CHAPTER

3

COMMUNICATION SITE BUILDING DESIGN AND INSTALLATION

This chapter provides requirements and recommendations for designing communications site buildings, including equipment shelters and outdoor cabinets. The following topics are discussed:

3.1 SITE CATEGORIES

The list below describes typical configurations that could comprise a communications equipment site. See Chapter 4, "External Grounding (Earthing)," for Type A and Type B for definitions and site grounding requirements.

- Modules within a single rack:

  Several frames of radio and support equipment within a general-purpose room, containing other telecom or broadcast equipment.

- Dedicated radio room within a new or existing building:

  Self-contained outdoor cabinets (land or rooftop), or semi/fully underground vaults. These are often used where zoning or site availability are issues, sometimes in conjunction with camouflaged towers or antennas.

- Pre-fabricated equipment shelter of concrete/fiberglass construction:

  The shelter may be installed at an existing tower site, a new tower site (green site) or on the roof of an existing building.

- A "shipping container" that has been outfitted as a self-contained radio site must meet strict dimensional requirements, including protrusions such as HVAC, RF entry assemblies, or AC entrances, and must conform to applicable shipping requirements.
- Renovation where an existing building or room is modified or retrofitted to accommodate a new communications system.
- A new "green site" on undeveloped land.

3.2 DEFINITIONS OF COMMUNICATIONS EQUIPMENT SITES

This manual defines and distinguishes various site types as described in Table 3-1.

TABLE 3-1 STANDARD DEFINITIONS OF COMMUNICATIONS EQUIPMENT SITES

Site Type	Description	Notes
Building	A permanent structure built on a foundation, containing communications equipment and related ancillary support systems, and which may contain other unrelated equipment and/or facilities. A building **shall** be suitable for human occupancy during equipment installation, maintenance, and use. A building typically does not have equipment or supporting systems (cable trays, antenna ports, etc.) installed before general installation.	Consists of dedicated site structures as well as interior installations such as shared commercial space in existing buildings, dispatch centers, central office installations, and other sites occupied, on a regular basis, by operations-related and possibly other personnel. **Example**: A dedicated dispatch center and communication equipment site within a dedicated, permanently occupied facility.

TABLE 3-1 STANDARD DEFINITIONS OF COMMUNICATIONS EQUIPMENT SITES (CONTINUED)

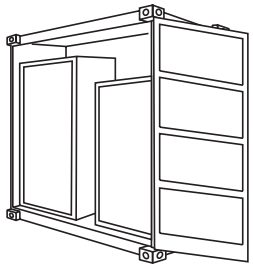
Site Type	Description	Notes
Shelter	A permanent structure built on a foundation that contains communications equipment and related ancillary support systems. A shelter **shall** be suitable for temporary or permanent human occupancy during equipment installation, maintenance, and use. **Example**: (See Figure 3-1.) A prefabricated building, usually located with a tower or rooftop antenna system, which houses equipment related only to over-the-air communications. The shelter supports personnel only on a limited basis for installation and maintenance functions; a dispatch center would be located elsewhere in this case.	Consists of smaller buildings or prefabricated shelters containing only equipment directly related to the function of the site. A shelter is intended for human occupancy only during equipment installation and maintenance. The Motorola Standard Building (MSB) is a predesigned all-inclusive self-contained equipment shelter.  **FIGURE 3-1** TYPICAL PRE-FABRICATED EQUIPMENT SHELTER
Cabinet/ Enclosure	An enclosure that houses communications equipment and ancillary systems only, designed such that equipment contained within can be accessed without the need for personnel to enter the cabinet. An enclosure is typically pre-wired and its equipment is pre-installed. **Example:** (See Figure 3-2 and Figure 3-4.) An unmanned, weather-tight enclosure.	A cabinet/enclosure can be installed indoors or outdoors, placed on a small foundation, or wall/pole mounted. A cabinet installed indoors uses the existing building environment (heat and air conditioning) to maintain temperature requirements. An outdoor cabinet contains its own environmental controls.  **FIGURE 3-2** METAL SHIPPING CONTAINER ENCLOSURE

