395	Standard Criteria	2a	**a.** All design work, supply and installation of OCS equipment shall conform to the latest edition of codes and standards issued by the following organizations: ▯ American Railway Engineering and Maintenance of Way Association (AREMA) ▯ American Institute for Steel Construction (AISC) ▯ American Society for Testing & Materials (ASTM) ▯ Institute of Electrical and Electronics Engineers (IEEE) ▯ Insulated Cable Engineers Association (ICEA) ▯ National Electrical Manufacturer's Association (NEMA) ▯ National Fire Protection Association (NFPA) ▯ CaliforniaUniform Building Code (UCBC) ▯ Underwriters Laboratory (UL) ▯ National Electrical Code (NEC) ▯ National Electrical Safety Code (NESC) ▯ California Public Utilities Commission (CPUC): -GO95: Rules for Overhead Electrical Line Construction -GO128: Rules for Construction of Underground Electrical Supply & Communication Systems -GO143B: Safety Rules and Regulations Governing Light Rail Transit ▯ All other applicable State, Local and County Codes In no case can exceptions be taken to the CPUC General Orders without prior approval of Metro and ultimately, the CPUC	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3396	Performance Criteria	3	System Description	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3397	Performance Criteria	3a	Subways	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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3398	Performance Criteria	3a	In subways and tunnels, a low profile Simple Catenary Fixed Termination (SCFT) or Conductor Rail system shall be used. SCFT consists of a single contact wire and a messenger wire located over the track. The system shall be fixed termination, with the result that conductor tension will vary with temperature. The Catenary shall be supported by direct insulated attachment of the messenger wire to the subway or tunnel ceiling, with the contact wire registered by support arms. The limited clearance requires close support spacing to minimize system depth. System depth is defined as the vertical distance measured at each support location, between the messenger and contact wires.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3399	Performance Criteria	3a	The Conductor Rail consists of a contact wire clamped on the lower side of a box shape aluminum profile. The contact wire should be solid grooved copper 350 MCM per ASTM B47. At the transition from catenary system to the to the conductor rail system, a transition bar should be used to accommodate a smooth transition and absorb the vibrations of the incoming contact wire. At tunnel mouths or at locations where dropping water is expected, protection must be provided such as a protective plastic cover clipped on the conductor rail profile. A typical conductor rail system consists of Expansion joints, Fixpoint anchors, Endpoint anchors, Electrical connections, Section insulators, Clips for hooking standard earthing rods etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3400	Performance Criteria	3b	**b.** At Grade Street Running On the at-grade sections, a Simple Catenary Auto-Tensioned (SCAT) shall be used, unless special considerations determine otherwise. The Catenary system shall consist of a messenger wire with a single contact wire supported by vertical hangers. The system shall be designed to meet capacity and power requirements without the use of supplementary along-track feeders. The system shall be auto-tensioned by means of weight-tensioning devices located at the termination points of the conductors. Tension in the conductors shall remain constant up to the conductor temperature of 130o F, after which a resulting increase in temperature is to be accompanied by a decrease in tension. Tapered tubular galvanized steel poles shall be used. A low profile catenary system, with a catenary system height of 2'-0" to 3'-0", shall be used only when required for aesthetic purposes. In the Long Beach and Central Business District (CBD) of Los Angeles, a Single Wire Fixed Terminated system is utilized. The system is a single contact wire that is fixed terminated on both ends of the tension length. A feeder runs parallel to the alignment in an underground ductbank and feeder taps are connected approximately every 150'.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3401	Performance Criteria	3c, d	**c.** At Grade – Dedicated Right-of-Way On portions of alignment other than subway or downtown areas, a Simple Catenary Auto-Tensioned (SCAT) system shall be used. The Catenary system shall consist of a messenger wire with a single contact wire supported by vertical hangers. The system shall be designed to meet capacity and power requirements without the use of supplementary along-track feeders. The system shall be auto-tensioned by means of weight-tensioning devices located at the termination points of the conductors. Tension in the conductors shall remain constant up to the conductor temperature of 130o F, after which a resulting increase in temperature is to be accompanied by a decrease in tension. **d.** Main Yard and Shops and Maintenance-of-Way Satellite Yards In the yards and shops, a Single Wire Fixed Termination (SWFT) system shall be used. This consists of a single contact wire located over the track. The terminations of the contact wire shall be made directly to the poles with the result that conductor tension will vary with temperature. The yard shall utilize tapered tubular steel poles consistent with the rest of the system. Any other support structure types, i.e. portals, flange beams, bridge mounted supports, etc. shall require Metro approval for use. Wherever practicable, eyebolt attachments to the exterior walls of the shops shall be used. Cross-span wires and backbone systems shall be used to minimize the number of poles where applicable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3402	Performance Criteria	4	**4.** Operations The OCS shall be designed for vehicle operations with a design margin of 10 mph over the specified maximum vehicle operating speeds. The OCS shall be designed for multiple pantograph operation with pantographs spaced in accordance with the specified train consists. The OCS shall be designed for operation of any type of Metro vehicle and take into consideration the use of pantographs both at one of the ends (trucks) of a vehicle or close to the midpoint of a vehicle, depending on their specific designs. Provide a permanent mark across all OCS hardware after they have been torques to the manufacturer's specified torque values.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3403	Performance Criteria	5	**5.** Sectionalization **a.** In all systems, the Catenary shall be sectionalized by means of insulated overlaps. Mechanical section insulators shall only be used at crossovers and not on the mainline track. Airbreaks are not allowed in the system. **b.** In subways, where low-profile SCFT Catenary is used, the OCS shall be sectionalized by means of insulated overlaps. Mechanical section insulators shall be used at crossovers. If Conductor Rail is used, sectionalizing shall be by insulated overlaps. **c.** The interfaces between the Main Line-Yard and Yard-Shops shall be non-bridgeable section insulators. The running rails at such interfaces shall be provided with insulating joints. On the interface Main Line – Yard, normally open disconnect switch shall be used on both the OCS and the running rails in order to allow the connection of the Main Line to the Yard. **d.** Inside the shop building(s), the OCS Catenary shall be sectionalized at each entrance location to the building and at the center of the building, by mechanical section insulators. Each track shall have a manually operated switch for the feed to that Catenary. Where there are personnel gantries, there shall be an electrical interlock system that will not allow access while the Catenary is energized. See Section 11 for additional details on Yard and Shops requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3404	Performance Criteria	6	Span Lengths and Staggers	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3405	Performance Criteria	6a-c	**a.** The tension length design shall be as long as practical and shall consider balance weight movement, cantilever effect, along track movement, pantograph security, track geometry, physical constraints of stations/structures, grade crossings, and any other parameters of the system. Full tension lengths shall be no longer than 5600 feet in length, with no half tension lengths longer than 2800 feet. **b.** Half tension lengths, where one end utilizes a fixed termination and the other end a balance weight, may be used only when system constraints will not allow for full tension lengths. Half tension lengths shall be no more than 2800 feet in length. Space for balance weight travel shall be verified for every pole during the design. Add 12" length past 130°F hot temperature stop to account for wire creep. **c.** Where difference in track elevation at each end exceeds 3% grade, balance weight equipment shall be designed to be positioned at the lower end of the tension length.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3406	Performance Criteria	6d-g	**d.** The span lengths (spacing between contact wire registration points) and staggers shall be designed to provide for pantograph security (i.e., no pantograph dewirement) and to maintain good current collection and uniform wear of the pantograph carbon collector. Pantograph security is established by maintaining a minimum contact wire edge distance (from the tip of the pantograph) of 6 inches (3 inches at overlaps) under worst operating condition. In addition, the contact wire shall be staggered to provide for uniform pantograph wear. **e.** The design shall consider the effects of environment, track geometry, vehicle and pantograph sway, and installation and maintenance tolerances. Vehicle roll into the wind shall be taken equal to 50% of the maximum dynamic roll value in accordance with AREMA Part 33.Manual, Committee recommendation, Bulletin 694. **f.** The determination of span lengths for single wire systems shall take into consideration the requirements of Rule 74.4 of CPUC General Order 95 regarding broken OCS suspensions and fastenings. **g.** Safety tethers for terminations shall be clamped to the messenger/contact wires. Anchor bracket on OCS pole shall be within 2' from the CW/MW termination. Do not clamp tethers onto intermediate wires of the termination assembly. Tethers shall be a completely separate entity from the termination assembly. Tethers shall not hang loosely from wire clamps to the OCS pole.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3407	Performance Criteria	7	Catenary Conductors **a.** The contact wire shall be a 350 kcmil solid grooved hard-drawn copper conforming to ASTM B47. Any change in size or shape of contact wire will require Metro approval. **b.** The messenger wire shall be a 500 kcmil 37 strand standard hard drawn copper conforming to ASTM B189 with stranding conforming to ASTM B8, class B or higher. Any change in size or shape of messenger wire will require Metro approval. **c.** Conductor tensions shall be in accordance with the requirements of CPUC General Order 95. Thirty percent cross-sectional area loss due to wear of the contact wire and the effect of temperature change shall be taken into consideration in the design for conductor tension. **d.** Typical conductor tensions are: Messenger Wire: 6000 lbs for SCAT Contact Wire: 3000 lbs for auto tensioned systems 3000 lbs for SWFT @ 60°F	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3408	Performance Criteria	8	Contact Wire Heights **a.** Minimum contact wire heights shall be in accordance with the requirements of the CPUC General Orders 95. Contact Wire Height: Minimum: Normal: Exclusive ROW: 16’-0”: 19’-6” Semi-exclusive ROW: In-Street 19’-0”: 19’-6” Grade Crossing: 19’-0”: 19’-6” Railroad Crossing: 22’-6”: 22’-9” Tunnels: 14’-0”: 14’-0” Under Structures: 15’-0” or as clearance allows Yard: 19’-0”: 19’-6” **b.** The contact wire height at supports shall take into consideration the minimum heights required by the various applicable codes and standards and installation tolerance (including track construction and maintenance tolerances).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3409	Standard Criteria	9	Clearances **a.** Electrical clearances between the OCS and other facilities shall be in accordance with CPUC General Order 95. **b.** Mechanical clearances between the OCS and other facilities shall be in accordance with CPUC General Order 143B.A. **c.** For vehicle-related clearances full allowance shall be included for dynamic displacement of the vehicle under operating conditions (including track and other installation and maintenance tolerances). **d.** The following clearances shall be maintained between live conductors (including pantograph) and any grounded fixed structures as follows: Passing: Static Normal: 4": 5" Absolute Minimum: 3": 4" **e.** Passing clearance is the clearance between the Catenary system or pantograph and an overhead structure during the short time it takes the power unit(s) of a train to pass. **f.** Static clearance is the clearance between the Catenary system when not subject to pantograph pressure, and the overhead structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3410	Standard Criteria	10	Pantograph Clearance Envelope For light rail vehicle characteristics and dimensions see sections 9.3 Rail Vehicle Interface in Systems and 4.1.3 Clearance Requirements in Track and Guideway. A pantograph clearance envelope shall be developed for application on all tracks including superelevation, for worst case track conditions and full vehicle roll plus a 6 inch mechanical clearance. No equipment, except OCS steady arms attached to the contact wire, shall intrude into the pantograph clearance envelope. See Section 4 for additional details.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3411	Standard Criteria	11	Construction and Maintenance Tolerance Design of the OCS shall be based upon a total construction-plus maintenance tolerance for the lateral and vertical locations of the structures as follows: **Contact Wire** Location / Lateral / Vertical Subways: ± 1"; +0”, -1” Railroad Crossings: ± 2"; +2”, -0” Overlap locations(Between parallel wires): ± 1/2"; +1/2” All others: ± 2"; ± 2" Structures Along-track spotting tolerance Special trackwork locations = ± 2'- 6" At other locations = ± 5'- 0" Cross-track spotting tolerance At restricted locations -13'- 0" track spacing = ± 3/4" At other locations = ± 1 1/2"	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3412	Standard Criteria	12a	Structure Design OCS support structures shall be designed to carry the design loads according to the requirements of strength design and deflection design. CPUC General Order 95 shall be used except where more stringent AISC and ACI requirements for steel and concrete design are applied. **a.** Design Loads OCS support structure design loads shall be the system self-weight plus the loads indicated in CPUC General Order 95, Light Loading. Self-weight shall be the actual weights of poles, cantilevers, assemblies and conductors computed according to the AISC Manual of Steel Construction or obtained from manufacturer's catalogs, as applicable. Wind loads shall be determined in accordance with CPUC General Order 95. According to this Order, a horizontal wind pressure of 8 pounds per square foot of projected area on cylindrical surfaces and 13 pounds per square foot on flat surfaces shall be assumed for all regions of California having an altitude of less than 3000 feet. The design load shall be multiplied by the following overload factors to allow for uncertainties in loading conditions: Design for strength = 1.1 Design for deflection = 1.0	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3413	Standard Criteria	12b	Design for Strength Steel poles, cantilevers and other structures shall be designed by the allowable stress method according to the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings (AISC S326). Reinforced concrete drilled pier foundations shall be designed by the ultimate strength method according to the ACI Building Code Requirements for Reinforced Concrete (ACI 318); anchor bolts shall be designed by the alternate method (working stress method). The anchor bolts shall be designed based on ungrouted pole baseplate. Laterally loaded pier foundations shall be proportioned according to the Texas Transportation Institute, Resistance of a Drilled Shaft Footing to Overturning Loads - (Research Reports 105-1, 2 and 3). A minimum factor of safety (to failure of soil) of 2.0 shall be used in the design. For combined dead plus live (wind) loading the 33 percent increase in allowable stress specified by the AISC and ACI code shall be waived.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3414	Standard Criteria	12c	Design for Deflection OCS support structures shall be designed so that structure deflections under service loads will not cause excessive movement of the contact wire. In addition, the steel pole shall be raked to compensate for the deflection generated by the self-weight and conductor tension loading. Design of support structures shall be based on the following criteria for deflection and foundation rotation: Structure / Loading / Maximum Deflection / Remarks Steel Pole / Live (wind) / 2 ½" @ contact wire, level, including foundation rotation effect / Total deflection level including foundation effect shall be less than 4" Foundation / Dead+Live / 2.5% of pole height Foundation / Live (wind) / 0.5% rotation Foundation / Dead+Alive / 5.0% rotation	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3415	Standard Criteria	12d-j	**d.** Seismic Design OCS support structures shall be designed to conform to the seismic design requirements of the UCBC. **e.** Anchor bolt holes in OCS pole base plates shall be continuous without any breaks in the structural plate. Slotted bolt holes are allowed in balance weight poles only. **f.** For each anchor bolt of an OCS pole or guy foundation, provide one leveling nut below and two nuts above the pole base plate. **g.** OCS tubular poles shall be of single ply construction only. Field drilling of poles after hot dipped galvanizing coating is applied is not permitted. **h.** OCS poles shall not be located within the station platform areas, accessible to the public, unless approved by Metro. **i.** Joint use poles for lighting, communications, train control and any other non-OCS related equipment will require Metro approval. Joint use poles shall be designed so that maintenance of equipment may be performed without requiring traction power shutdown and disruption of revenue service. **j.** Termination poles shall be supported by a down guy anchor assembly. Self-supported termination poles are allowed only when an additional FOS of 2 is applied to the criteria stated above (Section 12-a).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3416	Standard Criteria	13	OCS Design Parameters	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3417	Standard Criteria	13	Electrical Ratings Nominal System Voltage: 750 VDC Insulation Level: 3.7 kV AC, rms Creepage Distance: 1.88 in. 60Hz Withstand Voltage: 35 kV, Dry: 18 kV, Wet (Synthetic spool insulators shall withstand a 25 kV flashover across 2.5 inch distance.) Temperature Maximum Conductor Temperature: 165 °F Minimum Conductor Temperature: 15 °F Auto-Tensioned Temperature Range: 25 °F to 130 °F Median Set Temperature: 75 °F The median set temperature is for along track movement of OCS assemblies. Balance weight assemblies must be installed with temperature stops. Balance weights must have a minimum of 12" of additional travel length past the 130 deg F hot temperature stop to allow for wire creep. Position of the balance weight shall be centered on pole to allow for equal distance from the cold stop to the hot stop. Do not use top of baseplate as the hot temperature stop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3418	Standard Criteria	13	Wind Speed Maximum Wind Speed – Structural 85 mph Maximum Wind Speed – Operating 55 mph Seismic Zone Seismic Withstand Zone: Per CBC Contact Wire Gradient Yard: 2.3 % 15-30 mph: 1.3 % 30-45 mph: 0.8 % 45-55 mph: 0.6 % Maximum change in gradient shall be equal to one half the maximum gradient, from one span to the next. Pantograph Security Minimum Pantograph Security 6 inches from tip of pantograph.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3419	Standard Criteria	14	OCS Grounding and Bonding **a.** The OCS poles shall be properly grounded by grounding rods in accordance with NEC requirements. Ground resistance shall be a maximum of 25 ohms on regular poles. On poles with disconnect switches, surge arrestors, or feeders a maximum of 5 ohms ground resistance shall be provided. **b.** Within embedded track sections, negative rail grounding stations shall be provided at a minimum at all sectionalization locations. **c.** OCS poles located within station platform areas shall be tied into the station ground grid system. **d.** Ground rods for regular OCS poles and surge arrestor/disconnect switch poles shall be separate and meet the grounding requirements listed above.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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3420	Standard Criteria	15	Protective Screening **a.** In areas where the Light Rail alignment is constructed within a publically accessible area (i.e. tunnel portal, underbridge alignment, etc), installation of a protective screen or fencing will be required when human reach falls within 10 feet of the OCS conductors. The protective screen or fencing shall prevent people from reaching the OCS conductors from the side or above. All equipment for the protective screen or fence shall be grounded and conform to the surrounding architecture/aesthetic. Protective screening shall extend a minimum of 8 feet away from centerline of conductors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.19	CYBER SECURITY FOR RAIL COMMUNICATION NETWORKS/CONTROL SYSTEMS													
		9.19.1	OVERVIEW													
	Standard Criteria		This section summarizes the minimum requirements to secure control and network communications systems associated with Operationally Critical Zone (OCZ), Vital Interlocking Safety Zone (VISZ), and Fire Life Safety Security Zone (FLSZ) in Metro. OCZ contains the centralized SCADA, train control, transit passenger information system and other centralized control hardware and software systems, and the equipment from these systems extending out to remote facilities such as train stations and trackside equipment. VISZ contains any system that if 'hacked' and modified would cause an immediate threat to life or safety, for instance cause a collision or derail a train. For Example: Vital signaling which includes Interlocking, Automatic Train Protection (ATP), etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Standard Criteria		FLSZ contains any system whose primary function is to warn, protect or inform in an emergency. For Example: Emergency Management Panel, Emergency Ventilation systems, Fire Detection and Suppression systems, Access Control / Intrusion Detection Systems, Gas Detection Systems, etc. Compromise of FLSZ does not pose an immediate threat to life/property but can contribute to a higher loses in a multi-vector attack or unintentional environmental emergency. The designer shall address cyber security throughout the lifecycle of the systems including but not limited to preliminary hazard analysis, architecture design, final design, procurement, installation, testing, commissioning and acceptance. The designer shall follow the latest published American Public Transportation Association (APTA) recommended practices for "Securing Control and Communications Systems in Rail Transit Environments", National Institute of Standards and Technology (NIST) as well as the specific criteria identified in this section. All Metro Information Technology and Systems (ITS) policies, standards and guidelines must be adhered to by the designer.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.19.2	NETWORK DESIGN													
	Standard Criteria		Network design shall utilize experts holding current manufacture certifications in Layer 2 switching; Layer 3 routing; Security; Voice; and Video and those experts shall be approved by Metro. The certification shall include CCNP, CCNP Security, CCDE and MCSE Desktop Infrastructure. Network appliances shall be CISCO industrial rated products, made in the United States, except where the environment requires hardened equipment. Train Control or life/safety networks shall be physically separated (air gapped) from other networks. Subsystems shall each have separate services provisioned in the CTS system for interface to ROC. Virtual Local Area Network (VLAN) trunking through the CTS backbone shall be prohibited.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Standard Criteria		Wireless local area network communications shall be prohibited except those encrypted technologies and applications as approved by Metro. Any network switch, router or firewall that interfaces directly with the CTS node equipmentSONET shall be a managed device supporting: RADIUS authentication and accounting Port security SNMP traps for port security violations and general system exception conditions Local password authentication only when a RADIUS server cannot be contacted Local functions shall continue to function when the head end CTSSONET equipment is not functioning. A local industrial hardened firewall appliance shall be provided for each RTU to prevent unauthorized outbound traffic and specifically control inbound traffic to only that which is necessary.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Standard Criteria		Networks for local communications shall not be trunked or otherwise transported across the CTS node equipmentSONET and shall not be accessible outside of the local subsystems. The networks and their appliances shall be capable of and be configured to limit traffic only to that which is necessary and to only enable necessary features and functions. The configurations shall be documented. The design shall use fixed IP addresses and routing unless otherwise approved by Metro. All management and networks with connectivity to the ROC shall use an IP allocation schema to be provided by Metro at time of design. Network communications for vital train control or fire/life/safety critical functions shall utilize encryption and error checking equal or better than CRC16.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Standard Criteria		Dial up, Internet or other remote access capabilities outside of that which is required for system operation shall be prohibited. Any room or case housing configurable controllers, PLC or RTU equipment shall utilize keyless access control and intrusion detection reporting to the access control system. Any room, cabinet, or enclosure housing network appliances, manual override or local control capabilities shall alarm intrusion to the access control system and shall be in view of a fixed CCTV camera or the home position of a PTZ camera.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.19.3	CYBER/NETWORK SECURITY CONFIGURATION, DATA AND DOCUMENTATION													
	Standard Criteria		The designer shall provide a secure method for managing the network devices and changing addressing schemes. The designer shall verify and provide documentation that the network configuration management interface is secured. The designer shall provide access control lists (ACLs), port security address lists, and enhanced security for port mirroring. The designer shall remove or disable unused network configuration and management functions on the network devices. The designer shall provide firewall rules for inbound and outbound traffic based on deny all rule sets. The designer shall provide documentation on the network devices installed with security settings. Documentation of applicable protocols, ports, services shall be provided including verification that connectivity, bandwidth, response time, and latency requirements are within subsystem operating requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.19.4	ACCOUNT/PASSWORD MANAGEMENT AND DOCUMENTATION													
	Standard Criteria		Factory set default passwords shall be changed. Well known, anonymous and or guest accounts shall be disabled. Refer to the following ITS standards for details regarding account and password management: MIT-03 Password Standard and MIT-13 IT Account Management Security and Administration. The designer shall document which accounts/roles are necessary, which are disabled, and all passwords. Procedures to change passwords shall be documented and provided to Metro upon substantial completion. User authentication and authorization controls shall be transmitted in an encrypted manner. Security Critical Systems shall provide for user accounts with configurable access permissions associated with user defined roles. At minimum the following roles shall be definable: • User – Permissions are granted on the basis of least privileged access, legitimate functional business necessity, and with limits clearly defined. • Administrator – Includes permissions for maintaining and configuring the application and operating system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		9.19.5	VIRUS/MALWARE PROTECTION													
	Standard Criteria		All files and applications shall be checked for malware or other unauthorized modification prior to installation on equipment using software updated with the latest pattern and verification files.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.00		9.20	**EMI/EMC CONTROL**													
	Standard Criteria		For each new rail line extension, a comprehensive EMI/EMC (Electromagnetic Interference/Electromagnetic Compatibility) study shall be performed to identify interferences between the various electrical/electronic subsystems including vehicle systems that may adversely affect the operation, reliability, and safety of the system. The study shall also consider interference with any adjacent facilities commercial broadcasting stations including radio, television and mobile phone networks as well as other facilities that may be susceptible to EMI effects such as hospitals, recording studios, airports and emergency call/dispatch centers . Mitigating measures shall be implemented to eliminate the interferences, including in the design and test of the impacted systems. A complete EMI/EMC plan including study, testing and mitigation measures shall be developed by a professional who is knowledgeable and experienced in the field, and submitted for Metro's approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		10	OPERATIONS													
2.0		10.1	INTRODUCTION													
	Standard Criteria		This section in the Metro Rail Design Criteria (MRDC) describes the basic systemwide operating and maintenance criteria and requirements established for the Metro Rail Projects in Los Angeles County, California. They form the basis for project-specific operational plans developed for transit corridor capital and maintenance projects. The use of this section applies to project specific activities in corridor studies, project development, engineering and construction. The criteria and requirements described in this section typically inform the programmatic basis of design for transit capital and maintenance projects and are also used to develop the Operations and Maintenance Plan for these project activities. Any proposed deviation to Design Criteria cited herein shall be approved by Metro, as represented by the Change Control Board following consultation with Metro Operations and approval by the Chief Operations Officer's designee.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3.0		10.2	DEFINITIONS AND ABBREVIATIONS													
	Standard Criteria		**AAR** Association of American Railroads **Active fleet** Portion of the total fleet which is available for revenue service, including peak vehicle requirements, ready reserve and maintenance spares. **Alignment Classification** Metro uses definitions adopted by the California Public Utilities Commission concerning classification of a rail alignment. Pertinent classifications include "exclusive", "semi exclusive" and "non-exclusive." **AREMA** American Railway Engineering and Maintenance-of-Way Association **Automatic Train Control System (ATC)** A system that automatically controls one or more functions of train movement independent of operator intervention. See An ATC system may include one or all of the following: Automatic Train Operations, Automatic Train Protection and Automatic Train Supervision. Refer to MRDC Section 9.4.1.3 for definitions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Standard Criteria		**Auxiliary tracks** Tracks other than Main Line tracks. **Base Headway** This refers to the An off-peak standard time interval between trains. Often, the base headway is considered to occur during weekdays at mid-day times. See Mid-Day Headway. **Blue Light Station** Designated location within the Rail System identified by a blue light, where traction power may be de-energized. This station also includes emergency telephones and, where provided, under-car deluge buttons. **Built Out Year** This term describes the year in which the entire transit project is fully completed. **Cab Signal System** Rail track segments where cab signal operations govern train speed and indications from wayside equipment into operator's cab. **CEQA** California Environmental Quality Act **Civil design speed (civil speed limit)** The maximum speed authorized for each section of track, as determined primarily by the alignment, profile, and structure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		10.3	PROGRAMMATIC BASIS OF DESIGN													
	Performance Criteria		This section provides a program to describe how the Project will operate at interlockings, junctions and describes how the OCS will be sectionalized for maintenance or emergencies. The program will describe how train control needs are provided for ATS for Main Line activities such as - turn-backs between scheduled service, and when and how the ATS on the Main Line will be activated. The program provides the conditions when ATO will not be enforced and what additional control function or Standard Operating Procedures will be implemented. This program describes single track operations calculated from a station prior to a crossover to the next station after the single track section crossover to ensure trains stopping at safe location for exiting if the route becomes obstructed. This program is designed for 24 hour train movements with provisions to provide suitable work zones and train separation in accordance with the expected equipment maintenance, manufacturer's recommendations, and FRA Track Maintenance Requirements. Without this fundamental basis of design, the Design Builder will not have any guidance or requirements for validation or Operational Testing prior to Design Build Turnover to Pre-RevenueTesting.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
4.0		10.4	OPERATIONS AND MAINTENANCE PLAN													

