CHAPTER 4

STATION COMMUNICATIONS

A. GENERAL

The term “Station Communications” refers to the collection, dissemination, and transmission of information to and from passenger stations using electronic systems and methods. The purpose of these systems is to extend the physical reach of human operations, maintenance and security to enable centralized operations and security as well as provide additional data to maintenance personnel to improve the time to repair equipment and systems at the station. Because these systems concern the travelling public and Caltrain operations and maintenance staff, as well as safety and security personnel, the general philosophy is to strive for a system that is a fully integrated, user friendly system that presents timely and relevant information to its intended users in an easily intelligible fashion.

1.0 STATION OPERATIONS OVERVIEW

Passenger Stations are the hubs of passenger activity on the Caltrain system. The primary function of passenger stations is the orderly boarding and alighting of passengers to and from the trains. Passengers arrive at stations from personal cars, shared ride vehicles, bicycles, from transfers from other bus or rail transportation, and on foot. To support them in their journey a number of facilities are provided at stations including rail fare vending machines, passenger information signs, public announcements, pay phones, and even concessions and restrooms at some stations. At terminal stations, such as Diridon, and 4th and King, station staff are available to answer questions, make local announcements and resolve issues at stations.

However, the majority of stations are not staffed and a dynamic and reliable messaging to keep passengers informed is needed. This systemwide communication system is provided from a primary headend facility located at Caltrain Central Control Facility (CCF) which also houses the train dispatchers. The CCF is located within the Centralized Equipment Maintenance and Operations Facility (CEMOF) in San Jose.

Caltrain also utilizes a secondary headend facility located at Caltrain Headquarters in San Carlos. It is mostly dedicated to Caltrain security/video surveillance and processing; and maintenance and monitoring of the Caltrain WAN/LAN and fare collection.

Information from the CCF headend can be provided in real time, automated or in schedule mode via both audible and visual subsystems. The objective is to provide

passengers with scheduled and updated information and knowledge of the commuter system. Such information may include the following:

a. Safety and security advisories

b. Timetable, listing departure times at scheduled stations

c. Commuter rail delays, status, or travel updates

d. Alternate service plan advisories

e. Construction activities and interruptions

f. Timekeeping or clocks

g. Station (local) announcements

In addition to supporting the orderly boarding and alighting of passengers, Caltrain endeavors to keep both passengers and property safe and vandal free. As such, Closed Circuit Television (CCTV) cameras are present at stations to be the remote eyes of security and operations. Operational sensitive locations, such as train control, communications, and fare vending rooms or equipment may also be remotely monitored from the Caltrain headend facility in San Carlos.

2.0 SYSTEM-WIDE COMMUNICATIONS TO/FROM STATIONS

The existing Caltrain WAN, serving Caltrain passenger stations, is based on the Frame Relay Leased Services.

The new equipment design and installations at the stations, however, shall account for and be ready for upcoming Caltrain planned communication system upgrade to utilize future Caltrain owned fiber optic cable plant. The fiber optic cable backbone will provide for a fully redundant communication optical network, connecting all Caltrain Passenger Stations, Right-of-Way facilities and two central facilities at the speeds between 1 Gbps to 10 Gbps at optical nodes.

3.0 COMMUNICATIONS SUBSYSTEMS

There are two (2) primary communication subsystems used to convey public information and three (3) primary subsystems for fare collection and monitored security as follows.

a. Public Address Subsystem (PAS)

b. Visual Message Sign (VMS)

c. Ticket Vending Machines (TVM)

d. Clipper Card Interface Devices (CID)

e. Video Security or Closed Circuit Television (CCTV)

Telephones are provided for passengers' convenience. Passenger assistance telephones, such as Push to talk, are currently not provided.

Talking signs for visually impaired persons are available at the two (2) terminal stations: San Francisco 4th/King and San Jose Diridon.

4.0 STANDARDS AND CODES

Station communications design shall comply with the latest edition/revision, unless noted otherwise, of all applicable Federal and State Codes, ADA (American with Disability Act) requirements, and applicable local codes as well as communications industry standards as listed in the **APPENDIX**.

B. DESIGN REQUIREMENTS

Station communications design documents shall include System Description and Interface Requirements as follows:

System Description: System description, as a minimum, shall include the subsystem description, detailed design and interface information, all performance, functionality and operational description, as well as details such as the cable and equipment identification.

Interface Requirements: Interface requirements shall identify all required interfaces with other communications and non-communications systems and subsystems. This shall include the following:

a. Interfaces between new work to be performed and any other existing Communications work for example, Supervisory Control Software, Central Control Facility (CCF) provisioning, Alarm Point, and any other required interfaces.

b. Interfaces among the subsystems.

c. Identification and description of any required hardware and software modifications or additions to existing subsystems equipment.

d. Identification of all external interfaces, including service points and those to facilities and equipment provided by others. Interface examples include power, cable facilities, discreet signals, voice, and data.

e. Equipment list (bill-of-materials) depicting a table or list of model and part numbers for all proposed equipment and materials to be used for individual subsystems. The table or list shall be grouped for each subsystem with functional descriptions of equipment or material included. Quantities and locations shall be included.

f. Calculations as outlined in the subject subsystem section.

g. Phasing and cutovers to identify all major system cutover events or integration activities describing techniques, methods, duration and procedures.

h. Drawings to include electrical, mechanical, and system block and functional diagrams with corresponding parts list using current Caltrain CAD Manual and complete drawing index.

i. Complete cable identification and equipment labels.

j. Complete wiring diagrams for all equipment to be installed, modified, upgraded, or interfaced.

k. Top level mechanical drawings, if applicable.

l. Grounding details.

m. Power panel schedule and distribution.

1.0 COMMUNICATIONS NETWORK CARRIER

Communication network connectivity between the CCF, Central Headquarters and the stations shall be determined based on the best available technology and cost. This network shall be leased from a Competitive Local Exchange Carrier (CLEC).

For new construction or major rehabilitation, Caltrain station WAN services shall be upgraded to a “full” T1 service with serving speeds up to 1.544 Mbps. Many of the existing Caltrain stations utilize “partial T1” services providing for typical serving speeds of 128, 256, 512 and 768 Kbps. However, these speeds, in particular those in the lower range are marginal for current needs, and will not be adequate to support future needs. They should be upgraded to faster serving speeds of up to a “full” T1 (1.544 Mbps). If necessary, the existing MPOE should be upgraded at both ends: the existing station and the host end.