TABLE 3-1 STANDARD DEFINITIONS OF COMMUNICATIONS EQUIPMENT SITES (CONTINUED)

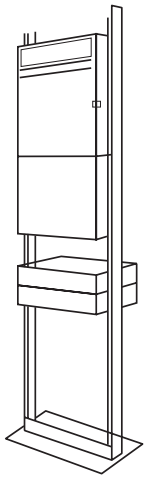
Site Type	Description	Notes
Vault	An enclosure that houses communications equipment and ancillary systems only and is fully or partially buried in soil. The vault supports personnel only on a limited basis for installation and maintenance functions. **Example:** Similar to a cabinet/enclosure, except the enclosure is buried below ground level.	Pre-fab shelters, cabinets, and vaults may have equipment fully or partially installed prior to building shipment, requiring additional building specifications to allow lifting with equipment installed. Weight and size must be considered if the site has limited access. For shipping, these structures must meet strict dimensional requirements, including protrusions such as HVAC, RF entry assemblies, or AC entrances. In the US, state certification may be required if pre-fab buildings are manufactured in a different state than deployed. (Similar requirements regarding out-of-state or province manufacture may also apply in non-domestic situations.)
Rack	A standard equipment rack used for supporting communications equipment to be installed in an existing Building or Shelter. **Example:** (See Figure 3-3) A radio rack installed in an existing building or shelter to provide an added function to the existing site. A standard rack is intended for indoor installation only in buildings or shelters.	 **FIGURE 3-3** TYPICAL EQUIPMENT RACK

FIGURE 3-4 TYPICAL OUTDOOR ENCLOSURE CABINET ON RAISED PLATFORM

3.3 BUILDING/SHELTER DESIGN AND LOCATION CONSIDERATIONS

Pre-fab buildings shelters, cabinets, and vaults may have equipment fully or partially installed prior to building shipment, requiring additional building specifications to allow lifting with equipment installed. Weight and size become a consideration if the site has limited access. For shipping, these structures must meet strict dimensional requirements, including protrusions such as HVAC, RF entry assemblies, or AC entrances. In the United States, state certification may be required if pre-fab buildings are manufactured in a different state than deployed. (Similar requirements regarding out-of-state or province manufacture may also apply in non-domestic situations.)

The following are general considerations regarding sites utilizing a new building or shelter capable of human occupancy.

- Consideration **shall** be given to the amount and type of equipment to be housed, along with adequate space for movement and expansion within the structure. The extent of equipment housed will typically determine the suitability of prefabricated structures (if desired). See Chapter 6, “Power Sources,” for electrical power sources and Chapter 9, “Equipment Installation,” for equipment installation.
- Equipment configuration typically dictates the structure design. The desired size and composition of a prefabricated shelter **shall** be considered along with weight in transporting the shelter to the site.
- All sites utilizing a constructed structure or a prefabricated structure with manned access **shall** utilize exterior lighting to some extent. See “Lighting” on page 3-22 for specific details on requirements for various categories of structures.

- Always consider not only the initial equipment loading of the site, but also future growth, which may double or triple the initial equipment and/or necessitate additional space at a site. This design should always include the shelter size, air conditioning, UPS, generator and electrical system.
- A “single point” grounding concept is required. This includes a single ground point located at all of the outside shelter or equipment room penetrations (RF, AC power and generator, GPS, tower light controllers, equipment and phone lines. This design will affect the overall equipment layout. DC power systems should also logically be located close to this ground point. Though this uses up some wall and floor space, it permits the systematic growth of communications equipment outward.