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	Performance Criteria		An Operations and Maintenance Plan (O&M Plan) is a plan that establishes a framework for the operations and maintenance of new rail corridors or expansion of existing rail lines. An O&M Plan is initially developed as a set of plans included in a Project Management Plan (PMP) for a transit capital project. In general, the O&M Plan includes a front portion that lists the type of equipment that is associated with line or section under discussion complete with Time Between Failures, Manufactured Recommended Practices, including Inspections, Trouble Shouting, Staff Needed, Time Allocation, System Operating Restrictions, etc. so that the plan can properly address the 24 hour operating requirements and how this required equipment maintenance and inspections can be performed between trains. The plan includes the person hours needed to support the State of Good Repair required by the designed system equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		The characteristics of an O&M Plan include: **A.** System performance (safety, on-time performance, operating procedures, reliability, line capacity, cleanliness). **B.** Level of service (performance elements that affect users, ridership, service quality, fares or cost). **C.** Corridor effects as a result of the proposed project **D.** Operations and maintenance budgets and costs **E.** Defined System Performance Details and characteristics such as Main Line / Yard Interface Issues, Yard Routing and Yard Activities listed with required durations, code requirements, man-power needs,nominal time test time for the activities, etc. such that the overall system O&M Plan is complete to support long term regulatory and federally mandated activities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		An O&M Plan is developed based on the following information: **A.** A project description as programmed into a fiscally constrained Long Range Transportation Plan (LRTP) **B.** Project integration into existing or planned transit networks as described in the LRTP **C.** A service plan prepared ahead of the O&M Plan, based on information from Metro's Transit Service Policy **D.** Systemwide and project description information from Metro's Rail Fleet Management Plan **E.** Ridership projections from travel forecasting information that includes peak hour ridership projections **F.** Rail Simulation(s) as needed **G.** Metro Rail Design Criteria requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.1	**FRAMEWORK FOR AN OPERATOR'S MANUAL**													
	Performance Criteria		The O&M Plan also provides a framework for an Operator's Manual, to be developed during the Engineering and construction phase of a transit capital project. This framework includes the following information:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.2	**WAYSIDE SYSTEMS**													
	Performance Criteria		**A.** Management and Supervision estimated requirements **B.** Track alignment, with defined maintenance access points, including Hi-Rail vehicles **C.** Communication and Signals with defined proposed systems and their integration with existing ones **D.** Traction Power and OCS, with defined power suppliers and Traction Power Substations (TPSS) **E.** Facilities Maintenance **F.** SCADA, with defined proposed systems and integration with existing ones	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.3	**RAIL FLEET SERVICES**													
	Performance Criteria		**A.** Management and Supervision **B.** Rail Fleet Service Facilities with defined sufficient existing, expanded existing or new proposed facility **C.** Rail Fleet Inspections and Maintenance (I&M), with size of proposed I&M facilities defined by I&M schedules per Rail Fleet Maintenance Plan	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.4	**SAFETY, REGULATIONS AND TRAINING**													

