

# California High-Speed Train Project



## TECHNICAL MEMORANDUM

### Communications Systems Site Requirements TM 3.4.2

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For the California High-Speed Rail Authority

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## System Level Technical and Integration Reviews

The purpose of the review is to ensure:

- Technical consistency and appropriateness
- Check for integration issues and conflicts

System level reviews are required for all technical memoranda. Technical Leads for each subsystem are responsible for completing the reviews in a timely manner and identifying appropriate senior staff to perform the review. Exemption to the system level technical and integration review by any subsystem must be approved by the Engineering Manager.

System Level Technical Reviews by Subsystem:

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## ABSTRACT

This Technical Memorandum provides guidance for space planning and provisioning of communications equipment at key sites in the California High-Speed Train system. This document can be used by contractors, planners and systems designers to support the communications system equipment needs for the sites presented herein.

The information presented in this TM will:

- Identify and describe key communications site and equipment needs for the CHSTP.
- Identify communication industry standards for site equipment design and layout.
- Detail the anticipated systems equipment and interfaces based on current industry best practices that can be applied across the entire CHSTP alignment.

Deployment of a standardized layout an equipment configuration will be specified for all the main communication equipment areas. Adherence to a common plan will ensure that the communications system can be deployed in a scalable and cost efficient manner.

Design strategies for both indoor and outdoor communications equipment areas are based on past successful communications designs and anticipated future growth. Communications space planning will allow for up to 50% future growth in communications rack space over the useful life of the project.

The space needs of application specific systems including fixed facility subsystems, are not included in this document. Tenants using space in multimodal stations owned and operated by CHSRA shall determine their own communications space needs and are not covered in this document. Where CHSRA leases space in a building owned and operated by another authority, this document covers only the CTS space required by CHSTP in that building. In all cases, except as noted, CHSTP communications space requirements will be developed independently of the needs of any other authority.

The information presented in this technical memorandum will be included in the CHSTP Design Manual and will form the basis of Design Criteria and Specification development.

## 1.0 INTRODUCTION

In order to support the communications capabilities of the CHSTP Communications Network, the following sites will need to be provided with communications and supporting equipment

- Operations Control Center (OCC) and any Remote OCC location(s)
- Passenger Stations
- Traction Power Facilities including Substations, Switching, and Paralleling Stations
- Automatic Train Control (ATC) houses
- Wireless Communications Equipment Shelters
- Maintenance Facilities
- Wayside infrastructure elements
- Wayside Fiber Optic Regeneration Cabinets

Equipment of these locations shall include duct banks and conduit, fiber-optic terminating panels, racks for optical network switching equipment, terminal blocks for telephone and SCADA I/O points, Ethernet aggregation and node switches, commercial AC electrical power, UPS with battery backup, wireless system transceivers, and antenna and antenna support structures.

ATC house site requirements are shown in TM 3.3.2. The house sizes defined in that TM include allowances for communications equipment associated with the ATC system at that location.

### 1.1 PURPOSE OF TECHNICAL MEMORANDUM

The primary design goal of the Communications Network is to insure the functionality, safety and reliability of high-speed train operations by employing proven, industry-accepted open communications protocols. These protocols, including TCP/IP and Ethernet, will allow future scalability, low cost maintenance and wide market availability for communications equipment.

In order to achieve cost economy and promote deployment of a standardized layout an equipment configuration will be specified for all the main communication equipment areas.

The assessments discussed in this document represent best practices and design requirements for the communications space management and equipment to be supported at each site. A list of applicable communications equipment standards to be employed in the design and planning of the sites is also presented.

The information presented in this technical memorandum will be included in the CHSTP Design Manual and will form the basis of Design Criteria and Specification development.

### 1.2 STATEMENT OF TECHNICAL ISSUE

In order to support a safe, reliable high-speed public transportation system, it is necessary to design a robust and secure communications network to connect all field locations to a central control facility. Modern fiber optic high-speed networks using failsafe redundant fiber optic rings provide a reliable backbone network to carry all control data, voice and video back to main and regional operations control centers

A wireless network links all mobile and portable devices required for maintenance, operations, security and train control back to central and regional maintenance and control facilities. Each major facility on the CSH alignment connects to the main Wide Area Network (WAN) through its own secure Local Area Network (LAN) allowing local data traffic to be segmented from system-wide traffic.

Facilities to house and support the communications equipment necessary for such a system, include but are not necessarily be limited to the following:

- Operations Control Center / Communications and ATC Control Room
- Regional Operations and Control Center
- Passenger Stations Train Control and Communications Room

- Traction Power Facilities (Substations, Switching and Paralleling)
- ATC Houses
- Yard ATC Houses and Cases
- Wireless Communications Equipment Shelters
- Wayside Fiber Optic Regeneration Cabinets

The space needs of application-specific systems including fixed facility subsystems, are not included in this document. Site requirements for Train Control Housings are described in TM 3.3.2.

### 1.3 UNITS OF MEASUREMENT

The California High-Speed Train Project (CHSTP) is based on U.S. Customary Units consistent with guidelines prepared by the California Department of Transportation (Caltrans) and defined by the National Institute of Standards and Technology (NIST). U.S. Customary Units are officially used in the U.S. and are also known in the U.S. as “English” or “Imperial” units. In order to avoid any confusion, all formal references to units of measure should be made in terms of U.S. Customary Units.

### 1.4 GENERAL INFORMATION

#### 1.4.1 Definition of Terms

<u>ATC</u>	Automatic Train Control
<u>ATS</u>	Automatic Train Supervision
<u>A-TEL</u>	Administrative Telephone. Part of the Voice-over-IP communications system.
<u>E-TEL</u>	Emergency Telephone. Part of the Voice-over-IP communications system.
<u>CAT</u>	Category
<u>CCTV</u>	Closed-Circuit Television
<u>CIC</u>	Communications Interface Cabinet. A stand alone cabinet containing racks used for Communications and SCADA equipment.
<u>CTS</u>	Communications Transmission System: For proposes of the CHSTP the CTS refer to the entire communication system including fiber optic cable, wireless transceivers, network Ethernet, IP and MPLS switches, and all the Local Area Networks at Passenger Stations, Yards, and Operation Control Centers.
<u>CPU</u>	Central Processing Unit
<u>DVR</u>	Digital Video Recorders
<u>E-TEL</u>	Emergency Telephone
<u>ETS</u>	Emergency Trip System
<u>FACP</u>	Fire Alarm Control Panel
<u>FCC</u>	Federal Communications Commission
<u>FDU</u>	Fiber Distribution Unit
<u>GigE</u>	Giga-bit Ethernet
<u>LAN</u>	Local Area Network: A network which provide interconnection between terminals, servers, switches, sensors and another electronic/optical equipment within a station or a operational facility.
<u>MCR</u>	Master Control Room. Facilities at the OCC which will house operational display and status information for the entire CHST system.

<u>Mbps</u>	Mega-bits per second
<u>MMIS</u>	Maintenance Management Information System
<u>NFPA</u>	National Fire Protection Association
<u>NMS</u>	Network Management System: A system used to provision, test and maintain network connectivity.
<u>OCC</u>	Operations Control Center
<u>P-TEL</u>	Public Telephone
<u>RF</u>	Radio Frequency
<u>RCC</u>	Regional Control Center. The Operations Control Center associated with a CHST Region and able to handle all train operations for that region.
<u>SCADA</u>	Supervisory Control and Data Acquisition
<u>TC</u>	Train Control
<u>TCCR</u>	Train Control and Communications Room. The central equipment room that houses all electronics, power and computing equipment necessary to the operation of the OCC and the CHSTSP communications network.
<u>TPF</u>	Traction Power Facility
<u>UTP</u>	Unshielded Twisted Pair
<u>VoIP</u>	Voice over Internet Protocol
<u>WCS</u>	Wireless Communications System: A major subsystem of the Communications Transmission System (CTS) which used radio propagation to transport voice and data.
<u>WLAN</u>	Wireless Local Area Network

## 1.5 LAWS AND CODES

Initial high-speed train (HST) design criteria will be issued in technical memoranda that provide guidance and procedures to advance the preliminary engineering. When completed, a Design Manual will present design standards and criteria specifically for the design, construction, and operation of the CHSTP.

Equipment needs will be assessed as the project design progress. All relevant project guidelines for Fire / Life Safety, Security and Access Control, Traction Power, Train Control equipment layouts, and Facilities Management and Operation requirements will apply to the layout and deployment of communications site equipment.

Criteria for design elements not specific to high speed train operations will be governed by existing applicable standards, laws, and codes. Applicable local building, planning, and zoning codes and laws are to be reviewed for the stations, particularly those located within multiple municipal jurisdictions, state rights-of-way, and/or unincorporated jurisdictions.

In the case of differing values, the standard followed shall be that which results in the satisfaction of all applicable requirements. In the case of conflicts, documentation for the conflicting standard is to be prepared and approval is to be secured as required by the affected agency for which an exception is required, whether it be an exception to the CHSTP standards or another agency standards.

## **2.0 DEFINITION OF THE TECHNICAL TOPIC**

### **2.1 GENERAL**

This Technical Memo (3.4.2) documents the space required by the Communications Transmission Network (CTS) equipment to switch, process, control, and deliver data traffic between field locations and a central control facility.

The underlying concept of the CHSTP Communications Network is for a high-speed optical data backbone to interconnect all equipment and devices requiring monitoring, communications, or control to a central operations center. Major wayside structures like passenger stations, train control houses, and traction power facilities will contain the electrical and optical equipment necessary for providing all equipment at that site with access to the fiber optic backbone rings.