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The leased T1 connectivity to the stations represents the network “carrier” side of the station design. In the future, considerations shall be given to increasing carrier network capacity (bandwidth) by using Caltrain owned fiber optic cable plant or backbone. The design objective then shall be to equal the network capacity (bandwidth) on both the carrier side and subsystem distribution side of the station Main Point of Entry (MPOE).

The station Communications shall account for Clipper network connectivity between Clipper Headquarters and the stations to serve station Clipper Card Interface Devices (CID). This network is leased by Clipper from a Competitive Local Exchange Carrier (CLEC) and is independent from Caltrain WAN/LAN.

At the current stage, the Station design will not include the interconnection by a wide area fiber network. However, the network equipment chosen for each station shall be adaptable/scalable for connection to this future wide area fiber network.

The existing network "carrier" and future Caltrain fiber network will interface with the station LAN at Communications Equipment Room (CER). Note that, in absence of CER, some Caltrain stations may still utilize outdoor Station Communications Cabinets (SCC) also sometimes referred to as Communications Interface Cabinets (CIC). It is the intent of Caltrain to phase out the SCC's/CIC's and upgrade to CER's. Unless specifically required, in this document, for simplicity, the terms "SCC" and "CIC" are omitted; and the term "CER" is used instead as a universal substitute for these various types of station central Communications architecture.

2.0 SUBSYSTEM NETWORK DISTRIBUTION

At each station, the Communications Carrier Network shall terminate into a flexible, scalable and robust station network distribution system. This subsystem shall carry signals from all subsystems according to their particular configuration and need. The objective of this subsystem is to extend the capability of the main network hub/switch throughout the station particularly in areas beyond the physical limits of the LAN switches copper connections. Characteristics of this network distribution system should be as follows:

a. Distribution cabinets (DC) shall be optimized such that most communications devices are less than 300 ft (by cabling distance) away from either the main switch or a distribution cabinet.

b. There shall be two sets of power wiring brought into each Distribution cabinet:

   i. Essential Power (from the central UPS in CER) – battery-backed power for essential communication equipment such as LAN switches, Media Converters, TVMs, CCTV, VMS, Clipper CIDs
   ii. Non-essential Power (from the station distribution power panels) – power for non-essential devices such as fans, maintainer jacks, cabinet lights, etc.

c. Distribution cabinets (DC) shall contain the following:

   i. Dual Caltrain LAN switches (if there are more than one of each: TVM, or VMS are wired to a DC, for redundancy they shall be divided into two groups: the first group will be served by one distribution switch, the second group will be served by the second distribution switch)
   ii. CID Switch (where required) (provided by Clipper)
   iii. CAT 6 patch panel(s)
   iv. Lightning/surge protection modules (for all copper LAN and other communication copper cabling coming into the cabinets from outdoors)
   v. Fiber splice/termination panel
   vi. Integrated cable management
   vii. Power distribution equipment for essential power (UPS-backed power from CER)

viii. Convenience outlets and distribution equipment for essential power
ix. Convenience outlets and distribution equipment for non-essential power
x. Grounding equipment
xi. Adequate temperature cooling equipment
xii. 24 V DC power supply for CIDs (one power supply per two CIDs) (where required)
xiii. Characteristics: NEMA 4, vandal resistant, lockable, etc.

d. Distribution switch(es) shall be as follows:

i. Capable of remote management
ii. Capable of forming redundant LAN configurations
iii. Fiber fed from main switch
iv. IEEE 802.af compliant (PoE)
v. Layer 2 switching capable
vi. Industrial Rated (i.e., operating temp range -10 deg C to at least +50 deg C; vibration tolerant, etc.)
vii. Sized to have 25% spare port capacity

e. A redundancy scheme shall be implemented such as redundant LAN configurations with the switchover based on rapid spanning tree protocol (e.g. Ethernet Rings topology).

f. Distribution to/from individual field devices shall be via CAT-6 cable using PoE where feasible. For cable runs over 300 ft (or if the field device's design specifically requires) a single-mode fiber connection shall be utilized. For such devices, the fiber cabling shall be accompanied by the essential power wiring. Use of local power for such devices is allowed only as an exception, which must be approved by Caltrain.

2.1 Closed Circuit Television (CCTV) Cameras

Closed Circuit Television or CCTV is used for video surveillance of the station platforms. At some stations, the CCTV is also used for video surveillance of station indoors (station concourse), underpasses, station surrounding areas (i.e. station plaza, parking lots, stairs and ramps, bus stops, etc.) and other facilities (e.g. Operations control center, maintenance yards, etc.). In addition, the CCTV cameras can also be provided for coverage of location where money is intended to be exchanged (fare collection). The quantity and location of cameras will depend on the type and size of station.

The CCTV project design (from concept to final stage), installation and acceptance shall follow CPTED (Crime Prevention Through Environmental Design) guidelines. The project design, installation, testing and acceptance shall be approved and witnessed by Caltrain, including CPTED certified personnel and Safety and Risk Management.

The station CCTV system components shall be compatible with the Caltrain existing CCTV headend in San Carlos provided by Verint Nextiva. The modifications to the existing Caltrain headend will be done by Caltrain personnel. The Contractor shall

facilitate integration of the new station CCTV equipment into the existing CCTV headend and coordinate with Caltrain personnel the design, implementation and testing details of the new equipment affecting the existing system.
All new CCTV installations shall utilize Day/Night IP Cameras only. Whenever is practical, the IP cameras shall be supplied dc power using Power-Over-Ethernet (POE) technology.

The station CCTV cameras shall provide for 100% coverage for inside stations, station train platforms, pedestrian underpass, waiting areas and stairs/ramps. This coverage shall be achieved by use of Fixed Cameras.

The design of the fixed cameras (placement; elevation; camera tilt; and Vertical and Horizontal Fields of View) shall allow for following resolution:

a. Forensic Detail – priority targets (underpass, station platform, TVMs/CIDs, parking exit/entrance, Stairs/Steps) require detailed coverage – at least 40 pixels per foot.

b. General Detail – remaining station areas – at least 10-20 pixels per foot.

The station CCTV System shall also include PTZ cameras, which shall provide for the following:

a. Redundancy of coverage

b. Means of real-time zooming in on a crisis area by the Caltrain or local agency security personnel when a problem is reported from the field or a pre-determined alarm is triggered (i.e., TVM Intrusion Alarm)

PTZ cameras shall provide for at least 90% of area coverage provided by the fixed cameras and, where feasible, shall cover 100% of high priority targets.