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	Performance Criteria		**A.** Responsibility for Safety **B.** System Safety Program Plan **C.** Regulatory Agencies **D.** Industry Organizations and Standards **E.** Operations, Maintenance and Safety Rules for all maintained mechanical and electrical equipment **F.** Standard Operating Procedures **G.** Training and Qualifications Plan shall include: **A.** System and equipment operations and maintenance training **B.** Multiple training sessions for different Metro departments and shifts **C.** Curricula and training materials	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.5	SERVICE INTERRUPTIONS AND EMERGENCIES													
	Performance Criteria		The communication systems are vital to the reliability and service of the rail transit system and must be designed that continuous communications can be guaranteed during emergencies, equipment repairs or equipment replacement. **A.** Principal Objectives **B.** Service Disruption Scenarios **C.** Role of Operations Control Center (ROC)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.6	STAFFING PLAN AND SUPPORT FUNCTIONS													
	Performance Criteria		The Project's O&M Plan typically provides a description of the staff necessary to fully operate, maintain and support all elements of an operating line including but not limited to: train operators, vehicle mechanics, non-revenue support staff, management and supervisorial personal, custodians, security staff, ROC support, inventory/supplies staff, etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.7	OPERATIONS AND MAINTENANCE PLAN GENERAL GOALS, PRINCIPLES, AND GUIDELINES													
	Performance Criteria	A-E	The O&M Plan assumes the following goals, principles and general guidelines: **A.** Promote excellence in service and support; ensure the safety of employees, passengers and general public; one that is safe, clean, reliable, on-time, and courteous service. **B.** All systems and infrastructure support and shall be constructed sufficiently to operate for maximum consist lengths operating at fully loaded passenger capacities. This includes trackwork, the Automatic Train Control system, Traction Power Substation systems and other related systems to be designed and constructed to reliably support a scheduled and functional operating headway. **C.** Provide a track alignment and system with sufficient operational flexibility to schedule service that accommodates emergencies, unplanned events, and planned track and systems maintenance. Refer to the Project's Safety Security Management Plan for further information. **D.** Provide all necessary infrastructure and systems to enable safe reliable operations at planned revenue service levels without delays and in an efficient manner for passengers. Refer to the Project's Safety Security Management Plan for further information. **E.** Provide safe operating speed that is consistent with weather, visibility, track conditions, traffic, traffic signal indications, and the ATP systems indicators.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		**F.** Provide the ability to meet future expansion and/or additional capacity requirements without significant disruption of service. **G.** Attract ridership to improve connectivity and mobility. **H.** Provide a system that can be operated efficiently and sustainably, as provided by Metro's Environmental Management System. **I.** Support the development of project plans that meet all required environmental reviews. **J.** Provide connectivity and compatibility between service and systems. **K.** Provide systems that are redundant so that in-service maintenance can be accommodated without the loss of essential services or systems necessary for efficient rail operations. **L.** Provide a life cycle cost analysis, including capital investments, operating, maintenance cost, labor cost and periodic overhaul/rebuilding costs	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2.0		10.4.8	OPERATIONS CRITERIA AND GENERAL REQUIREMENTS													
		A	Train Frequencies													