Station peripheral equipment such as passenger information VMS, PA, CCTV cameras, fire alarm panels, access control readers, telephones, fare vending equipment, and building SCADA, etc. will be interconnected together on a Local Area Network (LAN). This document presents layouts needed for such LAN switches as well as 50% expansion of rack space. Rack and equipment space planning needs include terminations for backbone and local fiber optic cable, CAT-6, and SCADA signal cabling.

Wayside Communications Shelters will link the fiber optic network to radio subsystems for train control, mobile voice and data services along the alignment. These communications facilities will also need to be included in space and land use planning.

Space planning for equipment specific to each application supported by the CTS is not within the scope of this document and must be decided in the final design phase of the project.

### **2.2 CHSTP DESIGN CONSIDERATIONS**

Deployment of a standardized layout an equipment configuration will be specified for all the main communication equipment areas. Adherence to a common plan will ensure that the communications system can be deployed in a scalable and cost efficient manner.

## **3.0 ASSESSMENT / ANALYSIS**

### **3.1 GENERAL**

Main fiber optic switching nodes will be planned for and laid out at major communications switching points on the network. These locations include the OCC, Regional Centers, and each passenger station. These facilities will house major communications equipment layouts for the communications system and will need to have a secure room with space adequate for current and future equipment. Smaller communications equipment footprints are planned for Traction Power facilities and ATC houses.

Land space along the alignment will be required for wayside communications shelters associated with the radio subsystem. In order to simplify land and space planning, radio equipment shelters towers, and antennas will be co-located as much as possible with traction power facilities located at 5 mile intervals along the alignment.

These requirements will be discussed in the following sections of this Technical Memorandum.

### **3.2 SITE EQUIPMENT FOR THE OPERATIONS AND CONTROL CENTER**

#### **3.2.1 Assessment**

The Operations Control Center (OCC) site will be the main control point for both the system-wide communications network and the location for all computing database and application servers, database servers and data archiving, passenger information, and radio system controllers and consoles.

Main operational control will be from a modern, centralized, and secure master control room at the OCC. This area will be interconnected by an OCC Local Area Network (LAN) back to the Train Control and Communications Room (TCCR) in order to provide secure, dedicated, and environmentally-controlled space to house all the supporting electronic and computing equipment.

For planning purposes, the footprint of the TCCR at the OCC will be 45' x 45'. Recommended height of the room should be (min) 9 ½ feet. This leaves the necessary 1 ½ ft. clearance above racks for cable ladders and clearance for 1 foot raised floors.

The footprint for one row of twenty standard 19 inch communications racks with spacing is 40 ft. long and requires a 360 sq. ft. working footprint. Four rows of racks would take 1440 sq. ft. An allowance of 150 sq. ft. for computing and desk space, space for a battery room and UPS plus 25% allowance for expansion puts estimated requirement for TCCR at approximately 2000 square feet.

Train control equipment is included in this space estimate and would be allocated one row of twenty standard 19" communications racks plus 25% for future growth.

Space should be planned for the necessary local communications conduit in and out of the TCC room which will be standard 4" diameter conduit with four innerducts.

It is assumed that fire access control panels will be allocated space outside the TCC room depending local fire and life safety codes.

Operations display, security, crew dispatching, and rolling stock dispatching are other functions that may be required either in the master control room or rooms adjacent to it. Space planning for these areas shall be the responsibility of the operations design group and is outside the scope of this Technical Memorandum.

### 3.2.2 Proposed Communications Equipment for OCC

The OCC shall be equipped to communicate with, control, process, and store all data from any connected point in the alignment of the CHSTP system. It will house and have access to all the communications subsystems located in the TCCR. Site equipment includes, but is not necessarily be limited to, the following elements:

- Ethernet Optical Node switches
- Aggregate and access Ethernet switches
- WAN Network Management servers
- Train-to-wayside radio communications control equipment and recorders
- System-wide radio communications control equipment
- CCTV monitors, video analytics and video mass storage units
- Traction power system SCADA display monitors, application and database servers
- ATS display monitors, application and database servers
- Voice over IP (VoIP) master database server and two (redundant) Call Managers
- 911 dispatch center for routing E-TEL calls to Public Safety Access Points (PSAP)
- Telco demarc block and access to local service provider's 911 trunks
- Access Control and Security application and database servers
- Fire and Life Safety Emergency Management Panel (EMP) or designated Command Area
- GPS Network time synchronization radio receivers and application servers
- Passenger information application servers and database storage units for pre-recorded announcements
- Maintenance Management Information System (MMIS) application and database server with an additional database server as a test platform.
- Training consoles and servers
- Internet gateway router and firewall server(s)
- Conduit and cable raceways and duct chases
- Fiber Distribution Units for fiber termination splicing and optical cable storage
- HVAC to support heat load of communications and control equipment
- UPS and nearby battery storage areas with appropriate ventilation
- Standard 45U (7 ft.) 19 inch communications racks, overhead cabling ladders, fiber distribution and terminating units, CAT6 patch panels and terminating blocks for SCADA I/O field cable.

The OCC Communications Equipment Room requires the following supporting systems:

- Commercial AC 400-500A electrical service and associated breaker panels
- Grounding system for communications equipment
- UPS equipment including rectifier, charger, and ventilated battery storage room
- Waterless fire suppression system
- Security access control system including card readers
- CCTV camera(s) at entry points
- Administrative Telephone (A-TEL) service
- Electrical panel and breaker boxes
- HVAC to maintain temperature control and air flow to a minimum of 400 CFM

### 3.2.3 CHSTP Standard and Regulatory Requirements

For purpose of communications space planning the location of fire access control panels (FACP) and/or emergency management panels (EMP) shall be at the discretion of facilities, operations and fire safety design groups in accordance with prevailing code and regulations.

This document does not include such panels in its assessment, but does allocate equipment space for all the supporting communications equipment these panels may require.

### **3.3 REGIONAL OCC (RCC) SITE COMMUNICATION EQUIPMENT**

#### **3.3.1 Assessment**

The same communications room space requirements as for the OCC should be assumed for the Regional Control Centers.

If the operations design team requirements include connectivity between any (or all) of the Regional Control Centers and the main Operations Control Center, provisions will be required for extra rack space to accommodate terminations for dedicated strands within the dual fiber optic cables in order to provide Intra-Office (e.g.OCC-RCC) communications. This will also require rack space for an additional dual fed 10 Gigabit Node switch at each OCC/RCC facility and the associated power and HVAC requirements to support them.

Equipment for this purpose will include space equivalent for one additional standard communications 19' rack cabinet.

### **3.4 SITE EQUIPMENT FOR PASSENGER STATIONS**

#### **3.4.1 Assessment**

All communications connectivity, as well as utility and UPS power connections, will terminate in the Train Control and Communications (TCC) room of each passenger station.

Each passenger station will be designed as a main fiber optical node in the CHTSP communications backbone. In addition each passenger station will have its own internal Local Area Network (LAN) to act as a hub for all station communications subsystems requiring connective to the node.

Each passenger station shall have its own secure and environmentally controlled Train Control and Communications Room (TCCR) to house all communication equipment required to support ATC, traction power and facilities SCADA, Passenger Information, CCTV, telephone and all other communications and data processing capabilities required to support station operations. For planning purposes the footprint of the station TCCR shall be 24 x 24' with a 3 ft. wide working aisle surrounding the all rack cabinets. The height of the room should be (min) 12 ft. leaving at least -3 ft. clearance above racks for cable ladders and trays.

At least four communications racks are provided within this space allocation for ATC equipment.

The larger terminal stations which include Los Angeles, Merced (during Phase One operations), San Diego, Sacramento, and the TransBay and 4<sup>th</sup> and King Stations in San Francisco will need larger facilities. In order to accommodate extra equipment to support these terminal stations, it is necessary to increase by 25% the space for terminal stations over what is allocated for other passenger stations. Specifically, the TCC plan for terminal stations will be 30' x 30 room (900 sq. ft.) versus 24' x 24' plan (600 sq. ft.) for a typical passenger station.

Standard 4" communication conduit with 1" innerducts for separate cables will be required to link equipment from locations within the station to the TCCR.

Separate conduit will be required for all power and lighting cable.

Space planning at TCCR rooms does not include the following systems to be decided as part of the final design phase:

- Clean agent system.
- Cable chases into\out of room.
- Wall mounted field cable (copper) termination racks.
- LV power distribution equipment to support the operation of the TCCR.
- Telephone instrument at doorway(s).
- Storage\ file cabinets\desks for O&M personnel.