The corresponding station devices' design shall accommodate means of passing the alarm information to the CCTV System.

The PTZ Camera design shall include Digital Input/Output contacts and the ability to set pre-defined Pan/Tilt/Zoom settings. When a Digital Alarm input is triggered by a station object, the associated predefined Pan/Tilt/Zoom setting shall be evoked for the associated PTZ camera to automatically zoom in onto the alarmed object.

The design of the PTZ cameras' placement; elevation; and Vertical and Horizontal Fields of View shall allow for resolution of at least 40 pixels per foot at maximum zoom in for any location of the required area of coverage.

The requirements to the CCTV design for these areas of video surveillance shall be determined based on the priorities input from the stakeholders, and CPTED personnel.

Video cameras, as with all subsystem devices, shall be networked and assigned dedicated bandwidth. The network protocol shall be TCP/IP for all subsystems.

The network video system (CCTV) shall be a fully digital system transported over an IP-based network using TCP/IP Ethernet protocol. A virtual LAN (CCTV VLAN) shall be partitioned to dedicate bandwidth solely for the CCTV subsystem. Network cameras shall be equipped to interface directly with Category 6 cable installed to the assigned distribution cabinet and associated networking equipment.

At the station CER the CCTV system shall utilize a dedicated station digital video recorder (DVR), which is a computer for recording and storing of the station CCTV video data. Station DVR shall utilize Nextiva Recorder Server CCTV management and recording software. The station CCTV PC hard-drives shall record and store video information up to 14 days for all station cameras, and at the highest resolution and frame rates allowed by the design of each implemented camera and the DVR (including 50% additional spare storage for future growth).

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The CCTV System design shall allow Caltrain personnel for both local and remote recording retrieval. Additionally, the system shall support requests for remote monitoring by independent agencies (i.e., Local Police Department having jurisdiction of where the system is located).

To accommodate current low bandwidth limitations for links between the CCTV headend at San Carlos facility and remote Caltrain stations, station's DVR shall support downscaling of the video streams to low resolution (i.e. 1-4 CIF) for remote "live" views. Note that downscaling will be used for a "live" view function only; the station DVR shall record video of the high resolution cameras at their maximum resolution and frame rate. To facilitate this function, station DVR shall utilize Verint Media Gateway Server software.

The station DVR shall support local and remote retrieval/download of recorded video. For local retrieval, the station DVR shall support export of the recorded video into DVD or external hard drive media. The remote retrieval of the stored video (recorded at its full resolution and frame rate) over the low bandwidth leased lines from the Caltrain San Carlos facility is expected to be done during off-peak hours. Such download shall be configured as a low priority function, which should not interfere with the performance of the remaining station subsystems.

All stored/retrieved video recording shall provide for evidence of authenticity (no video tampering took place), so that it could be submitted in the court of law as evidence,

As per the stakeholder input, for non-critical areas with the least amount of human traffic, use of motion and audio detection software is allowed, which could enable slowing down of the recording speed when there is no motion (e.g. during off or night hours) and speeding up the recording when motion is detected. This can be used to minimize the storage capacity requirements.

The network camera system shall deploy management software to automatically find and set up IP address, show connection status, and configure and manage firmware upgrades for multiple camera locations. To optimize bandwidth and image quality, the network camera system shall have a wide range of compression features,

enabling the system to view events at H.264 / MPEG-4 compression while recording at Motion JPEG.

For enhanced security, network cameras shall be equipped with remote input and output ports for monitoring other security and alarm devices such as door contacts, smoke detectors and temperature sensors, light or other switches or alarm relays. Activation of these I/O devices will cause the network camera to stream full video and generate activity reports.

Use of Megapixel IP cameras is encouraged for the majority of the station video surveillance applications. Megapixel images provide for the desired pixel-per-foot resolutions utilizing less cameras. As a result, even though Megapixel cameras are typically more expensive than traditional (4 CIF) cameras, however, they will more than compensate from the reduction of the number of cameras.

The designer shall produce storage design calculations showing that the capacity of video storage hard-drives is adequate. Note that typically such calculations include a variety of the various cameras types reflecting their specific frame rates, resolutions and compression types. The compression types and rates typically depend on a particular CCTV Software Vendor and the designer shall provide the corresponding DVR storage requirement calculation as a part of their CCTV design submittal. Also, to support future growth, the performance and storage of the station DVR equipment shall be rated to handle additional 50% of similar station CCTV equipment.

As a part of the design submittals, the designer shall provide for Caltrain Engineering all necessary calculations for performance and storage requirements of the CCTV system and identify adequate and up-to-date equipment/software fully compatible with the existing CCTV Headend in San Carlos.

At minimum, the station design shall provide for RAID 5 or 6 redundancy for the station DVR hard-drives capable of recording and storing video information for 14 days (including additional 50% spare storage allocated for future needs).

Within the station LAN a portion of the network shall be partitioned for CCTV as CCTV Virtual Local Area Network (CCTV VLAN). The designer shall produce calculations showing that allocated CCTV VLAN bandwidth is sufficient to serve all station CCTV System needs. This Virtual Local Area Network (VLAN) capability shall reside in the network switch hardware. Additional bandwidth shall be allocated depending on the station size and number of CCTV camera locations.

2.2 Fare Collection

A minimum of two (2) units of TVM per boarding platform shall be provided for redundancy, and to handle any peak usage.

The station Fare Collection Devices communications shall be implemented in a redundant manner; there shall be at least two separate LAN distribution switches serving their corresponding TVM (and/or group of VMS signs). The rationale is, should one of the switches fail, there will always be another functioning TVM (and/or

group of VMS sings) connected to the remaining switch and available to serve passengers at the station.

Clipper is a regional system that is designed and administered by the San Francisco Metropolitan Transportation Commission (MTC).

The Clipper CIDs are typically located near the TVMs. The quantity of Clipper Card Interface Devices is typically two per a platform; however, their exact quantity and placement shall be coordinated between the Designer and Caltrain/Clipper.

Though not a TVM, Clipper CID utilizes the same station fiber physical network. However, the Clipper LAN is independent from Caltrain LAN and their network devices shall never interface. The Clipper subsystem design shall utilize a station Clipper LAN IP-based network operating at 100 Mbps for field devices and 1Gbps for the station backbone connection (between DCs and CER).

A CID card reader is installed on a dedicated pole; and requires a 24 VDC power. The corresponding 24VDC rack-mounted power supplies are usually placed inside the closest CER or distribution cabinets.