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	Performance Criteria		General Requirement: Provide an operating headway that promotes safety, reliability and on-time performance. See Reliability, MRDC Section 12. Light Rail Transit: The Operating Headway is defined by the O&M Plan and consists of not greater than a 5-minute interval of time between trains for single line normal operations, and not greater than 2-1/2 minute interval of time in trunk segments and through junctions. The Light Rail Transit Design Headway is defined by the O&M Plan and consists of not greater than 200 seconds for single-line normal operations, and not greater than 100 seconds for trunk segments and through junctions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Heavy Rail Transit: The Operating Headway is defined by the O&M Plan and consists of not greater than 4-minute interval of time between trains for single-line normal operations, and not greater than 2-minute interval of time in trunks and through junctions. The Heavy Rail Design Headway shall be as defined by O&M Plan and consist of not greater than 168 seconds for single-line normal operations, and not greater than 84 seconds for trunk segments and through junctions. Where trunk operations are proposed, provide Operating Plans enabling compatible train movements among the related branch lines. Branch lines shall have equal and matching Operating Headways. Or, if proposed Operating Headways are not equal and matching, the larger operating headway shall be divisible by the smaller operating headway and result in a whole number.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.9	**OPERATIONAL FLEXIBILITY**													
	Performance Criteria	A-D	Metro Rail General Requirements **A.** Provide two tracks to allow for unopposed operation of revenue trains in either direction. A gauntlet track or single-track alignment shall not be used at any point in normal revenue service. **B.** Provide a track alignment that can support failure management and single track operations around disabled trains by means of overtakes or operational storage tracks (such as pocket tracks, sidings, or spurs) along the alignment to remove revenue service obstructions. **C.** No face to face train meets at points of opposed convergence are permissible in the normal direction at junctions or tie-ins with other lines. **D.** Provide a rail network simulation depicting train movements at stations, control points and switches proving safe and efficient operations. The simulation products shall include an assessment of train movement time through junctions, the theoretical and practical capacity of junction, and expected delay.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E-L	**E.** Provide terminal station crossovers within 500 feet of the terminal platform before and after the station. **F.** Provide an operating headway defined for weekday and weekend service, and also for different times of the day, with considerations for special events and for Gap Train considerations. **G.** Provide a typical station dwell time of 20 seconds for normal operations, 30 seconds for transfer stations and minimum 45 seconds for reverse operations. **H.** Provide a terminal dwell time of no less than three minutes. **I.** Provide requirements for Rail Operations Control to accommodate the Project. **J.** Determine train operator reporting locations and relief points. **K.** Provide planning for Pre-Revenue operations of no less than 12 weeks of uninterrupted access by Metro Rail prior to Revenue Service Date to conduct system compatibility tests, Operations Scenario Testing, and provide system simulated service. **L.** Light Rail Transit specific requirements: Provide two tail tracks at terminal stations, allowing for storage of the maximum consist length of the train, no less than 270 feet.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria	M, N	**M.** Provide special trackwork to support single track operations. The O&M Plan will determine locations to place crossovers to achieve an operating headway of 10 minutes or less on a single track. **N.** Heavy Rail Transit specific requirements: Provide two tail tracks at terminal stations, allowing for storage of the maximum consist length of the train, no less than 450 feet. Sufficient track shall be provided beyond this distance to provide for a safe braking distance and bumping post. Provide special trackwork to support single track operations. The O&M Plan will determine locations to place crossovers to achieve an operating headway of 12 minutes or less on a single track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.10	EMERGENCY													
	Performance Criteria		**A.** Provide automatic Transit Passenger Information System (TPIS), Public Address (PA) and Variable Message Signs (VMS) **1.** TPIS shall provide multi-media communications at each passenger station and other selected locations; **2.** PA services shall provide a fully supervised PA subsystem at each passenger station, the Yard and Shop buildings with access and control from various locations. The PA subsystem at the Yard and Shop buildings shall allow announcements from designated Yard and Shop phones to be directed to any one or multiple simultaneous zones; **3.** VMS, compliant with ADA Accessibility Guidelines requirements, shall provide safety and operations related messages to the traveling public at selected location.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.11	SAFETY AND SECURITY													
	Performance Criteria		**A.** Information regarding system safety and security is provided from the Project's adopted Safety and Security Management Plan. Designs for safety and security also comply to the requirements MRDC Section 9 Systems, MRDC Section 12 Safety, Security, and Systems Assurance, and Fire/Life Safety Criteria. **B.** Avoid access for utility metering cubical or rooms used by utility power companies through ROW that will require special training and escort.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.12	OPERATING PERIODS													
	Performance Criteria		Refer to Metro Transit Service Policy for information listed below. For purposes of estimating operating costs, train service levels shall be consistent with existing service levels and operating practices performed by Metro Rail, or planned service levels anticipated in the year service would commence. Weekday Approximate Service Levels: Revenue Service Hour Time Periods AM Peak Hour Build-up 04:30 to 05:30 AM-Peak Service 05:30 to 09:30 Mid-Day Service 09:30 to 15:00 PM Peak Service 15:00 to 18:00 Evening Transition Service 18:00 to 20:00 Night Service 20:00 to 23:59 Late Night Service 23:59 to 04:30	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.13	VEHICLE REQUIREMENT													
	Performance Criteria		The vehicle requirement shall be consistent with the peak vehicles necessary to operate the line, including integration into the existing network, and include allowance for a Gap Trains, and be consistent with FTA policy of a 20% spare ratio. Information regarding the capacity requirement of vehicles is provided by the adopted Rail Fleet Management Plan. The vehicle requirements shall include non-revenue vehicles including but not limited to sedans and hi-rail vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.14	SYSTEM OPERATIONS & OPERATIONAL DESIGN REQUIREMENTS													
	Performance Criteria		Availability of the system shall refer to AREMA Military Standard. Reliability of the system components shall be such that the availability targeted is achieved. Design shall specify appropriate failure rates for the major components and provide Failure Analysis or Hazard Analysis to indicate at least the consequences to operations of such failures. Also, the design shall incorporate the appropriate redundancies of these components for the critical functions (a component in standby is automatically activated when the main component has failed).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		A. Control: Control of vital rail systems (Train Control, Signals, Communications, Traction Power Blue Light System, Emergency Ventilation Systems, Emergency Lighting, SCADA, UPS, and Emergency Generator(s)) shall be field provided with monitoring, selection and over-ride capabilities by the ROC or Local Back-up Control Locations associated with the appropriate system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		B. Traction Power: Refer to Section 9.18 – Traction Power.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		C. Signals & Train Control: Refer to requirements in MRDC Section 9.4.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria		D. Track Design: All track design work should comply to AREMA standards.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		E. Communications: The communication systems are vital to the reliability and service of the rail transit system and must be designed that continuous communications can be guaranteed during emergencies, equipment repairs or equipment replacement.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		F. Normal Operations: A description about the Project's operating alignment and service patterns, build up, exchange of train consists due to vehicle problems, and service reduction at transitional times should be included in the O&M Plan so that the hours indicated by the service requirements established by the Metro Transit Service Policy are met. The description of transitional service build-up and reduction must provide a detailed discussion associated with train movements to and from on-line storage areas or to and from maintenance yards. This discussion must outline the implications and operational issues about these moves during scheduled transitions as well as for service problems when Bad-Order Trains are moved to such facilities during peak service schedules. The Project's alignment shall minimize deadheading and operators terminating shifts at outlying locations to minimize built-in overtime.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		G. Failure Management The O&M Plan must also have a detailed section dedicated to failure management of the rail system for midline turn-backs, as well as single track operation around incidents, emergencies or other events such as Train – Auto Accidents, Derailments, Power Loss, Track / Switch Failures, etc. The Failure Management Plan shall also indicate how Midline Turn-backs shall interface with Bus Bridging and Passenger Information for the Traveling Public.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.0		10.4.15	**OPERATIONAL REQUIREMENTS FOR METRO RAIL FACILITIES**													
	Performance Criteria		General Requirement: Metro Rail facilities shall be separated from other rail facilities which are not operated by Metro. This requirement applies to all track alignments, grade crossings, aerial and underground structures, Maintenance of Way rail access, wayside facilities, station platforms and maintenance yards and shops.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A	STATION DESIGN	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A1	Configuration: The station design shall be center platform to provide minimum passenger disruption and confusion if failure management or single track operations is required. If a center platform is not viable then two side platforms may be acceptable after sufficient detailed capacity and passenger flow information have been approved by Metro. If center platform and opposite side platforms are not feasible and a diagonally separated opposite side platform arrangement is designed, then the system train control system and automatic Passenger Information System at such stations must be modified. The train arrival information displayed is received in sufficient time for passengers to exit one side of a station platform, traverse the intersection, and enter the opposite platform to board a train if and when single track operation is in effect.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A2	Passenger Information: Each station shall be equipped with audio Public Announcement (PA) and Visual Message Signs (VMS) messaging remotely from the ROC for emergency or special announcements. In addition the system shall be equipped with pre-programmed information for automatically displaying train arrival information (Track Number and Destination) from the train control system for train arrival time information. The station train arrival information displayed at each station prior to the train's arrival shall be designed to use the Train to Wayside Communication (TWC) Train Identification Number used for automatic routing at junctions and track circuits. Adequate time shall be provided for display and passenger comprehension so that movement to the correct platform can be achieved prior to the train's arrival.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria	B	Operating Speeds The Maximum Operating Speed for LRT is set to 65 miles per hour (MPH) and is a subject to restrictions per California Public Utilities Commission General Orders (GO) (last revision is GO 143B), based on the Right-of-Way (ROW) classification and level of train and grade crossing protection provided. ROW classification includes exclusive, semi-exclusive and non-exclusive ROW The Maximum Operating Speed for HRT cannot exceed 70 MPH. The Operating Speed shall not exceed the Civil Design Speed. Refer to MRDC Section 4.1.6.1.H.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Special Trackwork Special Trackwork is provided for connections and crossings of tracks in Main Line and maintenance yards. Special Trackwork includes turnouts, frogs, crossovers, and crossings and also for additional safety in sharp horizontal curves and on the structuresby use of guardrails. Turnouts on and connected to Main Line tracks shall provide remote control powered operations from the ROC and the cab of the train. Additionally, remote control operations of main line turnouts shall be provided in locations consistent and convenient relative to switch locations and be easily accessible from train cabs. All maintenance yard turnouts shall provide remote control powered operations from the Yard Control Room/Tower. Refer to MRDC Section 9.4 for Interlocking and Train Control System interfaces. Refer to MRDC Section 4 for turnout and crossover design requirements. Refer to MRDC Section 10.3.3.1c for crossover location requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Auxiliary tracks Auxiliary track types and locations shall be defined in the Project's O&M Plan. Types of auxiliary tracks, which may be provided on the Metro Rail system, are: 1. Tail tracks 2. Holding tracks 3. Pocket tracks 4. Storage tracks 5. Run-around track 6. Siding track	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Rail Operations Control (ROC) Control and supervision of train operations and supervisory control of the associated electrical, mechanical, train control, traction power and communications subsystems shall be the responsibility Rail Operations Control (ROC) staff. The ROC shall function as the command center of system operations and include sufficient facilities for 24-hour operations. Every aspect of Main Line and station operations, Main Line maintenance activities and any Maintenance-of-Way (MOW) that affects Main Line operation shall be monitored, coordinated, and controlled from the ROC. The ROC shall provide centralized control and management to meet all of the operational requirements for each train on a single line or during the transfer between the lines. These operational requirements include radio, public address and telephone communications, CCTV and operations oversight. The selected function of security for each or combination of lines shall also be provided at the ROC. The rail line's response to failures and anomalies shall include either automatically or manually initiated changes in the system configuration, modifications of system operating strategies, and recovery operations. In all cases, ROC personnel shall have the capability of overriding or modifying any automatically initiated failure management strategy, except Automatic Train Protection (ATP). The design of Metro Rail Projects shall include appropriate means for informing passengers of unusual and/or emergency conditions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Yards and Shops A description of Maintenance Yards, Shops and Storage Facilities shall be provided per the Project's O&M Plan with provisions for minimal dead-head run. Refer to MRDC Section 11 for Maintenance Yards, Shops and Storage Facilities design requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria	G	Terminal Transportation Facilities Each permanent transportation terminal shall have as a minimum but not limited to the following transportation facilities: **1.** A Rail Transit Train OperatingOperations Supervisor's (RTOS) booth located at platform level at the outbound end of the station, positioned for should be located with the best line of sight. **2.** A Booth (preferably glass enclosed in tunnel sections) to be equipped with train radio and telephone communications, public address system, a writing surface and secure file drawers. Air conditioning and heating shall be provided where applicable. **3.** RestroomsToilets for Train Operator's use shall be provided. Each temporary transportation terminal shall have as a minimum but not limited to the following transportation facilities: **1.** Train Operating Supervisor's (RTOS) booth of the removable type. **2.** Train Operating Supervisor's (RTOS) booth at platform level at the outbound end of the station. **3.** Booth (preferably glass enclosed in tunnel sections) to be equipped with train radio and telephone communications, public address system, a writing surface and secure file drawers. Air conditioning and heating will be provided where applicable **4.** RestroomsToilets for Train Operator's use shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11	**YARDS AND SHOPS**													
5.0		11.1	**INTRODUCTION**													
	Performance Criteria		Rail Operations functions at the Yard may include, but not be limited to the following: Rail Fleet Services – vehicles storage, maintenance and repair Rail Transportation – train operators services Maintenance of Way – equipment and materials storage, maintenance and repair	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Yard design shall comply with track geometry and other requirements of MRDC Section 4 Guideway and Trackwork. Speed-based geometry requirements of Section 4 may not apply to the Yard tracks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
6.0		11.2	**YARD OPERATIONAL REQUIREMENTS**													
		A	Rail Fleet Services Yard Functions:													
	Performance Criteria	A1	Vehicles exterior cleaning	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A2	Vehicles interior cleaning	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A3	Vehicle undercarriage cleaning	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A4	Vehicle scheduled service and inspection with an access to the roof and undercarriage	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A5	Vehicle heavy repair, including wheel truck, air conditioner and pantograph (if applicable) replacement	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A6	Vehicle body structural repair	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A7	Vehicle interior repair	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A8	Vehicle exterior painting	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A9	Vehicle wheel truing	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A10	Vehicle sanding (refill of a sand tank)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A11	Components overhaul and repair, including electrical and electronic components	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A12	Storage of vehicle components, parts and materials	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A13	Storage of hazardous materials	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A14	Industrial and household waste disposal	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Rail Transportation Yard Functions:													
	Performance Criteria	B1	Train operators report desk services	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B2	Train operators transport services	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B3	Train operator transition services – operator platform	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Maintenance of Way Yard Functions:													
	Performance Criteria	C1	Storage and maintenance of rail and road running equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria	C2	Storage of components, parts and materials	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C3	Equipment, trackwork, traction power, communication and train control components overhaul and repair	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
7.0		11.3	**SITE REQUIREMENTS**													
		11.3.1	RAIL ACCESS													
	Performance Criteria	A	Site shall have rail access from both directions of the Main Line.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Site shall be located as close as possible to the Main Line, preferably next to a passenger station, to minimize the dead run.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Site, parallel to the Main Line shall have rail connections from the Main Line (Yard Leads) at opposite sides of the site; crossovers shall be provided in a Main Line for ability to use each lead for both (or more) Main Line directions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Site with one side rail access shall have two Yard Leads; both Leads shall have direct connection to the Yard Run-Around Track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Main Line shall be protected against run-away rail vehicles from the Yard by the run-away tail track or at least derail device on each lead track; yard leads shall be graded down away from Main Line tracks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	A buffer zone of a length, sufficient to hold the longest revenue train, shall be provided on Yard Leads to transfer the train control over to the arriving train from the Main Line to local Yard control or the other way around for departing train.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Design of the Yard Lead – trackwork and/or train control – shall allow a train to enter the Yard Lead with a cab signal speed for fast clearing of a Main Line.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.3.2	ROAD ACCESS													
	Performance Criteria	A	Site shall have rail access from both directions of the Main Line.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Depending on the size of the Yard Site, one or more additional Fire Department access roads (or just entrances to Yard interior) are required at opposite sides of the Site. Criteria for design of these roads are defined by local Fire Department requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Road access to the Yard shall accommodate large delivery vehicles (18- wheelers tractor-trailers) and waste disposal equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.3.3	SITE LAYOUT													
	Performance Criteria	A	Although location of major (or all) Yard facilities under one roof is preferable, the particular site specifics may dictate a layout with few different size structures to house groups or a single facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Site with one side only rail access shall have a track loop on an opposite end for rail cars (trains) turnaround ability. Metro approval is necessary to provide a tail track instead of a loop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	If a tail track is provided instead of a loop, it shall accommodate the longest train projected to be used by in revenue services.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Preferred layout for rail Shop Facilities is a through track. Metro approval is necessary to provide a tail track in a Shop Facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Storage and Shop Facilities with track access shall have direct connection to Run-Around Track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Run-Around Track shall be provided; by definition, it shall provide the ability to move a rail car through the Yard without entering any Storage or Shop Facility track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	As a rule, Run-Around Track consists of portions of separate track combined with portions of different running/connecting tracks in the Yard. Loop or (and) tail track shall be a necessary part of Run-Around Track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H	Run-Around Track shall provide the ability to by-pass any through-track Storage or Shop Facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I	Run-Around Track shall provide the ability to reach any Storage and Shop Facility with a track access from each of the Yard Leads and from loop or (and) tail track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	J	Track alignment in a Yard shall exclude entrance to the Main Track for any intra-yard movement.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	K	Control tower shall be provided with clear visibility of yard leads, loop or (and) tail track and storage (departure/arrival) tracks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	L	In an urban environment the office part of a building shall face the city street, and the main entrance to the building shall be accessible from the street.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	M	Employee and visitor parking shall be located as close as possible to the office side of the building and to the street access.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	N	Site layout shall exclude crossing of any track or service road by the employee's or visitor's car on a route from street access to the parking and back.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	O	Parking capacity shall be justified by the size of the proposed Yard staff.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	P	Parking and entrance to the building shall comply with ADAAG requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	Q	Layout of Fire Department Access Roads on a site (including geometry parameters) shall comply with requirements of local Fire Department and Metro Fire/Life Safety.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	R	Access and turnaround ability shall be provided for large vehicles involved in delivery and waste disposal. Destination points for such vehicles may be loading docks and loading gates at Storage and Shop Facilities, refuse tanks and large garbage containers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria	S	Access and turnaround ability shall be provided for large MOW road running vehicles. Destination points for such vehicles may be MOW Shop, Storage or designated parking.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	T	Access and turnaround ability at the traction power and power supply substations shall be provided for large maintenance and repair vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	U	Designated parking shall be provided for Metro Fleet general use vehicles and electric carts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.4	RAIL VEHICLE STORAGE FACILITIES (STORAGE TRACKS)													
	Performance Criteria	A	Storage Tracks shall accommodate the size of the Fleet, established in Operational Plan.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Capacity of the Storage Track shall be defined as a distance between clearance points for merging tracks, edge of the pavement of crossing road, insulated joint or a signal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Clearance point for merging tracks is at 13 foot track center distance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Storage Track capacity shall consider spaces between single cars, therefore, length of the LRV for storage capacity calculation purposes shall be 95 foot, HRV – 80 foot.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Capacity of storage tracks shall be measured in increments of maximum train consists (3 articulated cars for LRV, 3 married pairs for HRV) for ability to store coupled trains and use storage tracks as departure/arrival tracks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Capacity of storage tracks shall consider cross road in a middle of the track, which may be required by local Fire Department.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Storage Tracks shall be located on a horizontal tangent; Metro approval is necessary for curved storage tracks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H	Storage Tracks shall be level or have a dish profile (a sag in the middle); the dish profile slope shall not exceed 0.2%.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I	Simple track ladder shall be avoided in storage track alignment; the clearance points (insulated joints, signals) shall be aligned along the cross road.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	J	Storage Tracks shall be grouped in pairs with track centers 13.5 foot between the tracks in a pair and track centers 16.5 foot between the pairs; 13.5 foot satisfies minimum clearance requirements, assuming walkway at top of rail level or below it, 16.5 foot consider also a 5.5 foot wide road for electric carts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	K	Track centers above shall be adjusted accordingly for OCS and light poles, signals or other obstructions.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5	SHOP FACILITIES													
		11.5.1	GENERAL													
	Performance Criteria		Shop Facility in a Yard shall include Service Bays and Support Shop Space. Service Bay is an enclosed (rarely open) track, where rail vehicles (or a train) stay or move through, while undergoing services. Support Shop Space is one or more component repair or support shops; parts, tools and materials storages.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Any service requires constant flow of parts, tools, materials and movement of service personnel; therefore the Shop Facility shall consist of combination of Service Bays and Support Shop Space. Due to locations of multiple Bays in a Shop next and parallel to each other, the direction of supply flow and personnel movement is perpendicular to the Bay (track). It requires the location of Support Shop Space along the Bay and eventually, expansion of the Shop Facility in direction away from the Service Bays. For example, the Carwash, that shall be automatic, with minimal required supply and personnel movement, shall have provisions for Shop Support Space: supporting equipment (pumps, filters, waste water treatment, etc), power and control panels, storage of liquid and solid materials – all that in addition to actual washing equipment, which shall be a part of a Service Bay.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A	General Requirements for Service Bay Design:													
	Performance Criteria	A1	To be designated for particular service function	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A2	Length shall accommodate the longest vehicle or train, as defined by Metro	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A3	Shall accommodate space around vehicle under service, that is sufficient for movement of personnel and forklift or electric cart	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A4	Shall provide headroom, sufficient for operations, service and maintenance of necessary equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A5	Shall provide lighting, heating, cooling, ventilation, drainage and waste disposal sufficient to comply with federal, state and local regulations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria	A6	Shall provide access to Shop Support Space, Office and Employee Welfare Facilities	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	General Requirements for Shop Support Space Design:													
	Performance Criteria	B1	To be designated for particular support function	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B2	Shall provide access for forklift, electric cart or delivery truck	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B3	Shall provide loading dock for large volume deliveries and components shipping and receiving	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B4	Shall provide lighting, heating, cooling, ventilation, drainage and waste disposal sufficient to comply with federal, state and local regulations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Small Facilities (designated areas)													
	Performance Criteria		Requirements in sections below apply to major shop facilities; however, the local conditions may require small size facilities, such as:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C1	Components steam cleaning room	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C2	Paint booth for small components	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C3	Metal cutting and welding area	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C4	Other small facilities	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Shop Facilities shall have provisions for necessary functional and safety equipment and shall comply with all Federal, State and local environmental, workplace safety and other applicable regulations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		List of necessary functional equipment shall be obtained from Metro Rail Fleet Services; all equipment shall be industrial grade and in compliance with Metro Baseline Equipment Specifications.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.2	CAPACITY													
	Performance Criteria		Capacity of the Rail Shop Facility is an amount of Points of Service (like wheel truck hoist/bench) or Service Bays (like carwash), needed to meet fleet service requirements and size of designated labor force. Shop capacity for each service function shall be defined in Operational Plan-part of project deliverables. Fleet service requirements are defined in Fleet Management Plan, prepared by Metro Rail Fleet Services.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.3	CARWASH FOR EXTERIOR CLEANING													
	Performance Criteria	A	Carwash may occupy a bay (bays) in Main Shop Building or be located in a separate enclosure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Carwash equipment shall operate in full automatic mode, being activated by incoming train; train shall move through Carwash on its own power, driven by the train operator.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Length of the Carwash shall be defined, based on fleet size and washing requirements per Operational Plan.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Track alignment around Carwash shall prevent the longest revenue train to interfere with other Yard operations, while it moves through the Carwash.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Location of the Carwash (in a separate enclosure) shall provide the ability to perform the wash as a first service function upon train's arrival in a Yard from revenue service.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	In addition to car washing equipment (like sprinklers, brushes, etc.), Carwash shall accommodate blow dryers, water filtration systems, storage tanks, pumps, power and control equipment, material storage space and waste water treatment equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Road access shall be provided for equipment maintenance personnel, delivery of parts and materials, and waste water treatment equipment service and maintenance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H	Red strobe lights shall be provided at both openings, entrance/exit, of carwash to indicate major failure of carwash or RO system. RO system failure shall not render carwash inoperable.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.4	CLEANING PLATFORM FOR INTERIOR CLEANING													
	Performance Criteria	A	Cleaning Platform (Platforms) may occupy a bay (bays) in Main Shop Building or be located in a Yard as a separate facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Although ADAAG requirements don't apply to Cleaning Platform, for the safety of the employees, the distance between edge of platform and track center, and the height of platform surface above top of rail shall be the same as for a passenger platform – per Section 4 of the Design Criteria.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Length of the Cleaning Platform shall accommodate the longest revenue train.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Location of the Cleaning Platform (as a separate facility) shall provide the ability to perform the interior cleaning as a second service function (following the carwash) upon train's arrival in a Yard from revenue service.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria	E	Hot and cold water supply, mop sinks, centralized vacuum cleaning equipment and power outlets, storage for tools, accessories, liquid and solid materials shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Protective canopy over the entire platform (for a separate facility) and maintenance access ramp shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Road access shall be provided for cleaning and equipment maintenance personnel, delivery of materials and waste disposal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H	Cleaning Platform shall have fifty (50) feet of spring retractable 120V GFCI protected power cord reel mounted at alternating canopy support column.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.5	BLOWDOWN FACILITY FOR UNDERCARRAIGE AND ROOF CLEANING (ROOF CLEANING APPLIES TO LRV ONLY)													
	Performance Criteria		Items D through N apply to LRV only.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A	Blowdown may occupy a bay (bays) in Main Shop Building or be located in a Yard as a separate facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Length of the Blowdown facility shall accommodate the longest rail vehicle over the pit and provide access to the end faces of the vehicle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Underground pit along with service platforms at vehicle floor and roof levels shall be provided for undercarriage, vehicle floor and roof access.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Roof access platform shall be provided for cleaning of the vehicle roof from the platform, using a water hose; provisions for stepping on a roof are not required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Removable 3.5 feet tall safety railing shall be provided around the underground pit to enclose the pit perimeter, when there is no vehicle over the pit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Removable 3.5 feet tall safety railing shall be provided along the edge of the floor level platform, when there is no vehicle over the pit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Access to a roof level platform shall be blocked when there is no revenue vehicle present, using a system of electrically interlocked entrance gates and track occupancy sensors (Platform Access System).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H	Platform Access System shall include traction power (OCS) shut-off feature, combined with a visual indication (blinking lighted warning sign of energized OCS. The circuitry associated with these functions shall be of fail-safe design. This means that during an open circuit and/or a dropped relay the OCS shall be automatically shut-off. Two blinking signs shall be provided with independent circuitry and the OCS shall be considered energized upon the status of any single warning sign.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I	Platform Access System shall include provisions for recognition of non revenue vehicles on blowdown track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	J	Platform Access System shall block access to the platform in case of power outage in a Shop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	K	Platform Access System shall allow emergency exit from the platform in case of power outage in a Shop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	L	Platform Access System shall include provisions for manual override rights by higher level supervisor in case of emergency.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Prescriptive Spec	M	Walking surface of the roof level platform shall be at 12 feet above top of rail, the edge of the platform shall be 4.0 feet from track center and width of the platform shall not be less than 4 feet. Clearance between the platform and any part of the moving rail vehicle shall not be less than 4 inches.													
	Performance Criteria	N	Provisions are required for audio and video notification of shop personnel when traction power is activated.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	O	Supply of pressurized hot and cold water, compressed air and shop power shall be provided at all three levels (two levels for HRV).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	P	The blowdown facility shall accommodate water heating and pressurizing equipment, drainage and waste water treatment facilities, ventilation, and power and control equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	Q	Centralized vacuum cleaning equipment shall be provided to remove dust from vehicle undercarriage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	R	Centralized dust collection system shall be provided to remove airborne dust from compressed air blowdown operations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	S	Storage space shall be provided for tool, accessories and material storage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	T	Road access shall be provided for cleaning and equipment maintenance personnel, delivery of materials and waste disposal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	U	All of the above Safety related functions shall be powered by a UPS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		11.5.6	SERVICE AND INSPECTION (S&I) FACILITIES FOR SCHEDULED AND RANDOM SERVICE, INSPECTION AND LIGHT REPAIR													
	Performance Criteria		Items D through N apply to LRV only.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A	S&I Facility may occupy a bay (bays) in Main Shop Building or be located in a Yard as a separate facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Length of the S&I Shop shall accommodate the longest revenue train over the pit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Underground pit along with service platform at vehicle roof level for undercarriage and roof access shall be provided (roof access applies to LRV only).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Access to both sides of the vehicle at top of rail level shall be provided, including ability to open or remove vehicle skirt covers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Removable 3.5 feet tall safety railing shall be provided around the underground pit to enclose the pit perimeter, when there is no vehicle over the pit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Service platform at vehicle roof level shall be provided for roof access.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Access to a roof level platform shall be blocked when there is no revenue vehicle present, using a system of interlocking entrance gates and track occupancy sensors (Platform Access System).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H	Platform Access System shall include traction power (OCS) shut-off feature, activated, when access is allowed and combined with a visual indication (blinking warning sign) of energized OCS. The circuitry associated with these functions shall be of fail-safe design. This means that during an open circuit and/or a dropped relay the OCS shall be automatically shut-off. Two blinking lighted signs shall be provided with independent circuitry and the OCS shall be considered energized upon the status of any single warning blinking sign.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I	Platform Access System shall be segmented to allow service also of two-car consists and single vehicles on either side of a platform.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	J	Platform Access System shall include provisions for recognition of non revenue vehicles on S&I tracks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	K	Platform Access System shall block access to the platform in case of power outage in a Shop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	L	Platform Access System shall allow exit from the platform in case of power outage in a Shop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	M	Emergency egress and Exit lights shall be provided as required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	N	Platform Access System shall include provisions for manual override rights by higher level supervisor in case of emergency.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	O	Platform Access System shall incorporate occupancy sensors on a secondary platform and interlocking safety devices at the vehicle end (see below).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	P	A narrow secondary platform, not less than 4 feet wide, shall be provided on a side of a track opposite to a service platform for protection of a person working on a roof and for service flexibility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	Q	Access to the secondary platform shall be made possible only from the main platform through the roof of the vehicle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	R	The secondary platform may be replaced with a safety railing with Metro approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	S	The space between main and secondary platforms (or platform and safety railing) at the end of the last vehicle in a consist shall be blocked by a manual or mechanically operated interlocked end gate, integrated in Platform Access System.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	T	End gates shall accommodate three and two-car consists along with a single vehicle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	U	Walking surface of the roof level platform shall be at 12.25 feet above top of rail, the edge of the platform shall be in 4.0 feet from track center and width of the platform shall not be less than 4 feet. Clearance between the platform and any part of the moving rail vehicle shall not be less than 4 inches (0.33 ft). See Exhibit 1 diagram provided as reference.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	V	Maximum gap for a technician to step from the platform over the shroud down to the roof shall be 7 inches (0.6 ft) when vehicle is positioned for service:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	V1	Mechanically operated catwalk extension shall be used to achieve a maximum gap for the shroud, if needed (for the AnsaldoBreda LRV)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	V2	Extension mechanism may be activated only when vehicle, which requires catwalk extension, is positioned on a service track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	V3	Extension mechanism shall be interlocked with Traction Power System to eliminate possibility of catwalk to be extended, when traction power is on. This will prevent any vehicle movement on a service track next to an extended catwalk.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	V4	Catwalk extension shall be fully retracted before traction power can be turned back on (re-energized).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	W	Supply of compressed air and shop power shall be provided at all three service levels (two for HRV).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	X	Provisions shall be made for vehicle fluid supply reels in the inspection pit.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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	Performance Criteria	Y	Provisions shall be made for used oil evacuation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	Z	Road access is required for delivery of parts, tools and materials, service and maintenance and waste disposal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	AA	All of the above Safety related functions shall be powered by a UPS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.7	HEAVY REPAIR (HR) SHOP FOR HEAVY COMPONENT REPLACEMENT, INCLUDING WHEEL TRUCKS, AIR CONDITIONER AND PANTOGRAPH (WHERE IT APPLIES)													
	Performance Criteria		Items G through R apply to LRV only.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A	HR Facility may occupy a bay (bays) in Main Shop Building or be located in a Yard as a separate facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Length of the HR Shop shall accommodate the longest rail vehicle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Vehicle lift, consists of combined wheel truck and body lift, shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Overhead bridge crane, 15 ton capacity, covering the entire shop shall be provided to move heavy components.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Also, tracks, connected by turntables, shall be provided to move wheel trucks and assembled wheel axles at ground.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Access to both sides of the vehicle at top of rail level shall be provided, including ability to open or remove vehicle skirt covers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Service platform at vehicle roof level shall be provided for roof access.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H	Access to a roof level platform shall be blocked when there is no revenue vehicle present, using a system of interlocking entrance gates and track occupancy sensors (Platform Access System).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I	Platform Access System shall include traction power (OCS) shut-off feature, activated when access is allowed and combined with a visual indication (blinking warning sign) of energized OCS. The circuitry associated with these functions shall be of fail-safe design. This means that during an open circuit and/or a dropped relay the OCS shall be automatically shut-off. Two blinking lighted signs shall be provided with independent circuitry and the OCS shall be considered energized upon the status of any sign warning blinking sign.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	J	latform Access System shall include provisions for recognition of non revenue vehicles on HR tracks.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	K	Platform Access System shall block access to the platform in case of power outage in a Shop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	L	Platform Access System shall allow exit from the platform in case of power outage in a Shop.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	M	Emergency egress and Exit lights shall be provided as required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	N	Platform Access System shall include provisions for manual override rights by higher level supervisor in case of emergency.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	O	Walking surface of the roof level platform shall be at 12.25 feet above top of rail, the edge of the platform shall be in 4.0 feet from track center and width of the platform shall not be less than 4 feet. Clearance between the platform and any part of the moving or raised on a car hoist rail vehicle shall not be less than 4 inches (0.33 ft).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	P	Supply of compressed air and power shall be provided at all three service levels (two for HRV).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	Q	Access to component repair shops (areas) shall be provided to move heavy components to and from HR track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	R	Access to supporting shops and storage facilities shall be provided for supply of parts, tools and materials to and from HR track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	S	Access to overhead crane shall be provided for scheduled and random service, maintenance and inspection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	T	Provisions for waste disposal are required.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	U	Due to car lift and overhead crane, contact rail or wire shall not be provided; therefore, traction power stingers shall be provided for testing and other purposes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	V	Road access is required for delivery of parts, tools and materials, service and maintenance and waste disposal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	W	All of the above Safety related functions shall be powered by a UPS.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.8	BODY REPAIR SHOP													