### 3.4.2 Proposed Communications Equipment for Passenger Stations

These devices in the Station Communications Equipment Room may include, but not necessarily be limited to, the following equipment:

- Main Station Node fiber-optic 10GigEthernet switch(s) including redundant multiple power supplies and card shelves
- Ethernet aggregation switches or Ethernet access switches
- CCTV monitors, applications processing equipment, Digital Video Recorder (DVR) and video and digital video termination and patch panels.
- VoIP application and gateway server
- Terminal block(s) for termination of station SCADA I/O points and alarms
- Passenger Information Systems interface devices
- Fiber distribution, splicing and termination units including storage for slack fiber cable.
- CAT-6 Unshielded Twisted Pair (UTP) and fiber optic patch panels and jumpers.
- Network Timing database server
- GPS receiver and roof-mounted antenna
- Local Station LAN provisioning server and associated console equipment
- Radio transceiver equipment, transmission lines, and antennas as required by coverage analysis (i.e. if station locations are needed to support RF transmission coverage.)
- Breaker panel for communications equipment
- Radio and communications systems grounding equipment and cabling.
- Standard 45U 7 ft. 19 inch communications racks, and overhead cabling ladders
- Breaker panel and transfer switch for backup power generator

The Communications Equipment Room requires the following support systems:

- Commercial AC electrical service
- Ground system for radio and data communications equipment
- UPS equipment including rectifier, charger and DC battery plant in separate temperature controlled and ventilated room.
- Waterless fire suppression system
- Security access control system including card readers
- CCTV camera(s) at entry points
- Administrative Telephone (A-TEL) service
- Electrical panel and breaker boxes
- HVAC to maintain temperature control and air flow to a minimum of 400 CFM

At designated location(s) at passenger station the following equipment should be planned for:

- Main Ethernet fiber optic node switches
- Station LAN access switches
- CCTV security cameras and displays
- Voice over IP Call Managers / Voice Storage
- A-TELS, E-TELS, P-TELS and F-TELS
- Passenger information displays and PA speakers
- Fire Emergency Management Panel (FEMP)
- Fiber Termination and Distribution Panels

Space for a Station Control Room should be planned at each station to contain operations and display equipment to monitor and manage the passenger station. Space allocation will depend on functionality determined by operations and facilities design teams and is not included in the communications space planning scope.

### 3.4.3 Passenger Station Local Area Network

A station local area network (S-LAN) shall provide interconnection between all the systems and elements at the station which require connection to the main 10Gigbit communications backbone of the CHSTP Communications Network.

Conduit will need to be provided for this LAN carrying either CAT-6 UTP or fiber optic cable.

In addition, copper-based field routed signal cable may be required for connection from all facilities equipment SCADA points back to the station Communications Room. In certain layouts this cable may require a separate conduit especially to protect against EMI or to meet fire alarm code requirements.

Cabling to the station PA system speakers may require its own separate conduit to qualify as a voice evacuation system under National Fire Protection Association codes.

Standard 4" communications conduit will use innerducts to keep cables separate as required for safety and ease of installation and troubleshooting.

### 3.5 DIRECTIVE DRAWINGS

Refer to Drawing 3.4.2-A "Typical Passenger Station TCCR Space Plan".

### 3.6 SITE EQUIPMENT FOR TRACTION POWER SUPPLY SYSTEM

#### 3.6.1 Assessment

Communications Network shall be designed so that the three types of traction power facilities (e.g. supply, switching, and paralleling) will have reliable and redundant communications back to the OCC. This is to insure that vital traction power SCADA system information, such as temperature, voltage, and current as well as the operation and monitoring of switchgear shall be always available at the OCC's main SCADA server.

In order to save on costs and insure ease of deployment a standardized layout and equipment configuration will be followed for each traction power facility. Spacing size and rack footprints should be similar for all traction power facilities deployed in the system since essentially the same communications equipment will be required for each site.

Each traction power facility shall have a Communications Interface Cabinet (CIC). The CIC shall be located in a separate area in the facility to allow maintenance access without entering areas with high voltage. The CIC will measure 4' x 8' with a 3 ft. clearance on all sides to require a working footprint of 140 sq. ft. The CIC will contain two 42U 19 inch communications racks, with rack space left for future expansion.

Supporting requirements for communications equipment include HVAC, UPS battery backup, and an access-controlled area and have a non-liquid fire suppressing system. For planning purposes the footprint shall be 60 sq.ft.

Within the CIC space will be allocated for block terminations provided for SCADA field-routed signal cable from the system I/O ports. Indoor conduit for this cable will also need to be provided. The CIC will also support VoIP A-TEL and or E-TEL communications directly to the OCC.

For both security and safety, personnel access to the communications equipment area of the traction power facility will be separated from the access to the high-voltage traction power equipment. Each craft should have its own access-controlled doors and equipment enclosed in a locked and protected area.

### 3.6.2 Proposed Communications Equipment for Traction Power Facilities

The following communications site equipment is planned for CIC at traction power facility locations:

- Communications switching equipment such as Ethernet access switches or fiber optic modems
- Communications Interface Cabinet (CIC) for communications and traction power SCADA equipment
- Two standard 19" communication equipment racks 48U high (7 ft.)
- Fiber distribution units and patch panels for access to FO drops to backbone
- Terminal blocks to terminate SCADA I/O field cable.
- A-TEL phone and VoIP gateway interface box
- Two separate fiber optic conduits each of which will interface with redundant communication switching equipment to support the SCADA network for traction power equipment.
- ac/dc breaker panels for communications equipment racks
- Bonding to communications grounding net and shielding for RFI mitigation
- HVAC ventilation required to maintain fiber optic and electrical communications equipment

### 3.6.3 Directive Drawings

Refer to Drawing 3.4.2-B "Typical Traction Power Facility Communications Space Plan"

## 3.7 TRAIN CONTROL AND COMMUNICATIONS (TCC) HOUSE

### 3.7.1 Assessment

In order to provide wayside ATC houses the capability to provide A-MIN telephone service back to the OCC, ATS access control and alarms reporting for each Interlocking Main Control House will require a Communications Interface Cabinet (CIC) that can operate using the ATC 24 Vdc battery system.

In the event that a radio based ATC system is selected, there will be a need to interface between the ATC equipment in the houses distributed along the wayside and a local radio, tower and antenna. It should be assumed therefore that each ATC house has to provide space for wayside radio equipment to support the necessary RF coverage for the train-to-trackside communications system. If radio coverage dictates the need for a radio node, then wireless transceivers and cabling will need to be provided within the communication site space.

Radio equipment shall be able to operate on the same DC potential that Train Control equipment operates on, or if that not being practicable, space shall allow them to operate by means of an additional DC-to-DC power converter.

For space allocation planning purposes, the ATC House CIC footprint will be 4' x 6' cabinet with a 3 foot perimeter space surrounding the cabinet and for a total working footprint of 120 sq. ft. The CIC will contain two 7 ft. 42U 19 inch communications racks, with rack space allowed for future expansion.

It is envisioned that Train Control and Communication will share the UPS and battery backup facilities which will be sized to accommodate the loads of both systems. It is understood that co-trained personnel shall have access to both the communications equipment and train control equipment, so separate and locked access areas within the ATC House will not be required.

TM 3.3.2 contains more detailed information related to the train control equipment and layout.

### 3.7.2 Proposed Site equipment for ATC Houses

- Ethernet gateway switch for WPC and ATS, VoIP service and CCTV service.
- Fiber Distribution Unit
- SCADA/ATS terminal block(s)
- Radio transceiver and associated cabling
- Fiber splicing and slack enclosures
- Rectifier, charger and UPS battery bank (provided by Train Control)
- AC/DC breaker panels for communications equipment racks
- Necessary RF and communications grounding system
- Antenna support mast, foundation, grounding and antenna(s) (external and separate from house)

### 3.8 DIRECTIVE DRAWINGS

Refer to Drawing 3.4.2-C “Typical Train Control House Communications Space Plan”

### 3.9 SITE EQUIPMENT FOR TRAIN MAINTENANCE YARD

#### 3.9.1 Assessment

The Maintenance Facilities will require its own LAN to interconnect SCADA and local communications, plus Wireless Node Access Points to support a Yard Wireless LAN (WLAN) system to offload and process rolling stock and data from the onboard diagnostics and communications system.

The Yard communications system will be required to support the yard Traction Power system to operate motorized breaker switches and send and receive SCADA indications and commands to elements of power distribution and control for the yard, maintenance shops, and train storage area.

The Yard will require SCADA field cable termination boxes placed near traction power devices and well as fiber optic splicing and termination units and slack enclosures.

For purposes of interconnecting train control houses and cases and providing access to the larger communications network, a local Yard fiber optic network will have to be provided Any train control or traction power requiring access to the CHSTP network will have to be provided with a single communications rack containing a fiber distribution unit and an Ethernet fiber optic access (edge) switch,

The Maintenance yard will have its own wireless LAN (WLAN) to accommodate downloading of information about train health and maintenance as well as a to provide a high speed wireless link to download stored video from the rolling stock Digital Video Recorders. An RF coverage analysis will have to be performed to determine the exact number and location of the outdoor Wi-Fi wireless nodes. Each node will require a 4' x 4' x 6' high outdoor NEMA 4 enclosure on a slab foundation, 110 Vac utility power, HVAC, grounding and underground fiber optic cable conduit (to accommodate drops of 12 strand fiber)

The Yard will also require a communications room or area of about 8' x 6' with rack space, power, UPS and batteries, optical network switches, A-TEL and E-TEL equipment, CCTV interfaces, access control, and a non-liquid fire suppression system.

### 3.9.2 Proposed Communications Equipment for Train Yard

- Maintenance Yard LAN server to interconnect the main data backbone to the OCC.
- WLAN server and associated console and computing equipment.
- CCTV cameras and CCTV server and RAID units for mass video storage
- Administrative telephones and Voice-over-IP Call Manager
- Radio console to support local Yard radio communications
- EMP, access control, and life safety communications
- Fiber Optic Distribution units, splice cases, slack enclosures, and jumpers
- SCADA termination block for field cable
- Computer, console, and associated equipment for LAN network provisioning and management

## 3.10 SITE EQUIPMENT FOR WAYSIDE WIRELESS COMMUNICATIONS SYSTEM SHELTERS

### 3.10.1 Assessment

Wireless train communication for high speed rail may include GSM-R or TETRA radio technologies. These systems will have to operate in FCC approved frequency blocks that conform to those available along the alignment.