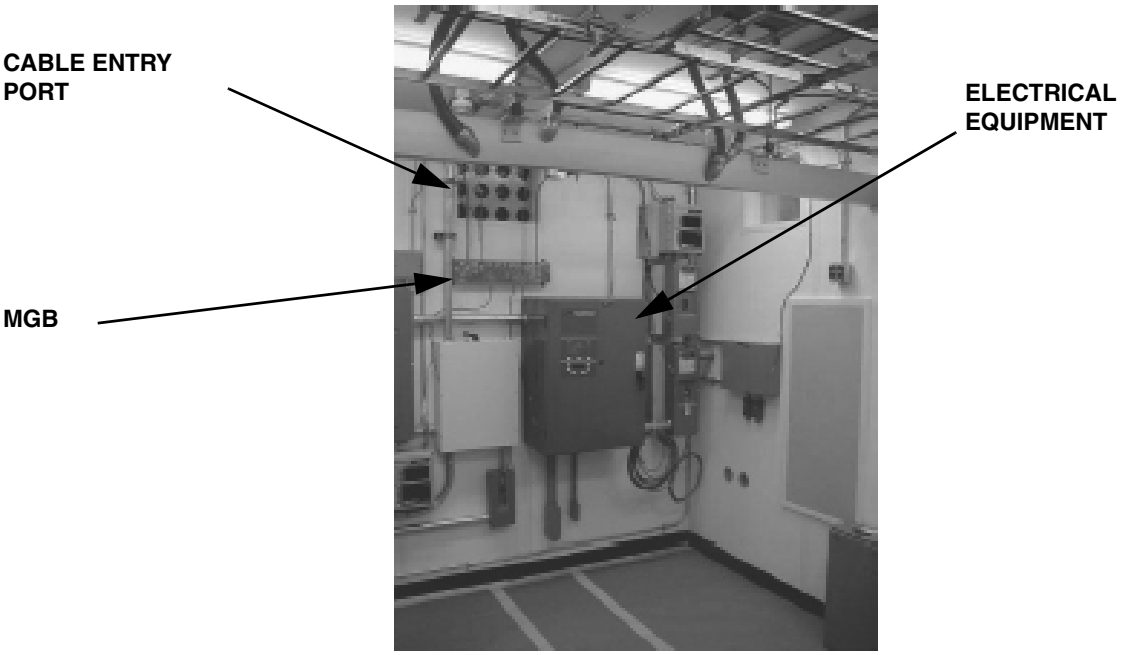


FIGURE 3-5 SINGLE-POINT GROUNDING AT ENTRY TO BUILDING

- Though not usually required for building foundations, some sites with unique soil conditions may require soil boring tests. Soil borings reveal the soil strength and water content, which are used to design a suitable foundation.
- In earthquake-prone areas (Moment Magnitude rating 3 or greater), foundation design and equipment anchoring **shall** address seismic requirements.
- Where high soil resistivity results in a poor grounding electrode system, see Chapter 4, “External Grounding (Earthing),” for information on using concrete encased electrodes (Ufer ground) as a supplemental ground.
- All buildings and shelters **shall** be designed or use features that prevent entry of animals and insects into the structure. Design should help discourage nesting of birds and small animals on exterior features of structure.
- Buildings may require compliance with human accessibility standards, such as Americans with Disabilities Act (or equivalent where required). These requirements must be considered during layout and procurement of facility.

- Buildings and shelters should utilize a locked chain-link fence where appropriate and appropriate deadbolt locks on standardized steel doors. Shelters and outdoor equipment cabinets **shall** be of the type designed for electronic equipment housing and accordingly fitted with locking doors.
- Buildings and shelters should utilize an alarm system capable of notifying a remote location of tampering, cable breakage, power outage, or system failure.
- When installing equipment racks, it is recommended that those located furthest from the access door be installed in the shelter first, so other equipment can be installed without having to fit it behind existing equipment.
- The current and reasonable future needs of the customer should be understood when considering available equipment enclosures. The customer should be made fully aware of the types of enclosures available.
- Shipping a prefabricated structure to a site may require special road use permits and/or special transportation methods (crane, double-length truck, helicopter, and so forth). Be sure the customer understands the shipping costs associated with a given building or shelter.

3.3.1 LOCATION CONSIDERATIONS

Sites should be selected for construction with the following consideration; cost, limited site preparation, environmental impact, public acceptance, accessibility, and future growth.