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
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	Performance Criteria	A	May occupy a bay (bays) in Main Shop Building or be located in a Yard as a separate facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Provisions are required for metal cutting and welding and body/frame pulling equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Overhead crane shall be provided for body parts lifting and moving.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Sufficient exhaust ventilation shall be provided for torch cutting and welding.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Shall have provisions for dust exhaust and collection due to sanding and buffing operations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Shall be in close proximity to Sheet Metal and Paint Shops.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Road access is required for delivery of parts, tools and materials, service and maintenance and waste disposal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.9	PAINT SHOP FOR VEHILE EXTERIOR AND COMPONENT PAINTING													
	Performance Criteria	A	May occupy a bay (bays) in Main Shop Building or be located in a Yard as a separate facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Shall include designated preparation area.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Shall have provisions for hazardous fumes exhaust.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Design shall comply with federal, state and local environmental protection and work safety regulations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Road access is required for delivery of parts, tools and materials, service and maintenance and waste disposal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.10	WHEEL TRUING SHOP													
	Performance Criteria	A	Shall be located in close proximity to Heavy Repair Bay.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Shall have provisions for industrial waste (metal chips) disposal	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Track alignment around Wheel Truing Shop shall prevent the longest revenue vehicle from interfering with other Yard operations, while it moves through the machine (i.e. track length 180 foot for LRV and 150 foot for HRV).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Road access is required for service, maintenance and waste disposal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.11	TRUCK, WHEEL AND AXLE SHOP													
	Performance Criteria	A	Shall be located in close proximity to Heavy Repair Bay.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Shall have direct access to Heavy Repair Bay through track/turntable link or/and overhead bridge crane.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Shall have truck hoist/work benches, connected to track/turntable link.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Shall have provisions for tire press, axle lathe, boring mill, etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Shall provide all-around work access to work benches and other equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Shall provide truck and axle rail storage space.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Shall provide storage space for wheels, axles and other truck parts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H	Shall provide 10 ton overhead crane for lifting and moving trucks, axles and wheels.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I	Shall have shop power and compressed air supply.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	J	Shall provide a loading dock for components delivery, shipping and receiving.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	K	Shall have an access for forklift and electric cart.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.12	SHEET METAL SHOP													
	Performance Criteria	A	Shall be adjacent to Body Repair Bay.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Shall have provisions for metal cutting, bending and welding equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Shall contain designated welding area with a work bench and ventilation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Shall provide storage space for tools, accessories and materials.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Shall have shop power and compressed air supply.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Shall have an access for forklift and electric cart.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria	G	Shall have a road access for service, maintenance and deliveries.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.13	MACHINE SHOP													
	Performance Criteria	A	Shall have provisions for various industrial type machines.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Shall provide storage space for tools, accessories, parts and materials.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Shall have a road access for service and deliveries.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Shall have an access for forklift and electric cart.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Shall have shop power and compressed air supply.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.14	VEHICLE SANDING FACILITIES													
	Performance Criteria	A	May be combined with another service function, such as interior cleaning at cleaning platform.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Shall be automatic and accommodate exterior sand ports on both sides of Metro Rail vehicles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Shall have a road access for service, maintenance and deliveries.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.15	OTHER COMPONENT REPAIR SHOPS													
	Performance Criteria	A	Traction motors	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Electrical Equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Control and Communication equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Pantograph (where applies)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Air conditioner	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.16	MAINTENANCE OF WAY (MOW) SHOP													
	Performance Criteria	A	May occupy a bay (bays) in Main Shop Building or be located in a Yard as a separate facility.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Shall have rail access to Main Line and Run-Around track.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Shall be equipped for service and maintenance of MOW rail and road running equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Shall have provisions for work space (including work benches, tools and equipment) to perform repairs on components of Trackwork, Overhead Contact System, etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Shall have provisions for storage of MOW materials, including open storage areas.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Shall have provisions for storage of large road running MOW equipment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Shall have provisions for road access for service, deliveries and waste disposal.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H	Shall have provisions for shop power and compressed air supply.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.5.17	OPERATOR PLATFORM													
	Performance Criteria		Function of Operator Platform is to provide a location – Operator Transition Point - on a main line (guideway), where train operator can be relieved en route due to shift end or for any other reason	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A	Shall be located on a main line tracks in close proximity to Operators Report Desk in a Yard	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Shall include two side platforms with a maintenance crosswalk/grade crossing as needed	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Each platform shall not be less than 15 feet long and 6 feet wide	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Distance from track center to the edge of platform shall be 5.0 feet	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Distance from track center to the stairs shall be 7.0 feet	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Overhead canopy shall be provided on full length of the platforms	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Edge of the canopy shall not extend over the edge of platforms	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H	Protective railing shall be provided in a back of the platforms	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I	Handrails shall be provided at the stairs	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	J	Platforms shall have area lighting with a minimum level of 15 fc; luminaires shall be designed per MRDC Section 7 minimum requirement.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria	K	Platforms shall have a roof mounted warning lunar light	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	L	Both platforms area lighting and a warning light shall be manually activated from the platform and controlled by a timer	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	M	Platforms shall have an operator assistance telephone with a direct ring to ROC; phone shall be weatherproof type and similar to PTEL	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	N	Platforms shall have Blue Light Station (BLS) per Metro Baseline Specifications 34-21-31	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	O	Per Metro directions, turnaround space and roadway of sufficient width shall be provided, if the platforms are located further than in a walking distance from Operators Report Desk	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	P	Walkway or roadway to the platforms along with a turnaround space shall have area lighting with a minimum level of 5 fc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	Q	Entrance to the guideway shall be secured by a locked gate to prevent unauthorized access	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.6	OFFICE FACILITIES													
	Performance Criteria		Office Facilities shall be provided, including but not limited to:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A	Control room with visibility of Yard Leads, Storage Tracks and the Loop (Tail Track)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Supervisors and technical staff offices	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Operators Report Desk	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Conference rooms	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Equipment, tools, accessories and office materials storage rooms	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Maintenance staff: FM and MOW Maintenance Shop, FM Office, MOW Office, custodial closets	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.7	EMPLOYEE WELFARE FACILITIES													
	Performance Criteria		Employee Welfare Facilities shall be provided, including but not limited to:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A	Lockers, showers and restrooms	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Kitchen and lunch room	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Recreation room	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.8	COMPONENTS, PARTS AND MATERIALS STORAGE FACILITIES													
	Performance Criteria	A	Shall have storage capacity sufficient to: maintain the designated yard revenue fleet; maintain all facility electrical, mechanical, pneumatic and hydraulic systems and equipment; and maintain necessary supply of frequent-use mainline train control, OCS, and traction power parts and components.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Shall have provisions for rail storage for wheel trucks and axles assembles.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Shall have provisions for special storage racks for wheels, axles, motors and other heavy parts.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Shall have provisions for hazardous materials storage.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Shall have provisions for easy access to corresponding repair shop or/and bay.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.9	WASTE DISPOSAL FACILITIES													
	Performance Criteria	A	Shall provide distinction between different types of waste (separate storage units) in compliance with local regulations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Shall have provisions for access and loading/unloading operations per local regulations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Road vehicles, involved in waste disposal, shall not cross any track or service road in a Yard on their normal route.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Waste disposal operations shall not interfere with normal Yard activities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.10	SECURITY													
	Performance Criteria	A	Metro property, in particular revenue transit vehicles, shall be protected against vandalism as well as from terrorist threats.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Provisions shall be made for continuous enclosure along the Yard perimeter made of metal picket fence with custodian style spike deterrent or concrete wall 12 feet high with NO TRESSPASSING and HIGH VOLTAGE signs and topped with single helical razor ribbon, full time live or electronic surveillance and access, limited to authorized Metro employees.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	Entrance inspection post (guard booth) shall be provided at the designated main gate.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	Additional entrances (gates) shall be full time locked with access provided for designated emergency services (Fire and Police) only.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Revenue vehicles shall be stored only in secured areas under full time live or electronic surveillance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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		11.11	**TRACTION POWER SUBSTATIONS, YARD LIGHTING, COMMUNICATIONS, SIGNAGE AND GRAPHICS**													
		11.11.1	TRACTION POWER SUBSTATION													
	Performance Criteria		For Yard electrification, a Traction Power Substation shall be provided with the necessary switch gear and control equipment. Substation shall be accessible to road vehicles for installation, repair, maintenance and Fire Department needs. See more of Traction Power requirements in Section 9 Systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.11.2	YARD LIGHTING													
	Performance Criteria		The Yard shall be illuminated for operations to be performed safely throughout a 24-hours day. A minimum illumination of two foot candle at ground level shall be provided in all areas, including aisle ways with tracks that are fully occupied by rail cars. This minimum shall not include any illumination from the rail cars. Yard lights, towers, poles and stanchions shall be located in a way, that they will be accessible for maintenance, minimize shadows and do not interfere with routine Yard operations. Yard lights shall be mounted on existing or proposed buildings or other structures whenever it is possible to minimize the need for separate Yard lighting support structures. Yard light pole shall be grounded and each shall have grounding rod (electrode). See more of lighting requirements in Section 7 Electrical.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.11.3	COMMUNICATIONS													
	Performance Criteria		All communications throughout the Yard and Shops shall be by radio, telephone and public address system. See more of Communications requirements in Section 9 Systems.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		11.11.4	SIGNING AND GRAPHICS													
	Performance Criteria		Signs and graphics shall be provided throughout the Yard and Shops wherever it is necessary for safety, security, directional, informational; shop, room and track identification location of Yard Limits and other such needs. Signage and Graphics appearance shall be consistent with ones at existing facilities. See more of Signage and Graphics requirements in Section 6 Architectural.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12	**SAFETY SECURITY SYSTEMS ASSURANCE**													
8.0		12.1	**INTRODUCTION**													
		12.1.1	ABBREVIATIONS AND ACRONYMS													
		12.1.2	REFERENCES													
		12.1.3	CODES, STANDARDS AND REGULATIONS													
9.0		12.2	**SYSTEM SAFETY**													
		12.2.1	SPECIFIC PROVISIONS FOR SAFETY													
	Performance Criteria		Specific provisions for safety are addressed in the specific design criteria for each rail system element. Certain provisions accounted for elsewhere in the Rail Design Criteria are cited in this section to highlight how safety shall be collectively incorporated in specific design elements. This section of the design criteria provides design guidance in System Safety for systemwide aspects and phases of the Metro Rail Transit System.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.2.2	GENERAL													
	Performance Criteria		Safety is a primary consideration through the evolution of each Light-Rail Transit and Heavy Rail Transit System, from preliminary engineering through revenue operations. To achieve safety goals, all applicable codes and regulations, augmented by modern safety engineering technology and industry standards, are to be used to ensure that each Metro Rail Line achieves a level of safety that equals or exceeds that of the rail transit industry.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Transit station construction should consider accepted Crime Prevention Through Environmental Design (CPTED) standards within underground station and on at-grade platforms or plazas. The basic function of public transit is to efficiently and safely move the public from one location to another. CPTED promotes open space and the use of structure and seating design to inhibit loitering.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Transit station construction should consider accepted Crime Prevention Through Environmental Design (CPTED) standards within underground station and on at-grade platforms or plazas. The basic function of public transit is to efficiently and safely move the public from one location to another. CPTED promotes open space and the use of structure and seating design to inhibit loitering.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria		Safety program(s) shall ensure the Visibility Triangle of both the cab of a moving train along the entire right-of-way and at stations, from adjacent moving automobiles, bicycles, and pedestrians. The Visibility Triangle shall be improved by removing visibility obstructions where practical, but never degraded by designing other obstructions such as equipment cabinets, TPSS buildings, trees, etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.2.3	SYSTEM SAFETY DESIGN APPROACH													
	Performance Criteria		Prior to preparation of specifications and design development, a Preliminary Hazard Analysis (PHA) shall be prepared which analyzes the loss or malfunction of each operational function and categorizes its affect on the equipment, personnel, patrons and general public to determine the associated hazard level as defined in the referenced documents.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Identified hazards shall be eliminated or controlled as applicable, using the following hierarchy of hazard resolution:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	1	Design for Minimum Hazard: To the extent permitted by cost and practicality, identified hazards shall be eliminated or controlled by the design of equipment and facilities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	2	Safety Devices: Hazards that cannot reasonably be eliminated or controlled through design shall be controlled to the extent practicable to an acceptable level through the use of fixed, automatic, or other protective safety design features or devices. Provision shall be made for periodic functional checks of safety devices.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	3	Warning Devices: When neither design nor safety devices can reasonably, effectively eliminate or control an identified hazard, devices shall be used to the extent practicable to detect the hazard and to generate an adequate warning signal to provide for operating personnel/public reaction. Warning signals and their application shall be designed to minimize the probability of incorrect operating personnel/public reaction to the signals.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	4	Procedures and Training: Where it is impossible to reasonably eliminate or adequately control a hazard through design or use of safety and warning devices, procedures and training shall be used to control the hazard. Precautionary notation shall be standardized, and certain safety-critical tests shall require certification of personnel.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.2.4	STATION AND GUIDEWAY DESIGN													
	Performance Criteria		Safety at stations and along the guideway shall be reflected in the following characteristics:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		<u>Visibility</u> - For Visibility Triangle, Safe Stopping Point and Crossing Sight Distances refer to FHWA (Federal Highway Administration) Grade Crossing Handbook, Chapter III.C Assessment of Crossing Safety and Operation, Engineering Study.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		<u>Platform Layout</u> - Platforms shall be designated with paid and non-paid areas where proof-of-payment fare enforcement is applied. The entrance to "fare enforcement zones" on each platform shall be clearly identifiable to separate the paid passengers from non paid passengers.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		<u>Equipment Accessibility and Fall Protection</u> - All serviceable equipment shall be safely accessible by maintenance personnel, and shall conform to Metro Corporate Safety Fall Protection Program. If equipment is more than 11 feet above the floor, OSHA compliant fall protection devices shall be installed with adequate room for ladder access. Alternatively, compliant service platforms and fixed ladders may be provided. Mobile lifts may be used to access lighting and other equipment/devices in the public or ancillary areas that cannot be reached with ladders. High rail bucket trucks may be used for access along the guide way for fan and lighting maintenance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		<u>Illumination</u> - Illumination shall be in conformance with Metro, IES, and ANSI criteria and recommendations within the station and along station perimeters with no dark or shadowy areas, including Park and Ride areas at designated stations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		<u>Materials and Construction</u> - In addition, any surfaces or equipment accessible to the public, such as emergency or passenger assistance telephones, station floors and walls shall comply with the architectural requirements and vandal-resistant design.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		<u>Service Vehicle Parking</u> – Each station shall have provision for service vehicle parking.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		<u>Signage</u> - Adequate signage shall be created and posted in plain view similar to those used in the Metro rail system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		<u>Landscaping</u> - Landscaping around the platforms and parking, and along the Right-of Way shall be selected to allow for minimal upkeep and to prevent persons and objects from being hidden or concealed. All areas of the stations shall be in clear view from adjoining streets and not hampered by landscaping. When police or security patrol units drive by the stations they shall be able to observe all areas of the stations without certain points being concealed by the landscaping.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.2.5	LRT PHOTO ENFORCEMENT													
		12.2.5.1	DESCRIPTION													
		12.2.5.2	SYSTEM FUNCTIONAL REQUIREMENTS													
	Performance Criteria		The following general requirements shall apply to public transportation corridors, where vehicular traffic crosses the corridor, particularly where vehicular traffic parallels then crosses the corridor.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	A	The Photo Enforcement system shall:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria		- Comply with intersection designs and be able to monitor or receive a direct feed from the automated train warning system or signal light controller to initiate enforcement mode capturing all applicable phases or gate arm movement in compliance with California Vehicle Code (CVC) statutory requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Utilize vehicle detectors (invasive or preferably non-invasive) that accurately capture vehicle presence and velocity	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Employ high definition video camera equipment capable of day and night time image capture without the need for auxiliary lighting that meets or exceeds issuance criteria established by Metro to capture a video clip of the violation	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Meet all requirements described in the CVC relating to photo enforcement systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Capture motor vehicle movements that violate straight movement, the dedicated left or right turn traffic signals. These movements are typically left or right turn movements that parallel then cross the LRT right-of-way	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Interface with a dedicated automated train warning system or signal light controller	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Capture infractions of motor vehicles with no minimum speed threshold as required per Metro Systems Safety	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Provide a minimal curbside footprint (visibly appealing installation and hardware) compliant to Metro design guidelines	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	B	Selection of the enforced approach shall be based on (but not limited to):	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Traffic analysis;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Crash statistics	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Status/implementation of alternate traffic safety measures	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Policy to be utilized for LRT	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	C	All applicable intersections shall have a minimum of two cameras, provided for each left turn (one digital still camera and one digital video camera) and two cameras provided for each right turn (one digital still camera and one digital video camera). Additional systems will be based on intersection configuration and traffic analysis. Rear still image or video cameras may also be required based on the intersection configuration.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	D	The functional requirements of the main components shall include, but not be limited to, the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- One digital still camera (between 18 and 22 mega pixels)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- One digital high definition video camera	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- One secure, weatherproof housing for both cameras	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- One digital storage device and camera controller (with capacity for up to 30 days of stored video and still images)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- One camera pole (per unit)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- One auxiliary flash unit with pole	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- One stop bar flash unit with pole	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- One detection unit per approach (invasive or non-invasive)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E	Capabilities of the main components shall include, but not be limited to, the following:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E1	General Characteristics:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Designed to withstand vandalism and other malicious intent	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Designed to withstand the elements (24/7 operating capability).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Designed to include "break away" capability in case of collision	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Height: Dependent on individual installation	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Designed for easy access by law enforcement personnel and field service technicians	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria		- Compliant with jurisdictional engineering standards	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Designed for aesthetics (minimal footprint)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Engineered to provide a simple, easy installation process	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Designed for maximum adaptability and flexibility	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Interchangeable and easily replaceable components	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Remote access ready	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E2	Security	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Strengthened cabinet	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Shatter-proof glass/plexiglass	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Multi point security locking mechanism	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- System components not accessible from the ground without the use of a ladder or other assistive device	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	E3	Interface	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Designed for ease of use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Web based connectivity that does not require camera specific software to access	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- High Speed internet or Ethernet communication connection	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- 120 V AC power	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Signal isolation detection of signal phases (limiting the interface connection to the intersection controller).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Compatible with other photo enforcement approaches currently in use within the Metro Photo Enforcement program	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F	Detection System	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F1	In ground (inductance)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Loop detection control and interface with camera system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Loop configuration designed to maximize capture of vehicle profile and speed data.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Pull boxes, power supply line, direct line connection to camera system, and in ground wiring.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F2	Radar	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Multi-object vehicle tracking radar with real-time interface to camera system	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Capable of tracking multiple objects with accurate speeds	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Designed to maximize capture of vehicle position and speed data.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Combined low voltage power supply line and, antenna for communications connection to camera system, power supply line, and pole (or mounting hardware for using existing intersection poles).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	F3	Light Detection and Ranging (LIDAR)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Scanning LIDAR multi-object vehicle detection.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Designed to maximize capture of vehicle position and speed data.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Pull boxes, power supply line, direct line connection to camera system, and in ground wiring.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G	Flashes	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G1	400 to 1600 watt flash unit (based on the intersection configuration)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G2	Recharge in under 1 second (to capture multiple photos in succession)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G3	Configurable for flash intensity settings	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	G4	120 V AC power	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria	G5	Direct line feed from camera system to fire flash	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H	Signage	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	H1	Designed to meet CVC and California Manual on Uniform Traffic Control Devices (MUTCD) requirements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I	Camera System	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I1	18-22 mega pixels digital still camera system	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I2	Professional grade, high speed glass lenses	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I3	High definition video camera	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I4	Designed to maximize image quality with remote functionality	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I5	Software allows remote access to camera system to adjust settings	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I6	Data collection system capable of remotely uploading data to secure server at regular intervals	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I7	Diagnostic and statistical screens to validate the health and status of the system on-site or remotely.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I8	Incorporates multiple vehicle detection options	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I9	Monitors up to 8 lanes of traffic	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I10	Is capable of capturing multiple simultaneous violations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I11	Designed with easily interchangeable components and hardware	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria	I12	Able to remotely send error messages and warning alerts in case of system failure	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.2.5.3	SERVICING AND EQUIPMENT MAINTENANCE													
	Performance Criteria		Photo Enforcement equipment will require regular servicing (collection of data and replacement of consumable supplies) and normal maintenance. On-site inspection is conducted five days a week based on Security/Law Enforcement guidance.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.2.5.4	INTERSECTION DESIGN													
	Performance Criteria		Provisions for power and communication will be included in the intersection design to accommodate Photo Enforcement power and data communication/upload. Location of Equipment (such as pole base (s) and loop(s)) will be determined and designed based on individual intersection designs and requirements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		A	Conduits and Pull Boxes													
	Performance Criteria		For communications, 3 inch minimum branch conduit to be run from each device location to nearest photo enforcement communication pullbox or junction box located within area of pole base.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		For power, minimum 3” size branch conduit shall be run from each Pole base location to the designated power connection for installation of power wiring.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Conduits shall have all sharp edges removed. Conduits shall be sealed and watertight	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		The conduit/pull box system shall be exclusively designed and built for photo enforcement use. No other system could share photo enforcement conduits and pull boxes.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		B	Connections to Photo Enforcement Equipment													
	Performance Criteria		Connections from the power and the communications at locations of Poles shall utilize conduit stub-ups	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Conduit stub-ups shall be used (locations with provisions to install additional poles in future as required).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		C	Electrical													
	Performance Criteria		Power conduit shall be installed to run power circuits from the power source to each pole. Conduit shall utilize intermediate power pull boxes appropriate for the length of main conduit run(s). Conduit arrangement should use main run to each general location of equipment with branch runs continuing between junction box and each pole location.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Dedicated 120V, 60 Hz, and 20 amp circuits shall be provided.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Power wiring shall be kept separate of data communications cabling and shall be run continuously, without splices, from source to each pole location including identified future locations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		D	Data Communications Equipment													
	Performance Criteria		Data communications cabling shall be kept separate of power wiring; and shall be run continuously, without splices, from source to System Components location.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.2.5.5	DATA COMMUNICATIONS													
	Performance Criteria		High Speed Communication Link Requirements for each site will require:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		All infrastructure conduits and communication link requirements for leased or Metro provided data lines.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria		The ability to upload collected data at regularly scheduled intervals for processing.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3	**SECURITY**													
		12.3.1	INTRODUCTION													
	Performance Criteria		Design for Rail facilities shall ensure a high level of security for patrons and operating personnel. Facility design and operating procedures shall promote a sense of well-being for patrons and personnel, discouraging acts of crime, violence, and abuse. Security provisions shall also discourage acts of vandalism, theft, and fraud.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		The purpose of system security design criteria is to provide sufficient definition and description of all facets of a system security concept so that design engineers and architects have guidance for the proper selection of equipment and the design of facilities. Through these criteria, security considerations shall be integrated into all aspects of the design, equipment selection, architectural concepts, procedures, and operations. Additionally, it shall enable trade-off studies to be performed to achieve a balanced, comprehensive level of system wide security	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.2	GENERAL REQUIREMENTS													
	Performance Criteria		The system shall provide deterrence from, protection against, and surveillance of potential acts of violence. This approach to design shall apply to both fixed facilities and mobile elements (vehicles) of the Rail system. In general, the design of the rail facilities shall include features that enhance patron and personnel security.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.3	BASIS FOR SECURITY STRATEGY													
	Performance Criteria		Rail system design shall consider preparing and implementing security strategies that are consistent with Metro's comprehensive system security plan that are based on a threat and vulnerability assessment (TVA). The results of the TVA can be used to help determine implementation priorities.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Security plan and TVA guidance can be found in The Public Transportation System Security and Emergency Preparedness Planning Guide [FTA, 2003].	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Metro will prioritize risks through threat TVA's and select sets of countermeasures for each rail project that provide the best overall risk reduction for the system as a whole.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.4	SECURITY PLAN													
	Performance Criteria		The purpose of a Security Plan is to enhance and maintain the security of Metro's operation by establishing a framework in which a comprehensive (i.e., encompassing the entire security "spectrum"), effective and sustainable security program can be developed, implemented and maintained. A Security Plan also enables Metro to:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Describe how various elements of its security program integrate;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Establish security program roles and responsibilities, thereby ensuring tasks are assigned, understood, documented, tracked and organized in a consistent manner;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Identify its partners and stakeholders in regards to enhancing and maintaining the security of its operations;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Adjust its security preparations and operations in response to changing circumstances;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Implement various security program elements, e.g. security measures, policies and procedures, etc. that can be measured, audited, and evaluated, to determine the effectiveness of Metro's security program.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.4.1	ROTATIONALE FOR CREATING A SECURITY PLAN													