Equipment employing these technologies will have to conform to power and emission requirements specified in 47 CFR, Part 90 – Private Land Mobile Radio as well as meeting the spectrum available needs over the counties of California that compromise the system alignment.

Antenna type, orientation, and location will be critical in meeting design requirements for 100% radio coverage within all track/dedicated guide way areas (including tunnels). Exact locations of wayside radio nodes will depend on radio simulation studies and coverage analysis. Such studies will have to take into consideration system bit error rates (BER), channel frequencies and local terrain and obstructions.

Where ever practicable, wireless wayside communications shelters will be co-located with existing facilities that supply space and power.

The site requirements for e wireless communications shelters include of ac power, UPS, and batteries for 8 hours of communications service, radio transceivers, and radio antenna, grounding and radio coaxial transmission lines. To minimize costs of construction the site design will take advantage of the presence of any other CHST infrastructure like passenger stations, traction power facilities, and ATC houses

Shelters require foundations for houses and antenna masts, grounding grids, trenched fiber optic cable conduit, ac power and HVAC support systems. It is envisioned these communications shelters will be sized at 8' x 10'. Concrete pad, grounding, fenced access, and trenched 4" fiber optic conduit will have to be provided. In order to simply the land acquisition process such sites will be co-located as much as practicable with existing traction power facilities already planned for 5 mile intervals.

Concrete pads for 100 ft. monopole will need to be 6 ft. to 8 ft. in diameter depending on soil type.

Communication ground ring will need to be 8 ft. diameter and fence line will need to be located outside that grounding ring diameter. Spacing between fence and wayside communications shelter needs to be at least 3 ft.

It may be necessary to deploy radio communications sites at yet unknown locations to meet system coverage requirements. Radio coverage analysis performed with the appropriate software tools will also be conducted to fine tune the places for wayside radio equipment including NEMA compliant communications shelters, towers, and antennas. All sites will meet application project architectural and structure requirements as well as all applicable California State and federal codes, regulations, and industry best practices.

### 3.10.2 Proposed Communications Equipment for Wireless Communication System Shelters

- Ethernet access switch
- Fiber optic splicing and terminating units, patch panels, and slack enclosures
- Access control and fire/alarms reporting SCADA
- Terminal blocks and fiber optic terminating equipment
- Radio Transceiver Unit (one per RF channel)
- Antenna, antenna masts, and foundations, transmission lines and grounding
- UPS rectifier, charger and batteries in a separate temperature controlled and protected area
- Waterless fire suppression system (e.g. FM 200 type)
- Computer, console and associated equipment for radio NMS.
- Each wayside wireless shelter equipped with HVAC, grounding, lighting protection, drainage, access road, security system, access controls and fencing.

### 3.11 DIRECTIVE DRAWINGS

Refer to Drawing 3.4.2-D "Typical Communications Shelter Space Plan".

### 3.12 STAND ALONE COMMUNICATION SHELTERS

Wherever practicable, communications shelters will be collocation with existing traction power facilities, passenger stations, or train control houses. However due to the results of radio coverage analysis, it may become necessary to deploy radio communications sites at yet unknown locations to meet system coverage requirements. In the event the need arises for a standalone facility, planning shall include space for a 12' x 8' fenced communications cabinet along the wayside plus space for 8' x 6' for auxiliary transformer and panels plus associated access roads, grading and drainage.

- All sites will be required to meet project architectural and structure requirements as well as all applicable California State and federal codes, regulations, and industry best practices.

#### 3.12.1 Wayside Optical Regeneration Facilities

In order to compensate for long distances between station optical nodes and wayside equipment needing fiber optic connectivity there will need to be optic regeneration points deployed in the alignment. These shelters will contain fiber termination units and splice cases where the backbone or drop cables are spliced into an optical-to-electrical-to-optical signal regeneration box. Such equipment will require a sealed, secure and alarmed communications grade shelter 12' x 8' along with 8' x 6' space for auxiliary transformer and associated power panels and breakers, or alternatively a high reliability solar powered 48Vdc battery UPS. This facility represents a mission critical communications point in the CTS and must be designed and provided accordingly, with climate control with superior water and dust protection.

Wayside fiber regeneration shelters will need to be spaced no farther than 5.5 miles apart following the path of the main fiber optic backbone. These shelters will be in protected areas of the alignment and therefore will not need separate fencing. But grading, drainage and access roads will need to be provided for ease of access and maintenance.

Where it is possible, Wayside Optical Regeneration equipment shall be co-located with existing TPF, ATC, Communications, MOWF or other maintenance facilities as space and power equipments for such equipment are relatively modest. Any fiber cable runs in excess of 5.5 miles where there are not corresponding facilities available for co-location, will require the provision of a standalone fiber optic regeneration facility as described above.

### 3.13 SITE COMMUNICATIONS EQUIPMENT FOR TUNNELS

#### 3.13.1 Assessment

A climate controlled area with UPS power for communications will be required to support voice/data radio tunnel communications, emergency telephone service, fire alarm and access control SCADA, and train control operations.

For space planning purposes two 8'x10' communications equipment areas should be provided for each tunnel. They should be located respectively near each portal. For twin single-track tunnels a total of four (4) communications rooms per tunnel complex will be required.

Tunnel communications will be implemented using a radiating coaxial cable transmission system. The coax cable run will be on both sides of the tunnel at approximately 6" from the wall. Bidirectional Amplifiers (BDAs) will be required to feed the amplified radio signals to the radiating coax lines. BDAs may be wall mounted or located at tunnel cross passages depending on tunnel design. . UPS power and grounding will be required at all BDA locations.

Emergency telephone (E-TEL) and Administrative Telephone (A-TEL) service will be determined by Operations, Fire Life Safety and Security design criteria. It is anticipated that telephone equipment will be stored inside 4'x4'x2' NEMA enclosures placed at points to be designed by facilities and safety management design teams.

At the tunnel portals 20'x15' fenced in and graded space will be required for antenna poles or self supporting towers next to the building. Antenna heights will be dependent on terrain and coverage studies to be conducted. Two rack spaces (2'x2'x8') plus wall mounted NEMA enclosure 4'x4'x2' for Fiber and Coax distribution in a secure building facility will be required.

#### 3.13.2 Proposed Site Equipment

- Ethernet aggregation and access switches
- Power supply and battery backup UPS
- Voice-over-IP gateway for E-TEL
- E-Tel boxes (may be wall mounted within easy reach of tunnel walkway)
- Bidirectional Distribution Amplifiers (BDA) rack
- Radiating coax terminating panels
- Fiber terminal equipment (for radio-over-fiber)

#### 3.14 DIRECTIVE DRAWINGS

Refer to Drawing 3.4.2-E "Typical Tunnel Communications Space Plan"

#### 3.15 MULTIMODAL SITES

In the case of multimodal stations owned and operated by the Authority is it assumed that tenants must provide their own equipment rooms separate and secure from CHST. Spacing planning and access control for these areas shall be the responsibility of the tenant.

Where CHSTA leases space in a building owned and operated by another authority, this document covers only the CTS space required by CHST in that building. In all cases, except as noted, CHST communications space requirements will be developed independently of the needs of any other authority.

## 4.0 SUMMARY AND RECOMMENDATIONS

Train Control Communications Rooms will be required at OCC, any Remote OCC (if provide ), Passenger Stations, Train Yard, Traction Power facilities, Train Control and Communications Houses, Tunnels and other locations to be determined by radio system planning and simulation. The following matrix summarizes the communications space allocations.

### 4.1 COMMUNICATION SITE EQUIPMENT PLANNING MATRIX

Site Location	Equipment Location	Space Allowance	Provisioning
OCC	Master Control Room	TBD	See relevant Operations and Facilities Technical Memo
OCC	TCC Room (TCCR)	45' x 45' TCCR Room 2000 sq. ft.	110/220Vac 600A utility power, UPS, HVAC, waterless fire suppression, security.
Typical Passenger Station	TCC Room	24' x 24' TCCR Approx. 600 sq. ft.	110/220Vac 300A utility power, UPS, HVAC, waterless fire suppression, security
Terminal Passenger Station	TCC Room	30' x 30 TCC Room 900 sq. ft.	110/220Vac 400A utility power, 600A UPS, HVAC, waterless fire suppression, security
Traction Power Substations	Communications Interface Cabinet (CIC)	4'x8' cabinet 140 sf. total working space	110/220Vac utility power, UPS, HVAC, waterless fire suppression, security
TCC Houses	Communications Interface Cabinet (CIC)	4'x6' cabinet 140 sf. total working space	110/220Vac utility power, UPS, HVAC, waterless fire suppression, security
Wireless Communication System Shelters	At Paralleling Stations. Exact location TBD based on RF coverage	24" x 12" plus 8'x6' space for auxiliary transformer and associated panels and breakers.	Grading, drainage, access road, 110/220Vac utility power UPS, HVAC, concrete slab, drainage access roads, security fence
Standalone Wayside Communications Shelters	Where required for optical signal regeneration.	12' x 8'	Power from OCS, battery backup solar, wind or nearest utility. Spacing planning shall include auxiliary transformer for 480 V feed from nearest utility or TPF.
Monopole Antenna Slab	At each Wayside Communications Shelter	6 ft. to 8 ft. in diameter	Diameter depends on soil type.
Tunnel Communication Areas CICs	Two per tunnel near portals. Four total for twin tunnel design.	8x10' area 250 sf. working footprint	110/220Vac utility power, UPS, HVAC, waterless fire suppression, security

Tunnel Portals (outside)	Two per tunnel complex	25' x 35' fenced in area for 100 ft. pole mounted antenna	Grading, drainage, access road, 110/220Vac utility power UPS, HVAC, concrete slab, drainage access roads, security fence.
Tunnel Areas (inside)	NEMA enclosures at approximately every 3000 feet mounted on both sides of each twin tunnel.	4'x4'x2'. (estimated)	110/220Vac utility power, UPS, and conduit.
Maintenance Yard	Yard Wi-Fi cabinets: location TBD based on RF coverage	4'x 4' outdoor cabinet	110/220Vac utility power, UPS, HVAC, underground conduit, drainage, concrete slab, security fence.
Maintenance Facility Com Room	Indoor TBD	8' x 6' area walled or secured area	May be part of Maintenance area TCC Room. 110/220Vac utility power, UPS, HVAC, waterless fire suppression, access security.