Rooftop shelters require a structural engineering analysis for both initial and final configurations. Verify that all portions of the access route to the installation site, including stairways and elevators, are also capable of supporting the weight of the enclosure. If the equipment must be lifted to the rooftop by a helicopter it will add significant cost to the project.

3.3.2 EQUIPMENT SHELTER OFF-LOADING

WARNING

To help prevent injury and/or damage to equipment, all appropriate safety precautions shall be taken during shelter off-loading.

The equipment shelter type determines the method and means by which it is off-loaded from the truck that transported it to the site. Typically, shelters require extensive rigging and a large hydraulic crane to off-load and set.

NOTE: It is required that all cranes be inspected and tested by crane operator personnel prior to any lift for Motorola related projects. Construction supervisory personnel **shall** insist that the crane operator demonstrate that the crane has been inspected. Any questions regarding this requirement **shall** be directed to the Motorola Project Manager.

3.3.3 SEISMIC CONSIDERATIONS

In seismically active regions appropriate seismic design factors must be incorporated into the building or shelter construction or layout. Site locations having a moment magnitude (MM) rating of 3.0 or greater require seismic design standards described below and in respective sections of this manual.

US seismic activity maps are available in Uniform Building Code, P. 194, Dia. 23-2, US Seismic Map. US maps and graphs are available on the following US Geological Survey (USGS) web pages:

http://neic.usgs.gov/neis/states/

Also, seismic information can be found using the search function provided on the USGS home page at:

http://www.usgs.gov

General seismic information can be found at:

http://geohazards.cr.usgs.gov

Also see IBC 2000, chapter 16 for seismic acceleration.

In general, observe the following considerations when designing to accommodate seismic risks of MM 3.0 or greater:

- A qualified architect **shall** be contracted to determine seismic structural needs for a specific location. Proper seismic design of a site helps ensure safety of personnel at the site should an earthquake occur.
- Shelters **shall** incorporate a steel door frame and a steel door for security and seismic integrity. In an earthquake a structure may deform, preventing doors from being opened from the inside. As most communication sites do not have windows, this becomes a serious issue for trapped occupants. Some concrete prefabricated shelter manufacturers also cross-brace the door frame area to prevent deformation during an earthquake.
- Only specifically designed seismic support hardware **shall** be used for seismic bracing.
- Seismic battery racks, seismic bracing and support, and seismic facility and antenna structure construction practices **shall** be employed in seismically active locations. Storage cabinets **shall** be closable and secured to walls.

3.4 FOUNDATION CONSIDERATIONS

- All foundation designs **shall** comply with the guidelines set forth in “Foundation Design and Installation” on page 2-11.
- The foundation **shall** be appropriate for the structure.
- If a site is to use concrete-encased grounding electrodes within the foundation or other concrete structures, appropriate measures **shall** be taken to accommodate the grounding system within a concrete structure before the concrete is poured. See “Concrete-Encased Electrodes” on page 4-20.
- A foundation for a prefabricated shelter **shall** be in accordance with manufacturer's specifications. Prefabricated building manufacturers usually provide typical foundation specifications for their particular model of building.
- A foundation for a cabinet **shall** be level and sealed.

- Design of foundation **shall** consider any special precipitation conditions unique to the installation locality. These considerations include, but are not limited to, elevated (pier type) platforms used in low-lying areas prone to regular flooding and elevated foundations to prevent burial of site due to snowfall. Special foundation designs include:
  - Footings
  - Piers
  - Columns