Clipper provides and installs all station CID network equipment: CID Router, CID Switches and the end CID devices. The Clipper vendor also provides for a separate Wide Area Network connection (at MPOE).

Caltrain is responsible for provision of CID poles and poles' temporary covers, and the MTC is responsible for their installation. The MTC is responsible for provision and installation of all remaining equipment, such as: rack space; all interconnecting conduits and comm/power wiring; and provision, installation and termination of all necessary 24VDC power supplies in DC cabinets (one power supply per two CID devices).

Each TVM or CID shall have dedicated Category 6 connectivity to the distribution network switch via physically separated conduit runs. The CIDs' Category 6 cables shall also share the conduit with two #16 AWG power wiring conductors (for 24 VDC power).

Distribution cabinets shall house dual network (aggregate) switches for Caltrain LAN and single CID switches for Clipper LAN. Each TVM device shall be assigned to a separate distribution switch for additional network reliability.

2.3 Visual Message Signs (VMS)

Visual Message Sign or VMS is required by ADA to augment and complement audio public address messaging for the benefit of hearing impaired commuters. Visual messaging shall be both centrally and locally controlled.

VMS boards are typically 16.125 inches high, 62.5 inches wide and 10 inches deep, 110 lbs weight, with multiple styles of text and font displayed by LED (light emitting diode).

VMS boards shall be spaced to comply with MIL-STD-1472 for non-emergency visibility for the center 80% of the platform or any non-platform signs. For the design submittals, the designer shall submit the actual distance calculations for the selected VMS boards.

Designer shall place a minimum of two (2) dual sided units per platform for redundancy and passenger convenience. VMS design shall include a plan view depicting both message sign and support structure location within the station, including distances to platform edge, conduit size and route, and conduit pull-box locations.

This subsystem design shall utilize a VLAN IP-based network operating at 100Mbps. An IP address will be assigned to all message signs in the network. Messaging shall be controlled at the CCF. The CCF will be able to message individual stations, groups of stations, or broadcast messages to all stations as required.

VMS shall be equipped for Category 6 interface. Connectivity shall be made to the assigned distribution switch. Each visual messaging unit will have dedicated Category 6 data cables connectivity to the distribution network via physically separated conduit runs.

Distribution cabinets will house dual network (aggregate) switches. Each VMS device shall be assigned to separate distribution switch for additional network reliability.

The VMS systems shall be powered by essential power (from CER station UPS).

The details of the VMS specifications are in Specification Section 17750, Visual Messaging Signs.

2.4 Public Address System (PAS)

Public Address Systems are designed for Caltrain staff to communicate with passengers, locally or from remote location. Station public announcements are made in a clear, audible and uniform manner to provide train and general information, as well as emergency and security announcements throughout the station facility.

Public Address Subsystem or PAS consists of speakers located along boarding platforms to provide clear, audible communication to commuters. Major Caltrain passenger stations also allow for inside and outside station announcements (e.g. Station plaza, Station concourse, etc.).

Public Address (PA) announcements sahll have capability to be initiated either remotely or locally.

The remote announcements shall be initiated as follows:

a. Automated PA Announcements from the Central Control Facility (CCF) by the PAS Headend equipment

b. PA Announcements over a phone line by Caltrain end-users

Automated PA Announcements from CCF are the primary user of the PAS and provide for Caltrain's train and general information. This includes the following:

a. Timetable, listing departure times at scheduled stations
b. Commuter rail delays, status, or travel updates
c. Alternate service plan advisories
d. General safety and security advisories
e. Construction activities and interruptions

However, unplanned announcements such as emergency/security announcements and local events related information are typically initiated locally utilizing local paging microphones.

At major Caltrain passenger stations the following additional means for local PA Announcements shall be provided: one hard-wired paging microphone and one wireless paging microphone at the PIDS (Passenger Information Display System) Clerk Office. The wireless paging microphone would allow the station agent to make the PA announcements while walking along the station and guide the patrons according to the situation taking place within the station area.

Also, at multiplatform stations (with more than 2 platforms), a paging microphone for each platform shall be provided.

In order to ensure that various types of announcements do not overlap each other, station PAS shall support implementation of priority scheme. In-progress PA announcements shall be pre-empted according to the priority scheme defined below (Priority 1 being the highest; Priority 5 the lowest):

a. Priority 1 – Automated PA Announcements from CCF
b. Priority 2 – Local Wireless Paging Microphone from the station PIDS Clerk Office (where applicable)
c. Priority 3 – Local Hard-Wired Paging Microphone from the station PIDS Clerk Office (where applicable)
d. Priority 4 – Local Paging Microphones at the station platforms
e. Priority 5 – Remote PA Announcements over a phone line by a Caltrain end-user

For stations, where PIDS Clerk Office is implemented, the station PAS shall support the ability of turning the remote messaging off. This shall be done for special or

emergency events to prevent PAS from announcing PA messages other than related to the event.

Local announcements are expected to be of a limited duration basis. The majority of the announcements are expected to be Automated PA Announcements from CCF. These are PAS pre-recorded voice announcements, which (for ADA compliancy) shall be coordinated with stored, preset text messages for display on the VMS, also generated by the CCF.

The corresponding PA messaging shall be sent to the Caltrain stations over leased 4-Wire E&M Lines. The CCF has the ability to send messages to individual stations, groups of stations, or broadcast messages to all stations as required. The station PAS shall incorporate the corresponding E&M Cards and the associated muting relays.

To prevent “prank-call” announcements, the PA Announcements over a phone line by Caltrain end-users shall utilize a phone access device, which can limit access to the PAS by requiring the phone user to enter an authorized access code.

In the future, Caltrain is planning on switching to “all Ethernet” PAS. When ready, the switchover shall take place by connecting to the Caltrain WAN the stations’ IP-to-Audio Gateways (or Station Control Units) and plugging their analog audio outputs as inputs into the existing amplifier(s).

As the goal for any PA system is speech intelligibility, designers shall ensure that following minimum values of the STI (Speech Transmission Index) are met (measured at a height of 5 feet above the floor level):

a. Station Platform: The desired STI should be minimum 0.6 measured at 95% of all station platform areas assigned to be covered by the PAS

b. Inside Station Areas: The new PA System shall cover all publically accessed areas within the station. For new stations, the desired STI shall be minimum 0.6 measured at 95% of all station indoor areas. For an existing station with a challenging reflective materials and architectural design, the desired STI should be minimum 0.5 measured at 95% of all station indoor areas.

c. Outdoor Station Areas (including the Station Plaza): This is an open area where the designers can impose the list amount of control for the PA System design; and the adjacent neighborhoods and street traffic represent a large concern. For these areas, the STI should be minimum 0.5 at 25 ft within vicinity of the station doors; and minimum of 0.5 STI and uniformity of 80% coverage of the Station Plaza areas.