1. Space planning and coordination with architectural, mechanical and civil design teams will be required to provision the necessary power, HVAC, conduit trenching and indoor cable raceways, cable risers and intra-building conduit layouts.
2. Not part of our 30% Architectural design will need to accommodate the ingress of underground fiber optic cable conduit and radio antenna transmission lines in sites with wireless nodes and will need to accommodate ceiling heights to provide space for overhead cable ladders and cable trays.
3. Coordination will be required with electrical disciplines to provide the necessary commercial power, panels, bonding and grounding elements to support the communications equipment. UPS power load for both charger and battery will require input from communications system design.
4. Coordination will be required from communications design with the mechanical engineering groups to size HVAC to accommodate power dissipation from the optical/electrical equipment and to assure proper air flow and temperature stability.
5. Contractors will be required to construct trenches and underground conduit pathways for fiber optic cable carrying communications and train control information. Below-grade grid for grounding optical network and radio communication systems will be needed. Excavation, drainage, access roads, and fencing will be required for all wireless communication system shelters
6. The communications design team will be required, but not necessarily be limited to, providing the following design information:
  - Size and location of underground conduit (WAN backbone and fiber optic drops)
  - Size and location of intra-building conduit (i.e. LAN)
  - Power and current requirements for AC commercial service and panels
  - Communications system load current and time availability for UPS battery backup design
  - Equipment heat load and air flow requirements
  - Space requirement for racks and overhead cabling
  - Location and placement of radio antenna for WLAN system
  - Location and placement of radio antenna for train-to-wayside system

## 5.0 SOURCE INFORMATION AND REFERENCES

### Federal Communications Commission [FCC]

CFR 47 CFR, Part 90 – Private Land Mobile Radio

CFR 47 CFR, Part 15 – Class A Devices

### Americans with Disabilities Act

28 CFR Part 35, Title II Technical Assistance Manual

28 CFR Part 36, Title III Standards of Accessible Design

49 CFR Part 37, Transport Services for Individuals with Disabilities

### Institute of Electrical and Electronics Engineers

802.3af: Power over Ethernet

### Electronic Industries Association and Telecommunications Industry Association (EIA/TIA).

EIA 472, Generic Specifications for Fiber-optic cable.

EIA RS-310, Racks, Panels, and Associated Equipment.

EIA/TIA-598, Optical Fiber Cable Color Coding.

EIA/TIA-310-D - Racks, Panels, and Associated Equipment.

EIA/TIA-4750000B - Generic Specifications for Fiber Optic Connectors.

TIA/EIA 568-B – Commercial Building Telecommunications Cabling Standard.

TIA/EIA 569 – Commercial Building Standard for Telecommunications Pathways and Spaces.

### National Fire Protection Association

NFPA 70

NFPA 101

### Underwriter Laboratories Inc. (UL) Publications

UL 910: Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air

UL 1581 Reference Standard for Electrical Wires, Cables and Flexible Cords

UL 1778 Uninterruptible Power Supply Equipment

## 6.0 DESIGN MANUAL CRITERIA

### 6.1 COMMUNICATION SITE EQUIPMENT PLANNING MATRIX

Site Location	Equipment Location	Space Allowance	Provisioning
OCC	Master Control Room	TBD	See relevant Operations and Facilities Technical Memo
OCC	TCC Room (TCCR)	45' x 45' TCCR Room 2000 sq. ft.	110/220Vac 600A utility power, UPS, HVAC, waterless fire suppression, security.
Typical Passenger Station	TCC Room	24' x 24' TCCR Approx. 600 sq. ft.	110/220Vac 300A utility power, UPS, HVAC, waterless fire suppression, security
Terminal Passenger Station	TCC Room	30' x 30' TCC Room 900 sq. ft.	110/220Vac 400A utility power, 600A UPS, HVAC, waterless fire suppression, security
Traction Power Substations	Communications Interface Cabinet (CIC)	4'x8' cabinet 140 sf. total working space	110/220Vac utility power, UPS, HVAC, waterless fire suppression, security
TCC Houses	Communications Interface Cabinet (CIC)	4'x6' cabinet 140 sf. total working space	110/220Vac utility power, UPS, HVAC, waterless fire suppression, security
Wireless Communication Shelters	At Paralleling Stations. Exact location TBD based on RF coverage	24" x 12" 24" x 12" plus 8'x6' space for auxiliary transformer and associated panels and breakers.	Grading, drainage, access road, 110/220Vac utility power UPS, HVAC, concrete slab, drainage access roads, security fence
Standalone Wayside Communications Shelters	Where required for optical signal regeneration.	8' x 12'	Power from OCS, battery backup solar, wind or nearest utility. Spacing planning shall include auxiliary transformer for 480 V feed from nearest utility or TPF.
Monopole Antenna Slab	At each Wayside Communications Shelter	6 ft. to 8 ft. in diameter	Diameter depends on soil type.
Tunnel Communication Areas CICs	Two per tunnel near portals. Four total for twin tunnel design.	8x10' area 250 sf. working footprint	110/220Vac utility power, UPS, HVAC, waterless fire suppression, security
Tunnel Portals (outside)	Two per tunnel complex	25' x 35' fenced in area for 100 ft. pole mounted antenna	Grading, drainage, access road, 110/220Vac utility power UPS, HVAC, concrete slab, drainage access roads, security fence.

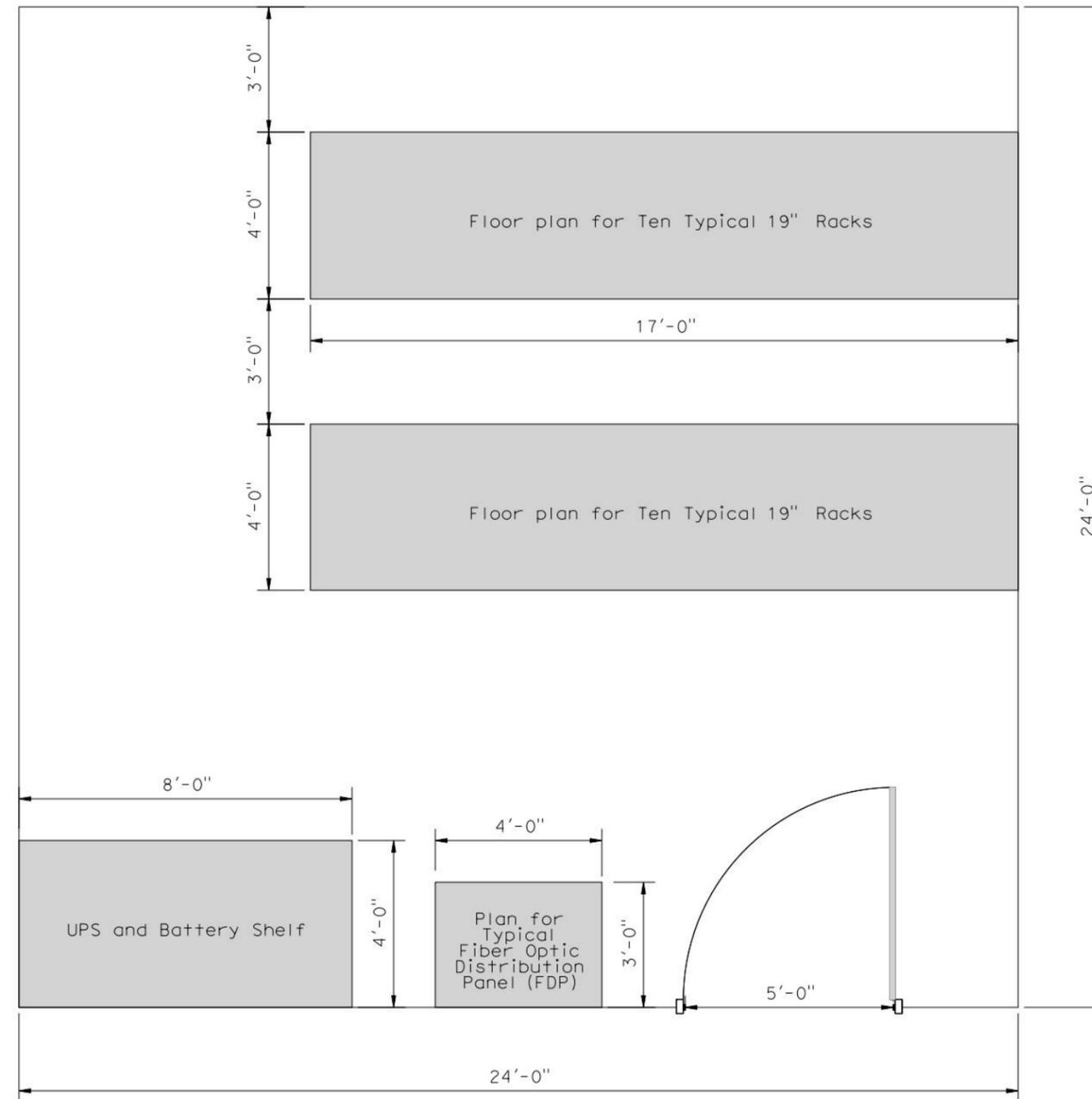
Tunnel Areas (inside)	NEMA enclosures at approximately every 3000 feet mounted on both sides of each twin tunnel.	4'x4'x2'. (estimated)	110/220Vac utility power, UPS, and conduit.
Maintenance Yard	Yard Wi-Fi cabinets: location TBD based on RF coverage	4'x 4' outdoor cabinet	110/220Vac utility power, UPS, HVAC, underground conduit, drainage, concrete slab, security fence.
Maintenance Facility Com Room	Indoor TBD	8' x 6' area walled or secured area	May be part of Maintenance area TCC Room. 110/220Vac utility power, UPS, HVAC, waterless fire suppression, access security.