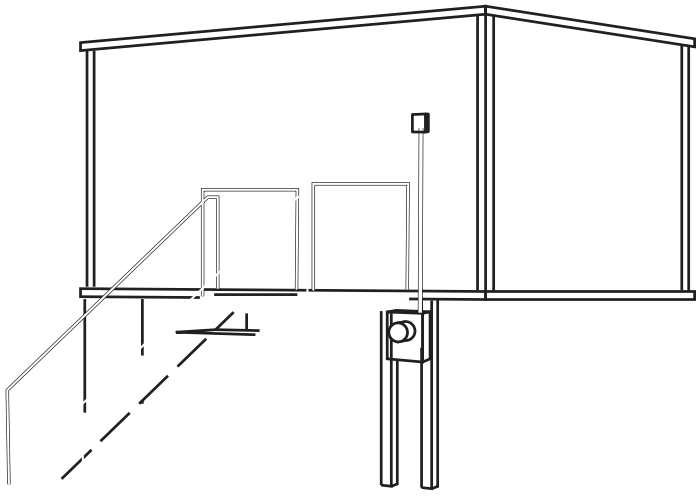


FIGURE 3-6 TYPICAL SHELTER MOUNTED ON ELEVATED PIERS

3.5 FLOOR LOADING

When determining equipment placement in an existing structure or when developing building specifications for an equipment shelter, attention **shall** be given to the Structural Live Load capacity of the building. Standard commercial construction specifications will, in most cases, provide substantial floor loading capacity. However, stacking and/or back-to-back placement of some equipment may exceed structural load limits. The weight and footprint dimensions of each piece of equipment to be installed **shall** be used to calculate floor loading.

The minimum floor loading standard for current Motorola manufactured equipment is 635 kPa (300 lb/ft^2 (PSF)). Calculations of the weight of the proposed equipment in PSF **shall** be compared to the rated load carrying capacity of the structure.

Battery configurations can sometimes be specified with feet, rails, or specialized load spreading devices that can facilitate deployments in high-rise structures. It is often necessary to specify a battery's location within a pre-fabricated shelter, such that if the building is staged (fully equipped and optimized) before shipment, the building has enough structural strength to be lifted and transported fully loaded.

Battery configurations with weight exceeding 300 lb/ft^2 **shall** utilize a specialized load spreading device for the battery rack. Remember to plan for expansion when calculating floor loading.

The civil engineering firm, contractor, or architect responsible for designing and/or constructing the site will need data relating to expected floor loading. Typically, the following initial information is required:

- Total weight of the equipment to be installed, determined by adding the individual weights of all electronic equipment, racks, and other ancillary support equipment to be installed.
- A diagram showing the amount, weight, and proposed location of the equipment planned for installation.

The engineering firm will determine whether the existing floor is adequate, and if not, how the floor can be reinforced to safely support the weight.

The distributed weight **shall not** exceed the rating of the existing floor and **shall** conform to jurisdictional building codes. If an engineering firm is designing the structure, ask their assistance in calculating floor loading.

Some of the practices used to distribute a Structural Live Load can prove to be counterproductive in an earthquake. For example, steel I-beams are sometimes used to support a modular shelter between parapet walls of a high rise building, where the roof itself could not handle the weight without costly retrofit. In an earthquake, the I-beams will flex to their limits with the moment of the shelter movement. This can all but destroy a shelter and its contents. Rooftop isolators attached between the roof surface and the I-beam supports can dampen the movement of the shelter, absorbing the energy of an earthquake.

3.6 CEILINGS AND FLOORS

For Tenant Improvements in existing high-rise buildings, it is critical that the contractor determine if post-tensioning is employed in floor, roof, or wall construction. If so, industrial X-ray mapping is required to avoid structural damage caused by accidental penetration of a tensioning cable.

3.6.1 CEILINGS

The following general considerations must be observed when designing a site building, selecting a prefabricated shelter, or installing equipment in an existing structure or room:

- Ceiling height **shall** conform to applicable jurisdictional building codes.
- Minimum acceptable ceiling height for communications sites utilizing 2.2 m racks (standard 7.5 ft. rack) are recommended to be 2.75 m (9 ft.).
- When adding equipment to existing sites, ensure that the ceiling is high enough to accommodate the planned additional equipment, including stacked cabinets.
- Determine the height of the tallest rack that could be deployed at a site, and then provide additional height to accommodate cabling, working room, and ventilation.
- Consider the size of the cable that might be attached to the top of the rack and that cable's bending radius. Typically the cable tray will be a minimum of 152.4 mm (6 in.) above the tallest rack or cabinet.
- The cable tray should be installed to provide at least 305 mm (12 in.) clearance between the cable tray and the ceiling (ANSI/TIA/EIA 569-B).
- In a site where the existing ceiling is too low to accommodate the specified clearances, the location of the cable tray may be moved to above the aisle behind the equipment row. Good site engineering practices must be considered, including accommodation of any electrical and working spaces.