For the preliminary analysis of the station PAS design, the following values should be used for the ambient noise (the final design of PAS shall be based on the tested values within the station environment):

a. Station interior has been shown to have an ambient noise level averaging between 66 dB and 73 dB

b. Platforms with stopped trains with operating car air conditioning show an average ambient noise level of 80 dB to 85 dB

c. Platforms with stopped trains and measured nearby the operating locomotives show an average ambient noise level of 85 dB to 95 dB

For the design of the station PAS' uniformity of coverage for the PA announcements the values below shall be achieved at least 95% of the station areas. The values are measured as Sound Pressure Levels (SPL) expressed in dBs. The new PA System shall be capable of producing output sound levels of at least 12 dB higher than the measured ambient noise. The uniformity of the coverage shall be as follows:

a. Complex Caltrain Station layout: Minimum Design Goal: +/ 6 dB @ 1000 Hz Octave band

b. Typical Caltrain Station (1 or 2 Platforms) layout: Maximum Design Goal: +/ 3 dB @ 1000 Hz Octave band

A signal to noise ratio between 6 to 12 dB (depending on each station particular environment) should be targeted for improving intelligibility.

In order to mitigate changes in volume of the ambient noise, the PAS shall utilize ambient noise measuring microphones and adjust the PA output accordingly.

There shall be one ambient noise sensor per a platform; at least one ambient noise sensor per a station indoors (where applicable); and at least one ambient noise sensor for station outdoors (where applicable).
Each station area with an ambient noise sensing microphone shall yield at least one associated PA Announcement Zone. All ambient noise sensing microphones shall be placed carefully, facing away from the PAS speakers; the goal is to sense the ambient audio levels; not the audio generated by the PAS.

If necessary, in order to implement this variety of PA zones, a multi-channel pre-mixer/feedback eliminator/amplifier system will be used. Each zone's PA volume will be increased/decreased according to the ambient noise level measured by the corresponding zone's ambient noise level microphone.

Analog (voice) signals are required at distribution amplifiers to drive the PA speakers throughout the station.

The new station PAS amplifier, pre-mixer and the corresponding equipment shall be rack-mounted.

2.4.1 Acoustic Modeling

As a rule, designers shall develop a computerized model of indoor spaces to ensure STI values noted above are met with the appropriate ambient noise. Outdoor spaces, which have little reverberation, need not require modeling. However, outdoor stations that are in areas that have a density of buildings or platform shelters etc., may need modeling to achieve the required STI performance levels.

The Pre-mixer shall accept all identified audio inputs (all remote and local phones inputs, E&M card / Mute Relay phone inputs; and all local paging and ambient noise sensing microphones); and, where necessary, digital inputs (e.g. On/Off switches, multiple-position switches, remote volume control devices). The device shall be of modern type with sophisticated software allowing programming and processing of the analog and digital inputs supporting any particular needs of the station new PAS.

The Pre-mixer software shall be programmed to support PA zones; eliminate microphone feedbacks; any undesirable "clicking/snapping" sounds and/or 50 Hz humming noise interference from power wiring; and adjust its output according to the ambient noise. Its software shall support the ability to automatically adjust the output of the system to meet day time and night time noise abatement requirements of local municipalities.

Standard Caltrain stations (center island platform or otuboard platforms) shall use traditional balanced 70.7 Volt PA outputs 2-channel (stereo) PA amplifiers (one amplifier per a platform).

Major Caltrain stations with multiple PA zones and variety of the speakers shall use 70.7 Volt PA outputs multi-channel amplifier(s).

The amplifier shall provide for fine tuning of the output levels of its channels using manual volume controls; and detection/reporting of alarms, such as amplifier issues, PA output circuitry issues (i.e. shorts and/or open PA wiring circuits, etc.) for each channel.

The Pre-mixer and amplifier(s) shall support dual remote alarm monitoring: over Ethernet / SNMP; and dry contact alarm reporting via UPS Digital Input sensing (to be wired later on to future SCADA system).

PAS speakers shall be mounted on existing station structures. For a station platform speakers are typically mounted on light poles (or canopy poles) approximately 50-70 ft apart. Each PAS speaker location shall have dedicated audio speaker cable connectivity to the audio output amplifier distribution network via physically separated conduit runs.

The PA speaker wiring gauge should correspond to the amplifier allowed voltage drops and wattage requirements. The designer shall submit the wire gauge calculation for each PA cabling. Because of the transit application environment, for mechanical strength and resilience, it should be a minimum of 16 AWG size for the speaker wiring and 18 AWG for the microphone wiring.

The PA speaker (and microphone) wiring shall provide for redundancy: preferably by using two PA channels per a zone (wiring one channel to odd number speakers and wiring the second channel to even number speakers); or, as a minimum, using 2 pair wiring brought to each device (1st pair is working and the 2nd pair is "hot spare").

2.5 Passenger Assistance and Emergency Telephones

Talking signs are provided at the terminal stations in San Francisco (4th & King) and San Jose (Diridon). Emergency Telephones are currently not provided at Caltrain stations.

3.0 CABLE AND RACEWAY

Fiber optic cable (FOC) at the station used to connect the CER to the distribution cabinets shall be loose buffered and rated for outdoor use. The minimum cable size shall be 24-strands per cable sheath. Fiber optic cable shall be enclosed in HDPE inner-duct rated to match the cable sheath.

3.1 Single-Mode Cable

Single-mode (SM) fiber optic cables shall be installed in the station backbone connecting CER with DCs and remote field devices.

The Station aggregation switch shall be single mode compatible and allow future fiber connectivity with Caltrain fiber WAN. Where possible, the Single Mode Fiber-Optic Cable (FOC) network shall be provided in a physical dual ring topology. Single mode FOC shall be installed in separate conduits and inner-ducts. FOC cable sheaths and inner-duct shall be color coded as to clearly identify single-mode cable.

All single-mode FOC, fiber connectors and patch cords shall be colored yellow. The preferred connector type is SC. At the CER and DC (distribution cabinet), fiber distribution panels shall be used for single-mode fiber demarcation.

Single-mode FOC shall be all dielectric (no metallic components).