## 6.2 COORDINATION AND INTERFACE ACTIVITIES

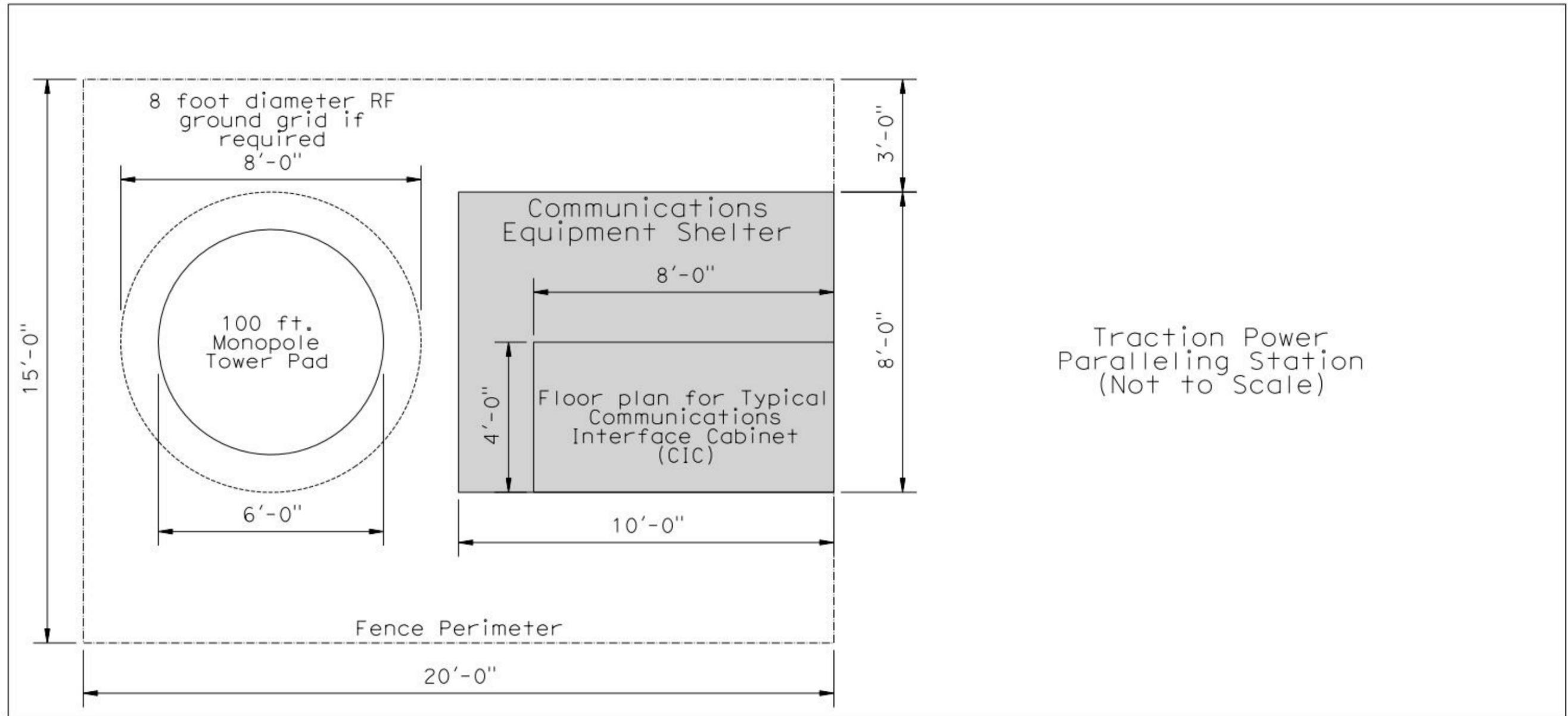
1. Space planning and coordination with architectural, mechanical and civil design teams will be required to provision the necessary power, HVAC, conduit trenching and indoor cable raceways, cable risers and intra-building conduit layouts.
2. Communication design team will require planning and coordination with security and safety teams for the siting of CCTV surveillance cameras.
3. Architectural design will need to accommodate the ingress of underground fiber optic cable conduit and radio antenna transmission lines in sites with wireless nodes and will need to accommodate ceiling heights to provide space for overhead cable ladders and cable trays.
4. Coordination will be required with electrical disciplines to provide the necessary commercial power, panels, bonding and grounding elements to support the communications equipment. UPS power load for both charger and battery will require input from communications system design.
5. Coordination will be required from communications design with the mechanical engineering groups to size HVAC to accommodate power dissipation from the optical/electrical equipment and to assure proper air flow and temperature stability.
6. Civil engineering will be required to construct trenches and underground conduit pathways for fiber optic cable carrying communications and train control information. Below-grade grid for grounding optical network and radio communication systems will be needed. Excavation, drainage, access roads and fencing will be required for all wireless communications shelters
7. The communications design team will be required, but not necessarily be limited to, providing the following information as part of the Communications Systems Design Criteria.
  - Size and location of underground conduit (WAN backbone and fiber optic drops)
  - Size and location of intra-building conduit (i.e. LAN)
  - Power and current requirements for AC commercial service and panels
  - Communications system load current and time availability for UPS battery backup design
  - Equipment heat load and air flow requirements
  - Space requirement for racks and overhead cabling
  - Location and placement of radio antenna for WLAN system
  - Location and placement of radio antenna for train-to-wayside system