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	Performance Criteria		Creating a Security Plan permits Metro to enhance its capabilities to prevent, mitigate, respond to and recover from a terrorist attack or security incident in a systematic and consistent way. A Security Plan outlines the measures Metro will use to secure its passengers, employees, freight, tenants, assets, operations, facilities and communications and the public against potential and actual terrorist attacks or security incidents. Hence, a Security Plan helps Metro to establish and maintain a formal and comprehensive security program and serves as a blueprint for all of Metro's security activities. The Security Plans shall be developed in consultation with appropriate partners, including transit police, sheriffs and police and other first responders, to help assure it is comprehensive and achievable by all stakeholders.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.4.2	DEFINITION OF A SECURITY PLAN													
	Performance Criteria		A Security Plan is a strategic and agency sensitive document that:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Sets security goals and objectives based on the results of a comprehensive TVA;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Establishes a framework, reflecting the full security "spectrum" (prevention, mitigation, response and recovery) for addressing security threats and risks;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Reflects a coordinated approach to Metro system security that integrates all available resources to enhance protection from potential terrorist activities and/or security incidents;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Identifies key assets that require protection (as a result of the TVA);	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Identifies, and establishes measures to be implemented to address risks identified in the TVA (i.e., prevention and mitigation measures), including measures applicable at each alert level (e.g., low, medium, high);	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Clearly identifies coordinated and related plans (e.g., Emergency Management Plan, Business Recovery Plan) procedures, protocols and responsibilities for implementing Metro's security program;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Identifies a timetable or action plan to introduce new measures that are required to address priority risks, such as interim and long-term measures as appropriate;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Gives full consideration to actions or resources required to support the implementation of various security program elements (e.g., security and emergency response training and awareness, information technology security, document control, etc.).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.4.3	RELATION TO OTHER DOCUMENTS													
	Performance Criteria		A Security Plan is part of a holistic approach to security. The Security Plan establishes a framework for Metro's security program. The Security Plan may operate as part of a suite of other related plans, which in turn references more specific procedures. Plans that could be referenced by a Security Plan shall include, but are not limited to: the Threat and Vulnerability Assessment, Business Continuity Plan, Fire Evacuation Plan, Security Escalation Plan (Alert Levels), Information Management Plan, etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.4.4	SCOPE													
	Performance Criteria		Metro's Security Plan represents its commitment to continuously improving the security of its operations and services and to integrating security into all of its activities. Hence, the Security Plan shall address security risk, where appropriate for all of Metro's activities as well as all of its organizational units, employees, and contractors.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.4.5	GOALS AND OBJECTIVES													
	Performance Criteria		The Security Plan shall establish goals and objectives for the purposes of identifying goals as broad and general statements, while objectives shall be more focused and specific statements.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.4.6	GOALS AND OBJECTIVES													
	Performance Criteria		The overall goal of a Security Plan shall be to enhance the level of security and protection afforded to its employees, customers and assets from various security threats including terrorism, crime and disorder. The Plan may also identify other goals applicable to Metro's operation.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.4.7	OBJECTIVES													
	Performance Criteria		The Security Plan shall include the following objectives:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Enhance Metro's ability to prevent, mitigate, respond to and recover from a terrorist attack and or security incident;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria		- Describe current security program elements and define associated security measures;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Define roles and responsibilities for all personnel with regards to security;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Demonstrate how security concerns are factored into relevant aspects of Metro's activities;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Establish processes for maintaining, evaluating, and modifying the Plan;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Establish processes for identifying, receiving input (e.g., from employees, contractors and the public), reporting on and addressing security concerns, security incidents, suspicious activities, etc.;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Establish processes for interfacing with partners, stakeholders and the public;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Establish processes for reviewing and assessing Metro's implementation of and adherence to the Plan and other related documents;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Identify security program training requirements;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Establish processes for investigating security incidents or suspicious activities;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Ensure potential security implications are taken into account when making decisions regarding Metro's rail operations.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.4.8	CONTENTS OF A SECURITY PLAN													
		12.3.4.8.1	Minimum Contents													
	Performance Criteria		At a minimum, a Security Plan shall contain:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- A summary of and reference to the TVA;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- A description of security-related roles and responsibilities;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- A description of Metro's current security program elements and reference to associated security measures; and security capacities (e.g., personnel, technology, resources, tools, instruments, etc);	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- A description of the measures in place to address the risks identified by the TVA (including under various alert levels) and a reference to the relevant procedures for implementing those measures;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- A description of Metro's security training and awareness programs;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- A description of Metro's security exercise program(s);	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- A description of Metro's processes for evaluating and auditing its security program, and references to the relevant procedures for implementing those processes;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- A description of Metro's processes for reviewing and updating the Security Plan and for securing sensitive documents;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- A description of the agency' communications strategy and security incident reporting;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- An indication of how the Security Plan integrates with other related documents (e.g., the Emergency Management Plan, Business Continuity Plan, etc.);	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- References to other relevant documents (e.g., procedures, etc.) necessary to implement the Security Plan and the security program of which it forms a part.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.4.8.2	Content Limits													
	Performance Criteria		The Security Plan shall not include detailed descriptions of the procedures, resources, tools etc required to implement the plan. Rather it shall identify the measure, tool, resource, etc., and reference the other relevant documents (e.g., procedures, inventories, resource allocation, etc.) where the more detailed and required security plan implementation information can be found. For example, by providing the file number or identifying its custodian. The three main reasons for this are:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- First, such detail would make the plan too long and more difficult to use;	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Second, details about Metro would make it more difficult to serve its intended audience and purpose: i.e., as a strategic document and framework; and	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		- Third, Metro's entire security program shall not be in one single document, in case the document should fall into the wrong hands.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		The Security Plan shall also indicate where the referenced documents can be found (e.g., by providing the file number or identifying its custodian).	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.3.4.9	PROTECTION OF SENSITIVE SECURITY INFORMATION (SSI)													