3.2 Protection Terminal Blocks

All outdoor copper cabling (e.g. Cat 6, PA and Microphone audio cables, etc.) shall be connected through the suitable protection type terminal blocks at the entry points of the Distribution and Station Communication Cabinets.
The protection equipment shall match the application type of each terminated cable and shall be implemented according the vendor recommendations.

3.3 Conduit Raceway Systems

When designing conduit raceway systems for station communications, the following considerations shall be given:

a. Where possible, the CER or DC shall be centrally located in the station. Backbone cable and conduit shall extend from the main equipment throughout the station as required.

b. Backbone cable and conduit from the CER or cabinet shall have at least two (2) pathways to each platform. This means two (2) conduit paths for single platforms and four (4) conduit paths for dual platform stations. Providing

pathway redundancy improves subsystem reliability by guarding against total subsystem failures due to conduit collapse, cable cuts, or other cable path problems.

c. The CER at outboard platform stations shall have redundant pathway to the platform pull-boxes comprised of four (4), four (4) inch conduits each with four (4), HDPE one (1) inch inner-ducts per pathway. ANSI/TIA/EIA 569B shall govern the conduit pathway design with pull-boxes.

d. The conduit system shall be placed to avoid crossing other utilities. Where crossings can not be avoided, adequate clearances must be adhered to when crossing either under or over another utility. Outside plant conduits will be spaced at least 12 inches from other paralleled utilities, and at least six (6) inches of spacing when crossing perpendicular to other utilities. This space will allow work to be accomplished on either utility's equipment at the point of intersection at any later date. Grade changes necessary to get under or over obstructions should be at an approximately five (5)-degree grade change. At no time should both utilities equipment become encased in the same trench or concrete pour.

3.4 Outside Conduits

There are three (3) types of conduit used in outside plant conduit structures. They are as follows:

a. Schedule 20 ("B") Plastic Duct (thin-wall conduit): this conduit is used when concrete encasement is specified on design.

b. Schedule 40 ("C") Plastic Duct (medium heavy-wall conduit): this conduit is used when conduit is to be direct buried (without any type of encasement).

c. Schedule 80 ("D") Plastic Duct (heavy wall conduit): this conduit is used when conduit is to be exposed to direct/indirect sunlight (such as exposed bridge crossings). This type of conduit is resistant to ultraviolet light and will not become brittle due to the sun's exposure.

The following design criteria shall be followed:

a. Outside plant rated hand-holes with covers marked "communications" shall have a highway rating of H-40 (40 tons).

b. Outside plant rated conduit shall be trenched or buried to a minimum depth of 48 inches below grade to the top of the conduits. Where this depth requirement can not be met, the conduits shall be concrete encased.

c. Fiber optic conduit pathway installed below grade shall be concrete encased when installed under rails.

d. Outside plant fiber optic cable and conduit shall be protected using detectable marking tape placed six (6) inches below grade and over the area to be protected, in addition to above grade visual markers.

e. Cable raceway shall be sized to carry Category 6 and fiber optic cables per code and industry standards. The minimum conduit size used for Category 6 and fiber optic cables shall be one (1) inch when running cables between station distribution cabinets and the subsystem device location. The minimum conduit size used for bundled fiber optic cables shall be four (4) inches when running cables between the main equipment room and the station pull-boxes or distribution cabinets. All conduit fittings shall be compression type (not mechanical). All conduits ends shall be ream and bushed. All outside plant conduit openings shall be sealed after cable installations. All unused conduits shall have pull-strings placed.

C. POWER AND UPS

All station communications equipment and subsystem devices shall operate using an uninterruptible power supply (UPS) with battery reserve capable of sustaining the full equipment current load (plus additional 50% for future growth) for a period up to 90 minutes.

All UPS equipment shall be compatible with the existing Caltrain centralized UPS monitoring software (by APC) located in CCF facility. The new UPS shall be configured to report all types of the alarms already defined by this existing Caltrain UPS monitoring software.

The UPS shall be also programmed for monitoring and reporting to CCF Digital I/O alarms produced by other equipment (i.e., PA pre-mixer and amplifier(s) alarms, etc.). In the future these alarms will be re-wired to report to the future SCADA. UPS 120Vac receptacles shall be orange type NEMA L5-XX for identification.

The UPS load center shall be sized for the full complement of station subsystem devices and breakers shall be dedicated by subsystem as follows:

a. One 20A, 120Vac breaker per Visual Message Sign

b. One 30A, 120Vac breaker per Ticket Vending Machine

c. One 30A, 120Vac breaker per Distribution Cabinet

d. One 30A, 120Vac breaker per Communications Equipment Room

The central UPS shall provide for essential power for all station important communication devices such as Caltrain WAN interface, CER communication devices, PAS equipment, LAN switches, Media Converters, TVMs, CCTV, VMS, and Clipper Equipment.

Non-essential devices such as fans, air-conditioners, cabinet lights, and maintenance outlets shall be powered directly from the Caltrain station distribution power panels.

The UPS design shall include a conduit structure separate from the fiber optic cable distribution. UPS power cabling shall not share the same conduit space with fiber optic or other communication cabling.

UPS distribution panels shall be housed in common service areas shared with other platform utilities, and not housed in communication distribution cabinets.

The 120/208Vac UPS line side (input) shall be fed from the local ac electrical service on a dedicated breaker sized appropriately. The 120Vac UPS supply side (equipment side) shall have an adequate number of 120Vac receptacles for equipment distribution. If required, ac service strips with surge protection shall be installed within the main equipment room and distribution cabinets to facilitate the number of required equipment receptacles.

D. COMMUNICATIONS EQUIPMENT ROOM (CER)

The communications networking equipment shall be housed within the station and in the CER only accessible by authorized personnel. The CER is a prefabricated steel construction structure. All construction shall be applicable NFPA 70 (NEC) and California Building Code (CBC Title 24, Division 3).

Network electronics, termination panels, UPS, and other communications equipment shall be mounted in cabinets. Equipment cabinets shall be 84 inches tall with 19 inches EIA standard mounting side channels per EIA 310-D.

The positioning of equipment racks shall be such to allow adequate clearance for maintenance and safety per NEC (NFPA 70). This requires at least 3 feet of space between live circuit components and walls or other obstructions.

The communications equipment room shall have an adequate grounding and bonding system. A single point grounding scheme shall be used and a single main ground bar (MGB) shall be installed central to the room layout. Grounding design shall comply with ANSI/TIA/EIA-J-STD-607-A.