## APPENDIX – DIRECTIVE DRAWINGS

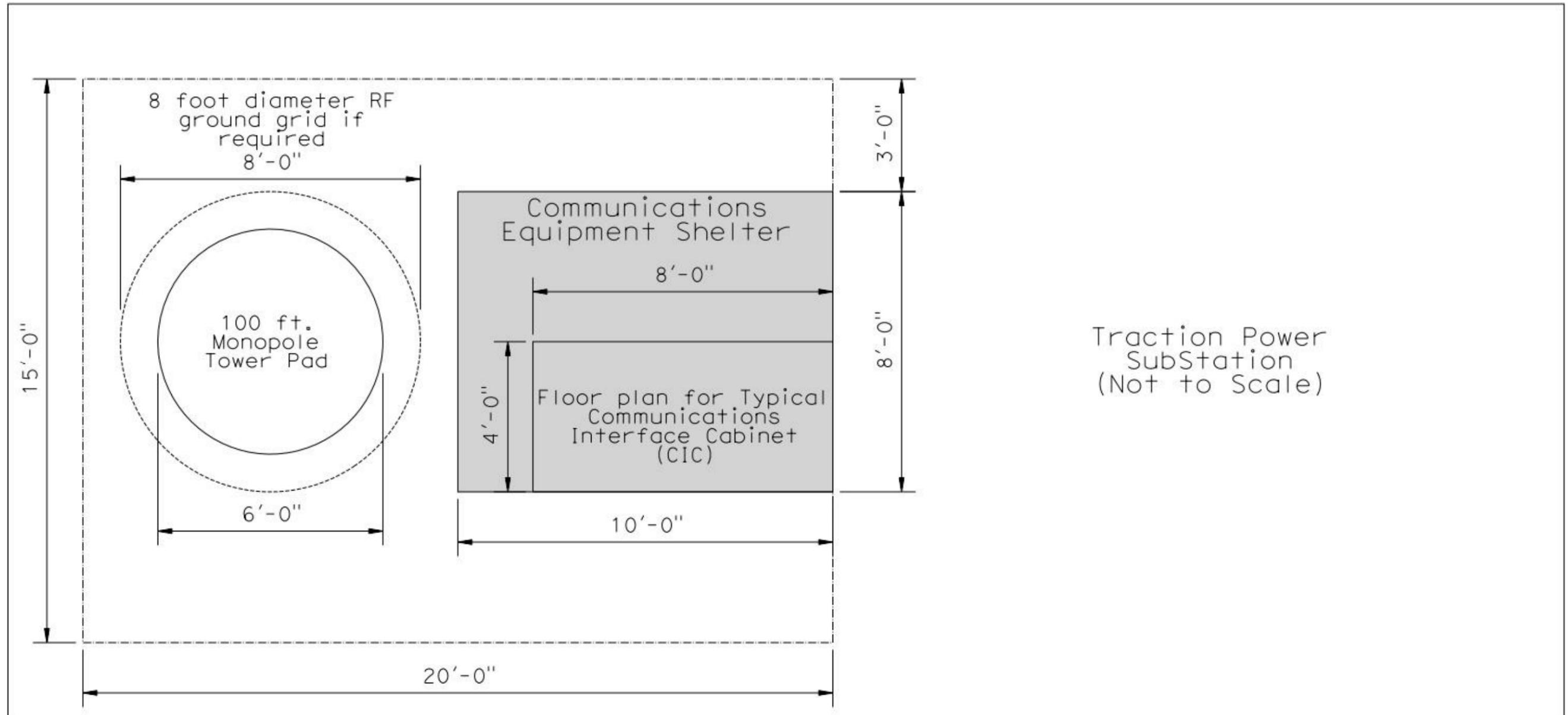
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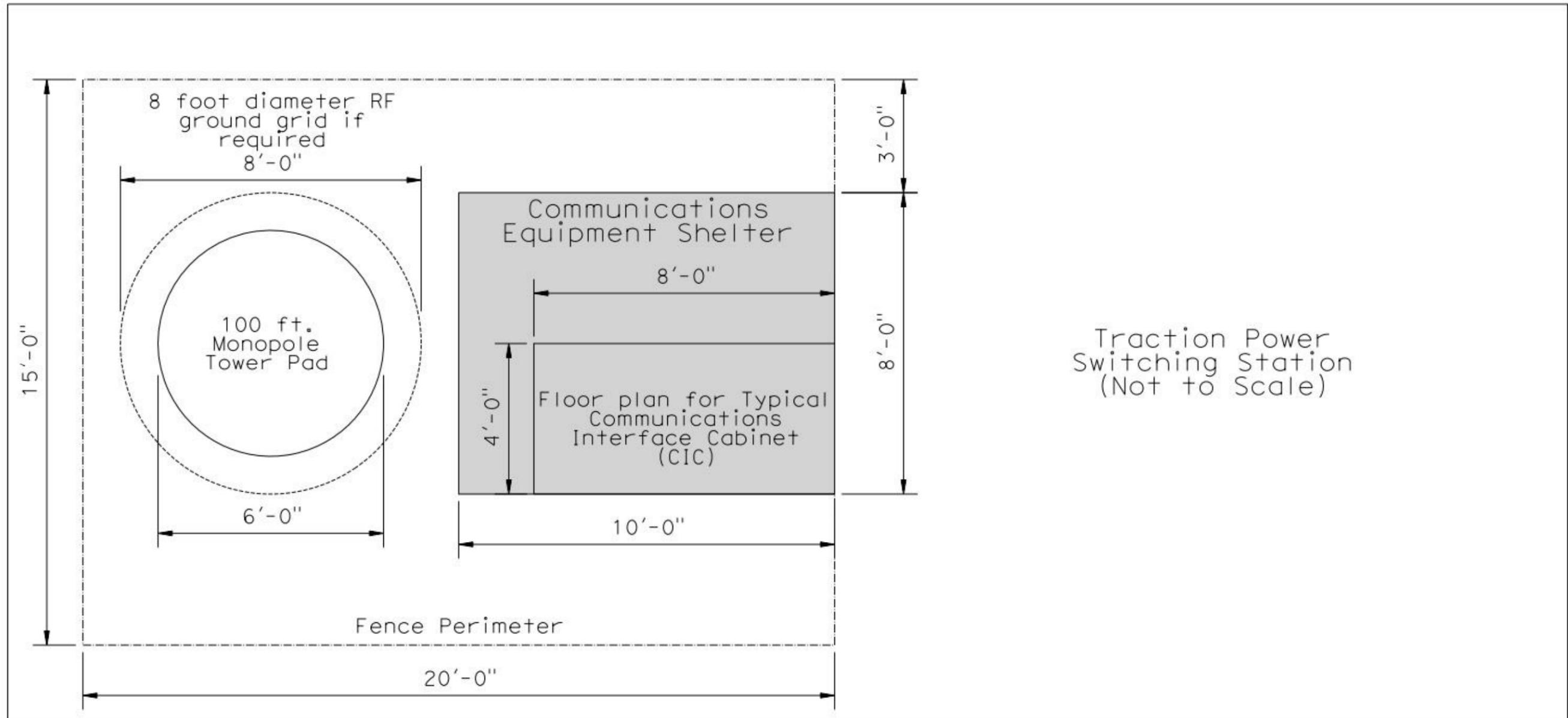
**Directive Drawing 3.4.2 – A - Typical Passenger Station TCCR Space Plan**



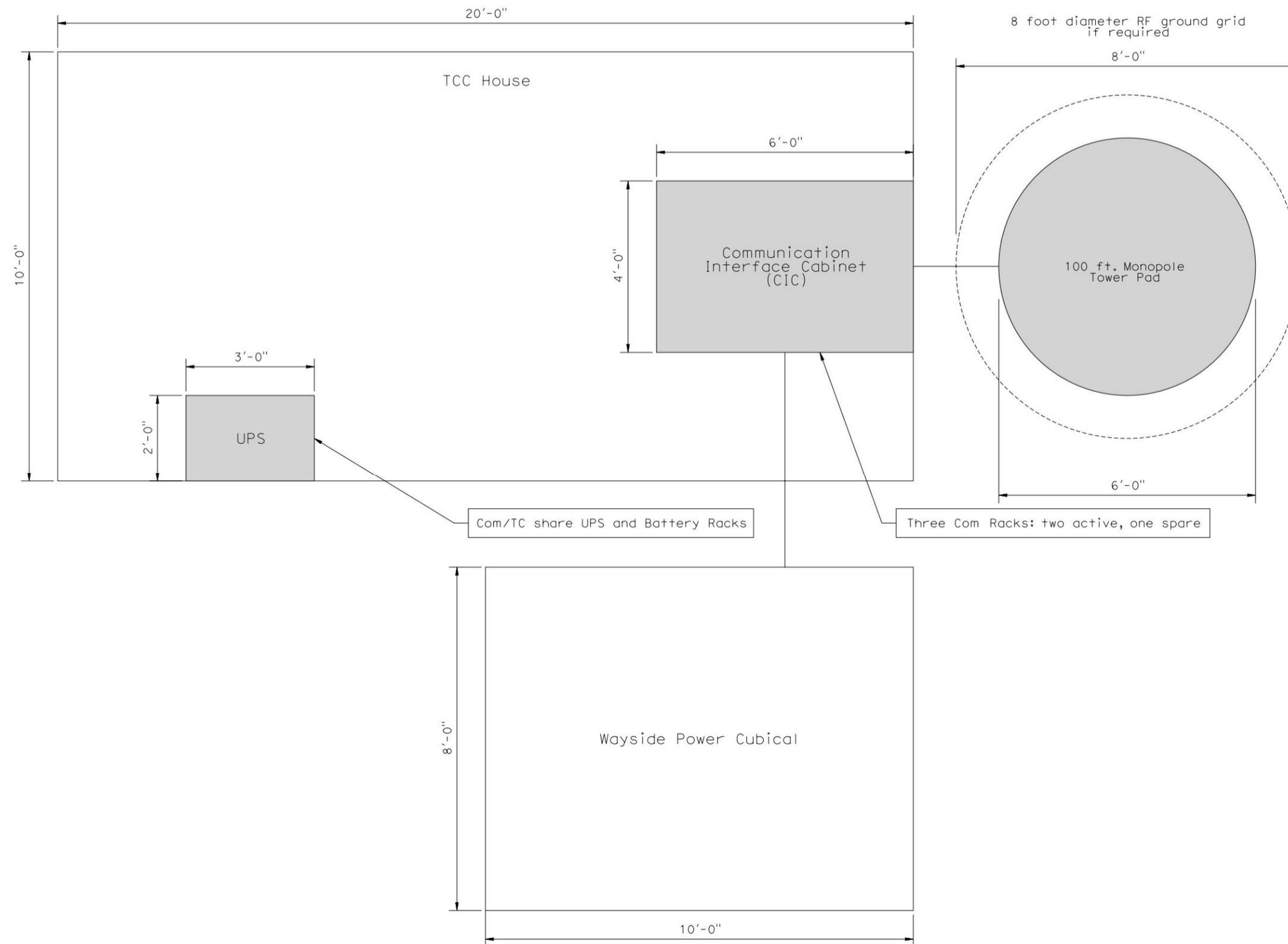
**Directive Drawing 3.4.2 – B - Typical Traction Power Facility Communication Space Plan – Paralleling Section**