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	Performance Criteria		By law, transit agencies are required to categorize and protect sensitive security information (SSI). Protecting SSI means restricting its distribution and controlling access to it. By law, SSI is not subject to disclosure under the FOIA or to state "Sunshine Laws." It is also not available under discovery in civil litigation, and it is not required to be part of the record in a federal rulemaking.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4	**SYSTEM ASSURANCE**													
		12.4.1	INTRODUCTION													
	Performance Criteria		The primary objective of the Rail project system assurance design criteria is to provide guidelines to provide the highest levels of equipment and service reliability and availability together with optimized maintenance burden. A program of sufficient depth and scope shall be developed and implemented to assure attainment of and to demonstrate compliance with all systems assurance goals/requirements. During all phases of the Rail project, design, evaluation, and test, the achievement of high levels of product systems assurance shall be a paramount consideration. In achieving compliance, the inherent interrelationship of safety, reliability, maintainability and availability principles and methods in analysis, design, test, demonstration, and failure correction shall be recognized. The system assurance and safety goals/requirements shall be considered as dependent on each other. In addressing a problem of noncompliance with a given requirement, an integrated approach to safety, reliability, maintainability and availability shall be employed. This shall recognize that while there may be separate reliability maintainability and availability actions that could each solve the problem, either action might impact safety	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4.2	SCOPE													
		12.4.2.1	DEISGN CRITERIA													
	Performance Criteria		The Consultant and/or the Contractor on ALL stages of the design (conceptual, preliminary and final) and Construction (as-built) shall develop a System Assurance Program Plan for Metro's review and approval. These System Assurance Design Criteria provide guidance for the following sub-systems within a rail system: Fare Collection Systems Traffic Signal and Train Control Systems Traction power Communications Systems Central/Satellite Control Facilities Maintenance Facilities Rail Station Facility Electrical Systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		The system assurance quantitative goals/requirements provided shall be developed and used as a baseline during conceptual and preliminary engineering. The goals/requirements shall be refined and enhanced through improved design depending on the technology utilized and ultimate operational requirements. Accordingly, it is possible that during the various testing phases or warranty period a design deficiency is discovered. Such deficiencies shall be identified and mitigated or eliminated through design enhancements. There are tradeoffs between cost, safety, security, risk, availability, reliability and maintainability. It is the intent to find the best balance between these items. Design Criteria shall define the minimum goals and prohibit any single point failures for each of these requirements. The design shall follow and implement system safety principles such that there shall be no single-point of failures in the operations of systems, subsystems, components, equipment, and parts that can result in an unacceptable hazardous condition. The single-point of failure determination shall include the lowest unit/component that is critical to the performance of the safety function.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		The following are representative examples, but do not include all SPOF issues, that Metro considers the, at a minimum, that must be addressed within the design. ▯ An electrical power SPOF would be considered as a failure of single power buss within Switchboards/Switchgear distributing power to systems that must have either one of the power loads functioning during an event resulting in the creation of a hazard conditions. ▯ A main radio fiber trunk with no apparent signal diversity using alternate cables must not result in complete loss of radio communication under all conditions. ▯ Infrastructure failures such as duct banks or their path that could result in a SPOF to operation of any of the safety critical systems. When calculated risk values indicate that reliability goals are reduced beyond the approved values and could result in the likeliness of the development of a SPOF. These System Assurance design criteria for Rail System are based on performance criteria that affect passenger service and the operational reliability of the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4.2.2	DEFINITIONS													

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	Performance Criteria			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4.3	MAINTAINABILITY													
	Performance Criteria		Each system element and its constituent equipment shall be designed to permit ready access for maintenance. Maintenance personnel shall have access to perform all maintenance functions, including failure location and isolation, disassembly and reassembly, removal/replacement, and repair, as well as routine inspection/testing. Quantitative maintainability goals/requirements shall be specified for system elements where applicable. Manufacturer recommended preventive maintenance requirements shall have no detrimental effect on the operation of the Rail service.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4.3.1	VEHICLE													
	Performance Criteria		The immediate operational requirement is to remove a failed vehicle from service and replace it with an operational vehicle with the minimum impact on the operation/schedule of other vehicles. The goal/requirement to remove and replace a vehicle from Rail service is 1 (one) hour. This relates solely to first line replacement, and includes logistic time to ready an alternate vehicle for service and recover the failed vehicle.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4.3.2	SYSTEMS													
	Performance Criteria		The design of all systems within the Rail operation shall allow ease of maintenance based on a modular design. Systems and equipment essential to the operational availability of the Rail system shall include redundancy. It is assumed that there will be no repair functions performed by Metro. Economic repair of electronic / microprocessor based systems is unlikely to be achievable by an operator, therefore a policy of return to the supplier is anticipated. An alternative policy may be suggested by the supplier however, this shall include the full implications including training of personnel, capital costs associated with a repair facility, test equipment etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4.3.3	ACTIVITIES													
	Performance Criteria		In addition to the quantitative goals/requirements, requirements may be defined for maintainability engineering activities, such as a maintainability program plan, analyses, maintainability predictions, and demonstration tests. Maintainability Program Plan (MPP): An MPP of the following system equipment, at a minimum, shall be established and submitted: Vehicles Fare Collection Systems Traffic Signal and Bus Control Systems Traction Power Communications Control Systems Central/Satellite Control Facilities Maintenance Facilities Rail Station Facility Electrical Systems	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		The MPP shall include: Maintainability philosophy and approach A detailed listing and description of each maintainability task A schedule for each maintainability task and related milestones The organizational element responsible for each maintainability task Procedures for maintainability problem resolution. Maintainability Analyses: Maintainability analyses shall include details such as FRACA, MTTR, and the consequences if the designer or the Contractor cannot meet the goals. The analyses shall be prepared which shall, as a minimum, include for each maintenance task: Frequency of task Time to perform Specified test equipment, tools, and facilities required Crew size and skill level Manuals and instructions needed.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4.4	RELIABILITY													
		12.4.4.1	VEHICLE													