3.6.2 FLOORS

Observe the following general considerations when designing a site building or selecting a prefabricated shelter:

- Floor construction **shall** conform to applicable jurisdictional building codes.
- Except for access flooring, floors should be constructed of concrete or wood. Normally if the building shelter floor is at ground level, the floor is concrete. If the building shelter is elevated from ground level, the floor is normally constructed of heavy duty floor joist and plywood or a Viroc composition.
- Concrete used as communications site flooring **shall** be properly mixed to ensure adequate tensile strength when under load.
- Concrete **shall** be poured and reinforced in accordance with applicable jurisdictional requirements. Where an earthquake-resistant structure is specified, additional considerations may apply.
- Floors **shall** be level before equipment is installed.
- If a wooden floor is to be used, ensure that the contractor's floor loading calculations take into account the type of equipment that will be installed, plus any future equipment. (See “Floor Loading” on page 3-9).

CAUTION

Equipment racks shall not be secured with screw lags into plywood alone.

- Floors **shall** be sealed to minimize the generation of airborne particulates. This is extremely important for a long equipment service life. Concrete and wooden floors may be finished using vinyl flooring. Concrete floors may also be sealed with an epoxy coating or equivalent (ANSI/TIA/EIA 569-B)
- Anti-static vinyl flooring is available for installations where equipment is vulnerable to electrostatic discharge (ESD). Care **shall** be taken when installing this type of flooring to ensure the integrity of the anti-static properties. Consult a contractor experienced with this type of flooring. See “Measures for Controlling Electrostatic Discharge” on page C-2 for proper grounding of anti-static flooring.

3.7 WEATHERPROOFING/SEALING

3.7.1 TRANSMISSION LINE ENTRY PORTS

Appropriate methods for entry of transmission lines into a building or shelter are as follows:

- An entry port specifically designed for cabling.
- PVC conduit, typically 102 mm or 127 mm (4 to 5 in.) diameter, allowing 50.8 mm (2 in.) protrusion at ends. If PVC is used, it **shall** be sealed using an appropriate all-weather silicone sealant between the conduit and the wall. The free space between the cables and the inside of the conduit should be packed with fiberglass insulation.
- Roof/wall feed-through.

In general, observe the following considerations for sites utilizing transmission line connections from an interior area to the exterior of a building or shelter:

- The entry of antenna transmission lines into a communications building or room requires a weatherproof, commercially made port assembly specifically designed for this purpose. These assemblies typically consist of a transmission line entry plate and boot assembly.
- A boot **shall** be used even if the cable is run through conduit. To avoid inconvenient rework in the future, it is recommended to select a transmission line entry plate with enough ports to accommodate the number of transmission lines at the site and allow for expansion.
- Entry plates should have 102 mm or 127 mm (4 or 5 in.) diameter openings. The plate is usually made of painted aluminum, with from one to 12 ports per plate. A single entry plate mounted on the outside wall or bulkhead is sufficient. See Figure 3-7.