The size of the CER will depend on the size of the station and assigned communications equipment, but in no case will the available floor space be less than 8 feet x 10 feet. Unobstructed vertical space within the room shall be eight (8) feet minimum.

Equipment room lighting, environmental controls, floor loading, space planning, service entrances, and other design criteria will be in accordance to ANSI/TIA/EIA 569-B.

For security, a means to control access to any equipment room shall be provided. A state-of-the-art card reader/access system utilizing a 56Kbps service channel via the station/CCF carrier network shall be the preferred method of choice.

E. STATION COMMUNICATION CABINETS (SCC) / COMMUNICATION INTERFACE CABINETS (CIC)

The terms “SCC” and “CIC” can be used interchangeably. “SCC” is used in this document.

As mentioned above, for temporary stations, in lieu of CERs, designer may house the station-related communication equipment (listed above as housed within CERs) within these outdoor cabinets.

They are typically housed outside the station (or within station rooms, which do not have climate control) and only accessible by authorized personnel.

Because of the variety and quantity of the equipment, which needs to be placed into SCCs, these shall be at least 6 ft tall, 6 ft wide, vandal-proof, two lockable doors, NEMA 3R cabinets and incorporate swing-out 19 inches racks for ease of access for installation and maintenance.

For outdoor SCC installations the designer shall incorporate all preventive measures mitigating affects of the outdoors:

a. The SCC cabinets shall be elevated (placed on a concrete pad)

b. Proper moisture protection and drainage shall be implemented

c. The designer shall produce heat calculations having worst case scenario for the given equipment (including provision for future 50% growth) and particulars of location (officially recorded max outdoor temperatures). Based on these calculations provide cooling means, such as: sun-shield, painting of the cabinet; cooling fans and, if necessary, a side mounted air-conditioning unit.

d. Proper conduit entrances

e. Proper protection for lightning, protection terminal blocks and overall grounding scheme

The designer shall submit UPS calculations and provide for the UPS to support of typically 90 min operation of the station essential communication equipment powered (either directly by SCC or via the DCs) by SCC UPS after loss of utility power.

The SCC shall include for Intrusion Alarm (and other equipment alarms, such as UPS loss of power) for connection to the future SCADA system. The SCC shall include proper lighting inside the cabinet and accommodate power outlets for ease of maintenance.

The designer shall determine the size and electric/thermal requirements of new SCC to include sufficient space, cooling and power to accommodate for 50% of future growth. The Contractor’s thermo-calculations shall be based on the temperatures

for the given locale and show that the chosen equipment can still operate within the enclosure without exceeding its temperature limits.

F. OTHER DESIGN CONSIDERATIONS

1.0 ELECTROMAGNETIC INTERFERENCE (EMI)

In addition to the industry design and equipment standards listed above, the following design criteria and considerations shall be adhered to for the network protection against Electromagnetic Interference or EMI.

Electrical, electronic, and communications systems design must perform in the Caltrain commuter system EMI environments with vehicles and other equipment without being functionally affected by them; and without affecting the system operation, safety, or other car-borne or wayside installations because of conducted, induced, or radiated emissions.

The design shall employ design techniques, construction methods, and whatever equipment is required to prevent interference caused by external and internal sources from affecting the proper operation of the equipment and systems specified herein. To contain EMI emissions wherever possible, the suppression of transients shall be at the source of the transient. The following design requirements shall be included in the station communications design:

a. In addition to coordinating frequencies, the design shall provide required balancing, filtering, shielding, modulating techniques, and isolation to maintain signal to noise ratio (S/N) above limits required to operate all equipment. Shielding, isolating, balancing, and grounding shall be used, as required, to reduce the undesirable effect of interference.

b. Electrostatic and magnetic shielding methods shall be employed to minimize the effect of stray signals and transient voltages on interconnecting cables.

c. Interconnecting power and signal cables shall be physically separated.

d. Equipment and facilities shall be located and arranged to minimize voltage induction into circuits due to future electrification, auxiliary power, and overhead catenary system current transients.

e. Suppressors shall be incorporated across inductive devices to minimize switching transients.

f. All relay coils and contactor coils shall have free-wheeling diode or metal oxide varistor transient suppression. The varistor is a surge protection device that is connected directly across the ac input. Other means of suppression or the absence of suppression for performance reasons shall be approved prior to use.

g. The number of suppression device types shall be kept to a minimum.

h. Equipment design and enclosures shall shield equipment from any effects resulting from the operation of any handheld transceiver when said transceiver is within 18 inches of the enclosure.

i. Equipment design and enclosures shall shield equipment from any effects resulting from the operation of cellular telephones, including when said telephones are operated in the vicinity of the equipment and on the passenger platforms.

Known EMI sources along the Caltrain right-of-way include but are not limited to the following major sources of interference that could affect operation of the System:

a. Medium and low voltage power circuits, including any future Traction Power ac source sub-transmission distribution system, operating at 60 Hz and carrying harmonics typical for the configuration and the loads served.

b. Direct-current traction power system:

i. Substation thyristor rectifier apparatus
ii. Direct current power distribution to trains, via overhead power catenary circuit
iii. On-board propulsion equipment, including solid-state chopper and motor circuits
iv. Direct current arcing, catenary to pantograph
v. Temporary faults on the ac or dc power circuits

Train Control signal system, which comprises a variety of discrete digital and digitally coded signal sources and receivers at the CCF, in Signal Houses, in wayside cables, in running rails, and in rail vehicles. Coded signal sources are in the dc to 20 KHz range.

The design shall provide surge arresters and other circuit protection devices required to protect equipment from lightning currents and voltages. Related to emissions, the design shall ensure that its equipment does not electrically interfere with the proper operation of the future electrified rail cars or wayside equipment. Additionally the equipment shall comply with FCC CFR 47 part 15 Over-voltage Protection.
Over-voltage protection shall be provided for all outdoor Public Address (PA)/ Visual Message Sign (VMS) and CCTV equipment.