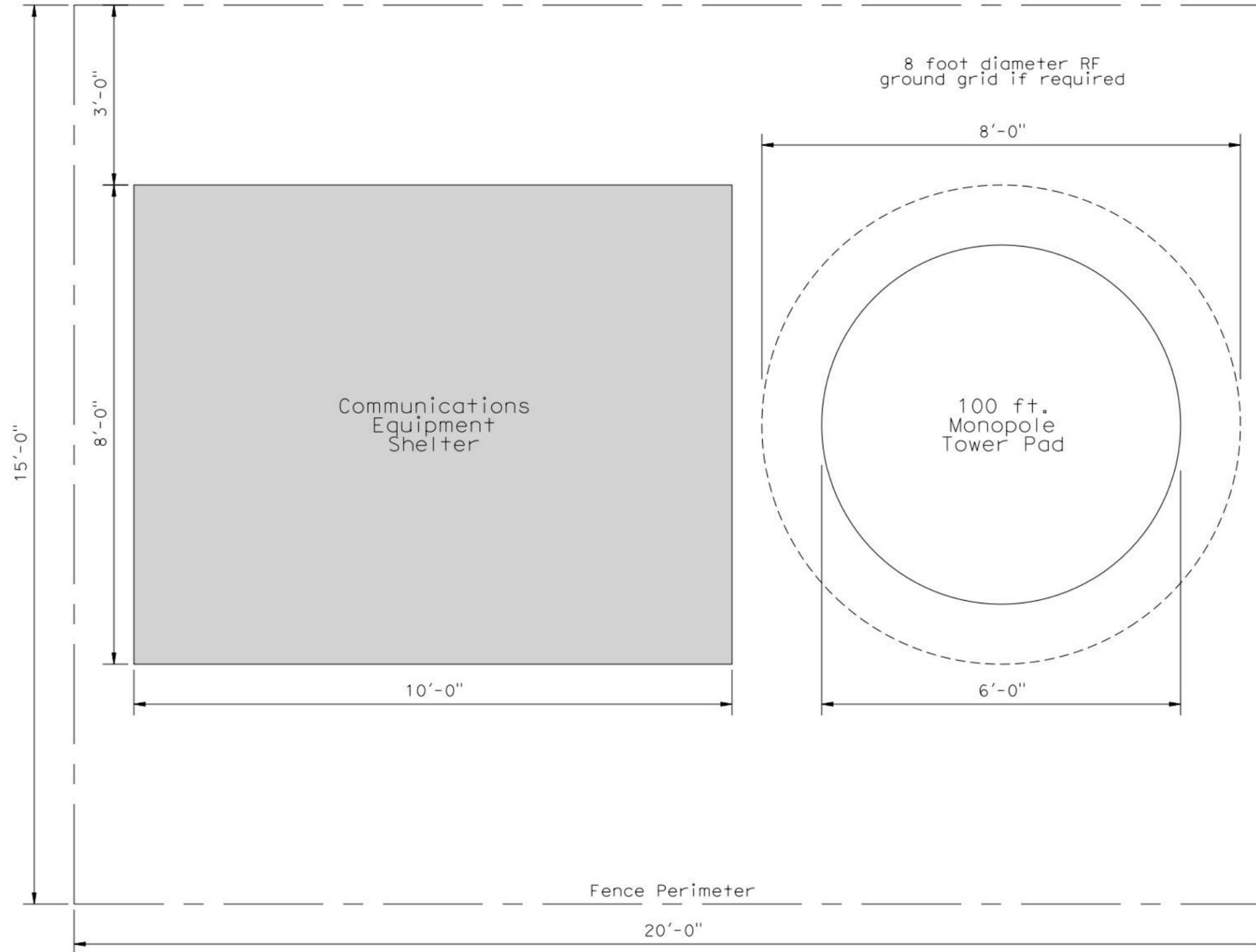
Directive Drawing 3.4.2 – B - Typical Traction Power Facility Communication Space Plan -- Substation



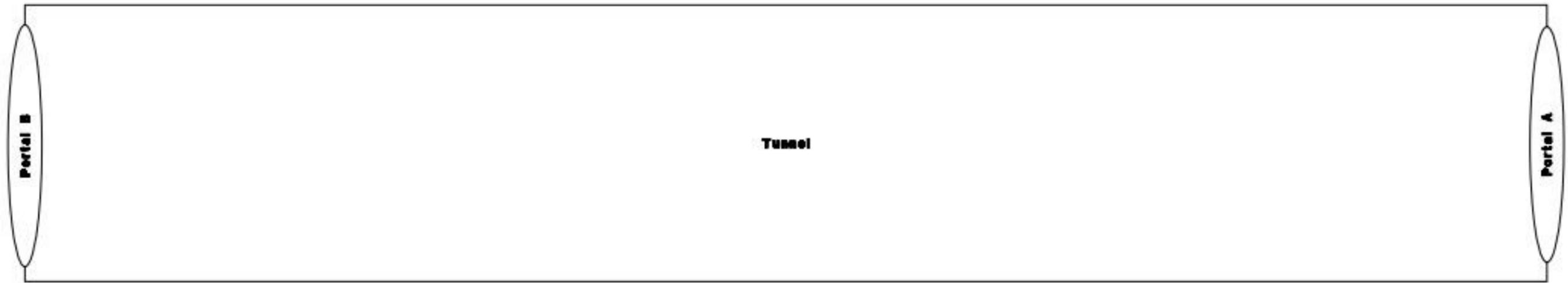
**Directive Drawing 3.4.2 – B - Typical Traction Power Facility Communication Space Plan - Switching Station**



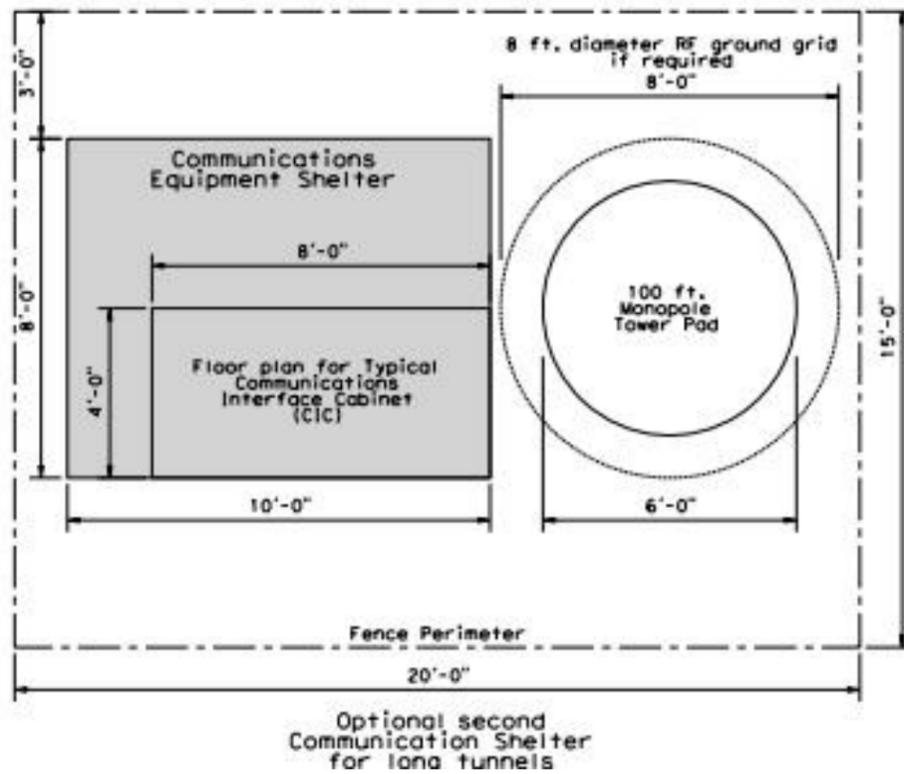
**Directive Drawing 3.4.2 – C - Typical Train Control House Communication Space Plan**



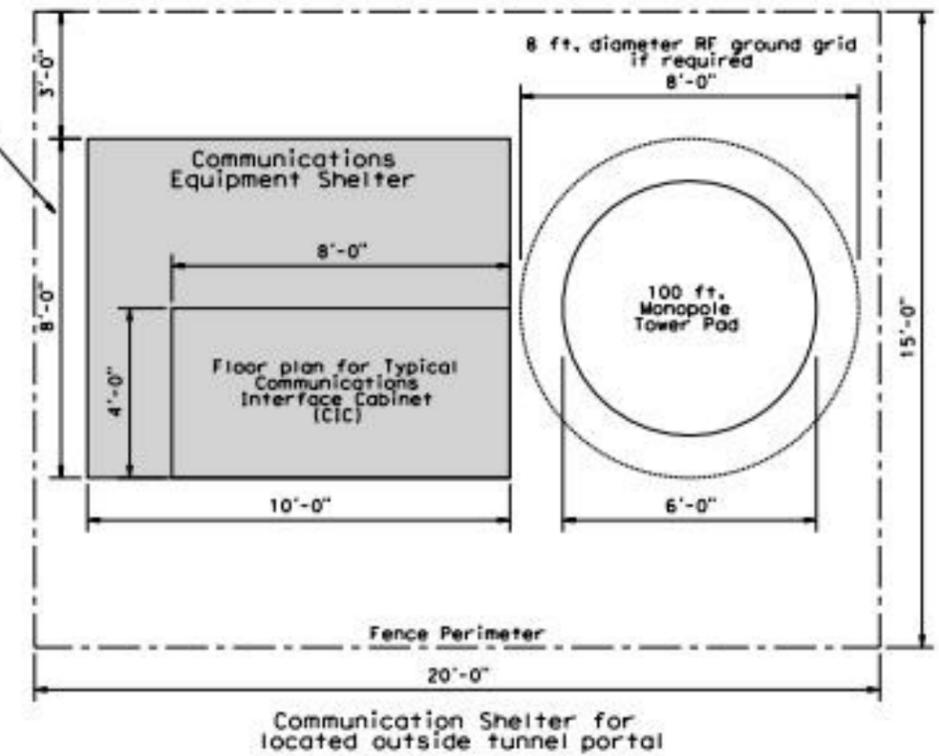
**Directive Drawing 3.4.2 – D - Typical Communication Shelter Space Plan**



**Notes:**  
Need for portal A & B will be dependent on length of tunnel.



- |                         |
|-------------------------|
| Communications POP      |
| RF communications equip |
| Ethernet access switch  |
| FO Distribution Panel   |
| USP and battery racks   |



Directive Drawing 3.4.2 – E - Typical Tunnel Communication Equipment Space Plan