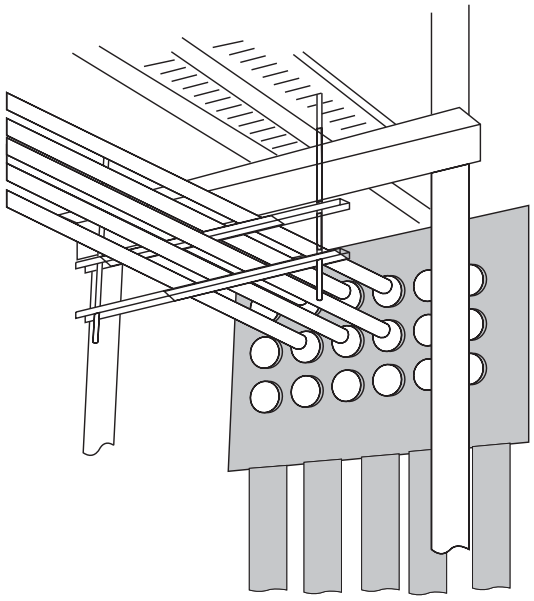


FIGURE 3-7 TYPICAL ENTRY PLATE

- Cable boots corresponding to the cable diameter(s) **shall** be used. Cable boots are sized for the transmission line they will carry and can be round, oval or rectangular. Some cable boots allow up to three small (12.7 or 22.2 mm (0.5 or 0.875 in.)) transmission lines to enter through one boot. The boot is usually made up of a two-piece cushion jacket, cushion (sized to cable diameter), and clamp set.
- To reduce heat loss from the building, two entry plates should be installed inside and outside, with rigid construction foam insulation between them. (Two sets of boots are then required.)
- The entry plate **shall** be installed per the manufacturer's instructions.
- The building/shelter and the port attachment to the building/shelter, **shall** be designed to prevent animals or birds from nesting in and around the entry ports.
- Transmission line entry ports **shall not** be used to feed through tower light power, building ground, or control cables.
- Boots **shall** be made of a material unaffected by ozone, sunlight, extreme heat, and cold.

- All unused ports in the entry plate **shall** be sealed with blank caps supplied by the port manufacturer.
- If a metallic port is used, it **shall** be bonded to the electrode grounding system. An integrated cable port **shall** be bonded to the external electrode grounding system.

3.7.2 SEALING OF BUILDINGS AND SHELTERS

To maintain optimum system performance and to avoid unnecessary HVAC costs, it is important to keep the communications site weather tight.

WARNING

Buildings and shelters that may have been open to the elements and animal infestations can pose health risks to personnel working in the structure. Avoid sweeping dry floors when rodent droppings may be present. Personnel occupying the site shall wash hands before eating and avoid touching mouth, nose, or eyes until site is sufficiently clean.

Animals and insects pose a threat to equipment and can cause health hazards to personnel. Accumulated rodent droppings can harbor hantavirus and other diseases. Hantaviruses are deadly airborne viruses spread by rodents. This threat **shall** be considered even more significant at remote sites in rural areas. Hantavirus infection can prove fatal in a few days without aggressive medical treatment. The best way to prevent hantavirus infection at a site facility is to assure that all site facility exterior openings are sealed. Floors in site facilities in rural locations should never be swept clean, but should be wet mopped to prevent airborne hantavirus contamination. A good practice when working at remote sites is to wash hands frequently and avoid touching your mouth and nose. To prevent the spread of disease and to prevent damage to equipment caused by nesting wildlife, observe the following requirements:

- All site buildings **shall** be weather tight and **shall** deter entry by animals, birds, and insects.
- If rodents are present within a site building or enclosure, the affected area **shall** be appropriately cleaned in a manner that is safe to personnel. Appropriate preventive measures **shall** be taken to remove and prevent further infestations. To prevent hantavirus infection, the floor **shall** be mopped in a safe and sanitary manner using a 5:1 water/bleach mixture.

For additional information on controlling the spread of hantaviruses, see the Centers for Disease Control website:

http://www.cdc.gov/ncidod/diseases/hanta/hps/

3.8 HEATING, VENTILATION, AND AIR CONDITIONING

One of the major considerations in site development is to maintain an environment in which the equipment can operate efficiently. A properly designed Heating, Ventilation, and Air Conditioning (HVAC) system provides the proper environmental conditions. Ambient temperatures inside the building or equipment room **shall** be maintained in a range within the specified requirements of each equipment. (All Motorola-manufactured products, as well as outsourced items that are drop-shipped per Motorola orders, have temperature, humidity, and cleanliness requirements, as listed in their respective manuals.)