2.0 PROHIBITED MATERIALS AND METHODS

The station communications design shall ensure the following materials and methods are excluded:

a. Extra-flexible, metallic or non-metallic, non-labeled conduit.

b. Plastic conduit for interior electrical use, except that Polyvinyl Chloride (PVC) conduit may be used for power circuits below basement concrete floors and for ground wire in any location. The transition from PVC to steel shall be made below the floor.

c. Steel Conduit shall not be used outside unless in concrete. Use Galvanized Rigid Steel (GRS) conduit outside and wet locations above grade.

d. Aluminum wiring.

e. Incompatible Materials:

i. Aluminum fittings and boxes shall not be used with steel conduit.
ii. All materials in a raceway system shall be compatible.
iii. Dissimilar Metals: All dissimilar metals shall be properly insulated to prevent galvanic action.
iv. When bronze and aluminum components come into contact with dissimilar metals, surfaces shall be kept from direct contact by painting the dissimilar metal with a heavy coat of a proper primer or asphalt paint.
v. When aluminum components come into contact with cement or lime mortar, exposed aluminum surfaces shall be painted with heavy bodied bituminous paint, water-white methacrylate lacquer, or zinc chromate.
vi. Fasteners: All exposed fasteners shall be stainless steel.
vii. Multi-use Suspension Systems: Piggy-back suspension systems for conduits and fixtures are prohibited. All suspensions shall be hung independently from structure, or, in limited cases, from trapeze suspension systems.
viii. Use of wire ties to support conduit: Use of splices to join communications or electrical wiring within duct banks and raceways.

3.0 ENVIRONMENTAL

Communications equipment and material shall be designed for indoor and outdoor locations along the rail right-of-way, at elevations of approximately sea level to 1000 feet above sea level, in a suburban environment. The areas adjacent to rail right-of-way are urban or suburban zones, some of which are occupied by industrial or commercial developments. Rail lines run parallel with major freeways along several lengthy sections.

Seismic 4 zone design requirements shall apply to all cabinets, racks and devices mounted on or hung from elevated structures.

All outside plant cables shall be suitable for outdoor installations. All outdoor Category 6 cabling shall be installed in protective conduits.

3.1 Climatic Conditions

The following particular climatic conditions shall be used as design guidelines and shall be considered as operational requirements. Actual localized temperatures and conditions within spaces and enclosures may be more severe than the ambient climatic conditions and the design shall include evaluating these during the design effort. The design shall address that no equipment damage occurs during manufacture, storage, and shipment as a result of climatic conditions which differ from those below:

a. Temperature and Solar Load:

i. Minimum ambient air temperature external to equipment is 14 degrees F
ii. Maximum ambient air temperature external to equipment is 120 degrees F
iii. Maximum solar radiation: 275/BTU/hr*ft2
iv. Maximum daily temperature range: 50 degrees F

b. Precipitation:

i. Maximum rainfall rate is five (5) inches/hr and this rate may occur simultaneously with wind
ii. Measurable quantities of ice infrequently occur
iii. Average relative humidity >90 percent

3.2 Air Contaminants

Related to air contamination, the equipment shall operate as specified in the atmosphere commonly found in rail vehicle environments and the San Francisco Bay Area. These include the following:

a. Enclosures Particulates:

i. Average: 0.175 mg/m3
ii. Maximum: 0.324 mg/m3

b. Ozone: 0.200 ppm, maximum

c. Noa: 0.25 ppm, maximum

d. Soa: 262 g/m3

e. CO: 20 ppm, max.

f. Chloride: 13.9 mg/m3

g. Moisture Acidity: pH 4.41

3.3 Outdoor Locations

a. Equipment and enclosures installed in outdoor locations shall be designed to operate properly in the extremes of local weather conditions, including heavy winds, rain, hail, outside air temperatures, and relative humidity up to 100 percent.

b. Where equipment is installed in outdoor enclosures and subject to temperature extremes caused by exposure to direct sunlight plus heat from internal electrical losses, the enclosures shall be equipped with sun shields and convection vents so that maximum internal temperature rise above ambient air does not exceed 25 degrees F. Equipment intended to be

installed in outdoor enclosures shall be designed and tested for continuous service at 140 degrees F.

The designer shall submit thermal calculations for each outdoor enclosure for each given equipment (calculation should include 50% growth for future equipment of a similar load) and environmental particulars of the given location. If use of fans appear to be insufficient, external air-conditioning cooling units shall be considered.

c. The design and construction of outdoor equipment enclosures shall include measures to protect against deterioration due to salt air, condensation, frost, and temperature extremes, including control of fungus growth and metal corrosion. Outdoor communication equipment enclosures shall comply with NEMA 4X or NEMA 3R and shall have a stainless steel finish.

d. Intrusion protection shall meet IP65 standards for all device enclosures not rated NEMA 4X.

3.4 Indoor Locations

Equipment and enclosures installed in indoor wayside locations shall be designed to operate continuously, properly, and safely in a temperature range of 32 degrees F to 120 degrees F, at relative humidity ranging up to 100 percent.

All cabling installed indoors shall be of low smoke fire-retardant design.

3.5 Cooling Devices

a. Designer shall provide cooling devices. Such devices shall be internal to the associated enclosures, and shall be included in the determination of conformance to reliability and maintainability requirements.

b. Unless otherwise specified, cooling devices shall be sized to maintain temperatures within enclosures between 60 degrees F to 80 degrees F while outside ambient temperatures are in the range specified previously.

c. More specific requirements for climate-controlled facilities may be found in the Standard Specifications.

3.6 Heater Devices

a. Designer shall provide heater devices to remove condensation.

b. Such devices shall be internal to the associated enclosures, rooms or houses, and shall be included in the determination of conformance to reliability and maintainability requirements. The requirements for heating devices are in the Caltrain Standard Specifications.

3.7 Vibration Limits

All equipment shall be designed to operate in an environment subject to the following vibration limits.

a. Wayside equipment:

   i. Equipment located adjacent to track on direct fixation or tie and-ballast sections, and mounted anywhere within the Caltrain right-of-way except as indicated herein below, shall be designed to operate in an environment subject to the following vibration levels: all frequencies less than 12 Hz, 0.02 inches peak-to-peak amplitude; all frequencies from 12 Hz to 1000 Hz, 0.14 g peak or 0.1 g rms.

   ii. Equipment located adjacent to and within 20 feet of special track work on direct fixation or tie-and-ballast construction shall be designed to operate in an environment subject to the following vibration levels: all frequencies less than 12 Hz, 0.2 inches peak-to-peak amplitude; all frequencies from 12 Hz to 1000 Hz, 1.4 g peak or 1.0 g rms.

b. Equipment located in communications equipment spaces at Central Control Facility (CCF), Distribution Cabinets (DCs), other communications facilities, Signal Houses, or Yards:

   i. For all frequencies less than 12 Hz: 0.02 inches peak-to-peak amplitude

   ii. For all frequencies from 12 Hz to 1000 Hz: 0.14 g peak or 0.1 grms.

END OF CHAPTER