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	Performance Criteria		The vehicles are the dominant factor for the rail system assurance characteristics (reliability, availability and maintainability). The vehicles will also produce the highest cost factor in terms of regular off line maintenance and overhaul. The dedicated rail track environment shall lead to measurable improvements in reliability when compared with normal street run operations. Detailed reliability goals/requirements shall be developed for the rail vehicle and support systems. The vehicle MTBF and MDBF goals/requirements shall ensure the ability of the rail system to meet the top level availability for the system. All items within the vehicle shall be developed from equipment with significant historical experience. In addition, minimum quantitative reliability goals/requirements shall be developed for the following vehicle subsystems: Propulsion Friction or Dynamic Brakes Auxiliary Electrical Equipment Door Operation Vehicle Train Control and communication Equipment There are significant differences in reliability of rail fleets from different manufacturers. Value engineering shall be completed during the selection of the vehicle supplier to determine its impact on the ability of Rail system to achieve its operational objectives.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4.4.2	SYSTEMS													
	Performance Criteria		Reliability goals/requirements shall be developed for the following systems included in fixed facilities:	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Fare Collection Systems - Ticket Vending Machines (expressed in terms of reliability for station platform) - Fare Validators - Fare Gates Traffic Signal and Train Control Systems - Intersection crossing controls - Wayside signals Traction Power Emergency Ventilation System Facility Electrical Power System Communications Control Systems - Power (UPS) - Communication Links - Radio communication - Data communication Central/Satellite Control Systems and Facilities - Power (UPS) - Work stations - Control processors - Data logging	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Data Sources Reliability quantification shall make use of the following data sources in the order of preference listed: In service (field) performance data (for identical or similar units) or from past projects of similar nature. Reliability predictions via parts count based on MIL-HBK-217 (from component reliability database). Note: Where operating environments for components, subsystems and systems are required, the prediction shall use the average of the Ground Fixed and Ground Mobile environments. Unnecessary lengthy list of assemblies to artificially increase reliability goals/requirements is not allowed. Supplier's assurance as to equipment performance with supporting documentation or other similar evidence. Sub-suppliers' and component manufacturers' data. Similar equipment from alternative suppliers or in different environments adjusted for the product maturity, quality, environment, etc. Quantities of equipment based on PHA, FMEA or Fault Tree Analysis.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria		Electrical Reliability Analysis Study in accordance with the following: The Emergency Ventilation Systems for purging generated smoke in Underground Structures/Tunnels electrical power sources, supplied directly by the electrical utility and the facility electrical distribution system, must achieve a high degree of reliability to allow for all conditions of Emergency Ventilation Operations Achieve a high degree reliability goal of 99.99 percent. Implement a joint electrical system configuration design at Utility and Metro Facility levels to achieve this reliability goal - Load transfer methods are acceptable but will be evaluated upon the following: ? Emergency Ventilation Systems facility components, ex-control apparatus, motors, dampers , etc. shall be supplied with two service feeders, each providing one half of the required capacity. ? Provisions made to enable transfer of selected loads between these feeders, to allow operations during a feeder failure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Metrics shall be provided through a detailed engineering study to quantify and qualify reliability goal is achievable. - Utility energy suppliers will be evaluated based on the following: **a)** Evaluation of the supply source reliability data (outage records) to determine the system configuration required to meet the required reliability and associated availability goals. **b)** Utilize system outages data over the last five years, if available. Where outage information for at least one year is not available, or where it is meaningless because it applies to a utility system since changed, the system being considered will be evaluated on the basis of the utilities reliability projections. **c)** Evaluation of the supplier's ability to serve the anticipated load and the expected load for the next 5 years. **d)** Utility arrangement of their system configuration shall be included in all evaluations - The reliability analysis of the electrical system for the Emergency Ventilation Systems facility components shall include frequency and duration metrics of both forced and maintenance outages including evaluation of Metro SOP's and available records **a)** The designer will evaluate the supply source reliability data (outage records) and determine the system configuration required to meet the required reliability and associated availability. - Reliability analysis utilizing mathematical models through performing assessment and evaluation of reliability choices per IEEE STD 493 Provide written detailed report and submit to Metro for approval.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4.4.3	ACTIVITES													
	Performance Criteria		In addition to the quantitative goals/requirements, requirements may be defined for reliability engineering activities, such as a reliability program plan, analyses, reliability predictions, and demonstration tests. Reliability Program Plan (RPP): An RPP of the following system equipment, at a minimum, shall be established and submitted: Vehicles Fare Collection Systems Traffic Signal and Train Control Systems Traction Power Communications Control Systems Central/Satellite Control Facilities Maintenance Facilities Rail Station Facility Electrical Systems The RPP shall include, at a minimum: A detailed listing and description of each reliability task A schedule for each reliability task and related milestones The organizational element responsible for each reliability task Procedures for reliability problem resolution. Consequences and steps to resolve if reliability does not meet	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Reliability Analyses: Reliability analyses shall be prepared and submitted for acceptance which shall include, as a minimum: System definitions and related assumptions Functional flow and reliability block diagrams Description of any data sources and adjustment factors System and subsystem failure assumptions and predicted failure rates Comparison of reliability predictions with contractually specified values Impact of operation conditions or design changes on predicted values Definitions of all interfaces, such that every part is identified as being part of a particular subsystem FRACA, failure to perform, corrective actions and schedule impact Reliability schedule extension upon non-compliance Failure Trends New failures during Reliability analyses	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

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	Performance Criteria		Reliability Demonstration Testing: Reliability demonstration includes the Reliability Test Plan, detailed Test Procedures, and the final Reliability Demonstration Test Report. The Reliability Test Plan shall include, as a minimum: Acceptance criteria for evaluating the equipment being tested Failure reporting procedures and corrective action to be used Using "moving period methods" in the calculation process is not acceptable when performing measurements of chargeable failures Mathematical verification that the test shall demonstrate the reliability levels specified The Contractor is fully responsible for the Reliability Test Plan, and shall take complete responsibility to provide resources to manage the program when Metro resources are unavailable Service Affecting: Failures of following vehicle systems shall be considered as loss of ability to provide service. Traction motors-reduction in power Gear boxes Door control – loss of control, failure to open or close Brakes –failure of the brake system (i.e. air system) HVAC – loss of ability to control climate within reasonable limits	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		Fixed Facility System Availability and Reliability: System architectures shall be capable of providing the required system availability. All designs shall be expected to achieve the highest levels of system reliability and availability and shall be measured by their ability to provide passenger service levels expected of a high end mass transit system. During final design, system designs and architectures shall be refined and contribution of failures to subsystems within the fixed facilities will be apportioned. Fixed Facilities: Fixed facility equipment shall include self-diagnostic capabilities sufficient to identify and report to central control the Line Replaceable Unit subject to fault. Local fault indication shall provide maintenance personnel with indication of module within equipment cases subject to failure. Self-diagnostic capabilities shall include continuous monitoring and start-up checks. Equipment shall include automated off line proof test capability, if appropriate. The proof test shall have the capability to confirm the proper operation of all functions within the equipment. The proof test may be initiated manually during routine maintenance operations (e.g. refilling ticket vending machines)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		All functions essential to the successful operation of the rail system at full service capability shall where possible include redundant paths to allow normal operation following a single failure. Fare Collection System: Failure of the fare collection system shall not prevent operation of the vehicles or overall system. Refer to MRDC Section 9.2 Fare Collection. Traffic Signal and Train Control Systems: During operation it may be beneficial to obtain automated information regarding the position of vehicles, however, the presence of communication systems and fall back to manual control shall still allow operation of the rail vehicle at full capacity. The control of crossings shall allow for local control (as per pedestrian crossings) to provide redundancy for the automated signal pre-emption systems (if procured). Communications System: A single point failure shall not cause a failure of the Communication System. Loss of data communications between the vehicle and Central Control shall not prevent operation of the rail system. Details such as loss of communications, fallback process if the primary means of communications fail, backup, failures and impact of failures on operations shall be developed	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		

METRO RAIL DESIGN CRITERIA				SEG LINE CITIES												
				No Exception= NE Exception = EX												Specs & Plans
ID	TYPE	SECTION	DESCRIPTION	LOS ANGELES	HUNTINGTON PARK	BELL	CUDAHY	DOWNEY	SOUTH GATE	PARAMOUNT	BELLFLOWER	CERITOS	ARTESIA	VERNON	VARIANCE	DOCUMENT/SECTION
	Performance Criteria		Central/Satellite Control Facilities: The design of the central control facilities shall allow for graceful degradation of control functions enabling continued operation. Provisions shall be provided to continue operation of the rail system at full capacity in the event of loss of automated vehicle position information. Maintenance Facilities: The inability to perform maintenance at the facility does not directly lead to the loss of rail service. However, the ability to perform regular maintenance on the system is essential to the success of the overall operation. The maintenance facility shall include redundant capability to perform overnight and weekly vehicle system checks, repairs, and replenishment.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4.5	AVAILABILITY													
		12.4.5.1	SCOPE													
	Performance Criteria		The Scope of availability is largely based on the types of downtimes used in the computation and on the relationship with time (i.e. the span of time to which the availability refers). This classification is what is sometimes referred to as the availability as seen by maintenance personnel. This classification excludes preventive maintenance downtime, logistic delays, supply delays and administrative delays. Since these other causes of delay can be minimized or eliminated, an availability value that considers only the corrective downtime is the inherent or intrinsic property of the system.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
		12.4.5.2	CALCULATIONS													
	Performance Criteria		The corrective downtime reflects the efficiency and speed of the maintenance personnel, as well as their expertise and training level. It also reflects characteristics that should be of importance to the engineers who design the system, such as the complexity of necessary repairs, ergonomics factors and whether ease of repair (maintainability) was adequately considered in the design. For a single component, the availability can be computed by: $A_I = \frac{MTTF}{MTTF + MTTR}$ MT	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
	Performance Criteria		For a system the mean time between failures (MTBF) shall be considered and compute this as follows: $A_I = \frac{MTBF}{MTBF + MTTR}$ MTBF = Uptime / Number of System Failures MTTR = Corrective Maintenance Downtime / Number of System Failures Note that until steady state is reached, the MTBF calculation may be a function of time (e.g. a degrading system). In such cases, before reaching steady state, the calculated MTBF changes as the system ages and more data are collected. Thus, the above formulation should be used cautiously. Furthermore, it is important to note that the MTBF defined here is different from the MTTF (or, more precisely for a repairable system, MTTFF: mean time to first failure). System availability can be enhanced during design by including redundancies and by the planned use of effective failure management procedure.	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
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Interoffice Memo

Date	June 14, 2024
To	Karen Gorman, Office of the Inspector General
From	June Susilo through Tim Lindholme
Subject	Response to OIG's Report on Comparison of MRDC to Cities' Standards Along Southeast Gateway Line

The Metro Office of the Inspector General (OIG) completed a study comparing design standards between the Metro Rail Design Criteria (MRDC) and those of the cities that the Southeast Gateway Line project (Project) traverses through including Huntington Park, Bell, Cudahy, Downey, South Gate, Paramount, Bellflower, Cerritos, Vernon, Artesia, and Los Angeles.

The following are recommendations from the OIG's report:

- Recommendation 1: Metro make updates to its MRDC promptly as requirements change and include best practices to ensure cities can trust Metro's MRDC to reflect legally correct and good quality requirements.

- Recommendation 2: Metro be self-permitting for substantially consistent or more stringent standards than a city where we are performing construction.

- Recommendation 3: Metro seek an accelerated, abbreviated permitting process for the SEG Line project and for other Metro projects in the future, for the non-conforming "exception" specifications related to the project.

The results of the OIG's report could not have been timelier as the Project recently reached two significant milestones on April 25, 2024, including Board certification of the Final Environmental Impact Report (FEIR) and the release of a Request-for-Bid for a Construction Manager General Contractor (CMGC) for Advanced Works. As noted in the report's conclusion on page 26, a "unified design and construction standard, conformed from the MRDC and the criteria of the SEG [Southeast Gateway] Line Cities would be valuable to guide the development of the Southeast Gateway Line construction contract and improve project delivery." **Metro agrees with the OIG's assessment and believes the recommendations align with the project's early due diligence strategy of addressing key risks early on including critical third-party approvals.**

Currently, on Metro projects, the contractor submits a permit application and fees to perform work (ranging from utility potholing to roadway construction and striping as an example) within city right-of-way. City staff (or their consultants) review the application with supporting documents such as construction drawings, provides plan check reviews and comments, and ultimately approves or rejects the application. On transit projects like Southeast Gateway Line, it is expected that the contractor would have to submit multiple permits to perform various work scopes within city right-of-way. This creates the potential for scope creep and schedule delays and ultimately increases costs to Metro. Allowing Metro to self-permit would likely improve Metro's control over the schedule and reduce schedule risks and costs.

For each of the OIG recommendations, Metro is undertaking the following steps:

- Recommendation 1: The MRDC is a living document in which Metro systematically updates to reflect change in law, industry practice, and lessons learned from recently executed projects. In fact, Metro is in the process of updating specific of the MRDC to address lessons learned from the K-Line/LAX and Regional Connector Projects.

- Recommendation 2: In ongoing coordination with cities within the Project, staff has mentioned the idea of Metro to self-permit for work within city and/or public right-of-way to help identify potential offset payments for cities' 3% contribution to fund the project. The cities generally have been receptive to the idea, and is expecting the Project team to present to the Southeast Gateway Line City Managers' Technical Advisory Committee on the valuation methodology this summer.

- Recommendation 3: As staff continues to refine the valuation methodology specific to the Project, Metro is planning to introduce this proposal to cities on other major transit projects including Eastside Transit Corridor Phase 2. This project also recently accomplished Board certification of the FEIR.

File #
2023-0022

Office Of The Inspector General

Metro Rail Design Criteria Review Report

Presented By

Karen Gorman

Inspector General

July 2024

Construction Committee

Los Angeles County Metropolitan Transportation Authority

Metro

Purpose Statement

The OIG initiated a study to determine what differences exist between the Metro's rail design criteria and the typical design specifications of cities in Los Angeles.

The 11 Cities along the Southeast Gateway Line were chosen to use as samples for the study.

The purpose of the review was to determine if there exists any opportunities for streamlining and further efficiency in the permitting processes in relation to the specifications.

Findings

1. MRDC and 11 Cities' specifications are 99.5% the same.

2. Permitting review is not warranted for the conforming specifications.

Recommendations

Recommendation 1: Metro make updates to its MRDC promptly as requirements change and include best practices to ensure cities can trust Metro's MRDC to reflect legally correct and good quality requirements.

Recommendation 2: Metro be self-permitting for substantially consistent or more stringent standards than a city where we are performing construction.

Recommendation 3: Metro seek an accelerated, abbreviated permitting process for the SEG Line project and for other Metro projects in the future, for the non-conforming "exception" specifications related to the project.

SOUTHEAST GATEWAY LINE RESPONSE

File # 2023-0022

Metro agrees with the OIG's recommendations as they align with the Project's early due diligence strategy of addressing key risks early on including critical third-party approvals.

Allowing Metro to self-permit would likely improve Metro's control over the schedule and reduce schedule risks and costs.

Steps SEG Line already taking:

- Metro continues to update MRDC to reflect change in law, industry practice, and lessons learned from recent projects.
- Discussions with corridor cities on the idea of Metro to self-permit for work within city and/or public right-of-way to help identify offset payments for cities' 3% contribution to fund the project.
- Metro plans to introduce self-permitting idea to cities on other transit projects including Eastside Extension Phase 2.