Equipment manuals may specify either operating or ambient temperature. Operating temperature refers to temperature within the equipment case, with the equipment operating at a given capacity or load. Ambient temperature refers to the environmental temperature as typically measured 1.5 m (5 ft.) above the floor in the center of an adjacent aisle.

In lieu of manufacturer environmental standards, the site HVAC system **shall** be capable of maintaining interior conditions of 17.8º to 24º C (64º to 75º F) and reduce humidity to a level of 30 to 55% relative humidity (RH) (per ANSI/TIA/EIA-569-B or other applicable Standards body design requirements).

The variables involved in maintaining ambient temperatures include, but are not limited to, the following:

- Building construction
- Building size
- Type and amount of equipment installed at the site
- Ambient outside temperature
- Room size
- Number of entry ports (windows, doors, transmission line entry ports)
- Insulation
- Roof type (slope and construction material)
- Surrounding structures
- Use of a forced fresh air system
- Geographical location of the site

Design considerations should be made for equipment deployments and locations concerning operating limits of the equipment should the HVAC provisions fail. The facility backup generator **shall** be sized to accommodate the HVAC system.

With generator systems, a start-up delay kit is recommended on the HVAC system so that site AC power cycling or stand-by generator cut-over does not present a drop-out/brown-out condition which could stall and damage HVAC compressors.

The type and number of HVAC units required **shall** be calculated accurately. Due to the large number of variables involved, a single HVAC specification cannot be applied to all situations. Sizing of the HVAC system **shall** be performed by a HVAC engineering firm or the equipment shelter manufacturer's engineer.

3.8.1 HVAC DESIGN CONSIDERATIONS

The HVAC requirements for each site **shall** be evaluated on a site-by-site basis. It is advisable to include an expansion factor of at least 25% in the planning calculation, with consideration given to the final growth potential. With pre-fab buildings, provisions in the wall structure can sometimes be made such that another unit can be added in the field for additional growth.

Consider the following when working with the HVAC contractor to design the HVAC system:

- Obtain thermal loading for each piece of equipment from the appropriate engineering personnel and provide it to the building manufacturer HVAC engineering or HVAC contractor. Motorola System Planners typically provide heat generation information in BTU and Watts.

- Obtain site specifications for construction materials, insulation type and R values, size, existing conditions, and predicted growth.
- In areas with a history of Moment Magnitude rating 3 or greater, seismic considerations for the HVAC system **shall** be addressed by the HVAC engineering firm or contractor. Typically, additional flexible bracing can be provided to prevent HVAC equipment from tipping or shifting position. Flex hoses or semi-rigid hoses with strain relief should be provided to prevent mechanical stress failure.
- Only HVAC equipment that uses chlorofluorocarbon-free (CFC-free) coolant **shall** be used for new installations.
- It is recommended that the HVAC system be alarmed. If the site has an alarm system, each HVAC unit installed at a site **shall** be connected to the building alarm system, so that the total shutdown of any HVAC unit results in an alarm.
- HVAC filters must always be used and maintained on a regular schedule in order to maintain a clean environment and prevent dust and contaminants entering into electronic equipment.

3.8.1.1 WALL-MOUNTED HVAC UNITS

Observe the following general considerations for wall-mounted HVAC units:

- Self-contained wall mounted HVAC units are acceptable in most applications, but use care in selecting the proper unit size for the projected BTU heat load. If more than one unit is required, plan to provide sufficient wall mounting space.
- Only commercial-grade HVAC units **shall** be used. Consumer-grade household units or window-mounted units **shall not** be used.
- To reduce operating costs and prevent the compressors from freezing during cold weather, all units should be equipped with heating elements and an economizer which allows the site to be cooled by outside air if the outside temperature falls below a predetermined value.
- HVAC systems using outside air circulation features may not be suitable for environments having unusually high dust or particulate emissions.
- Redundant HVAC units **shall** be installed and available as a backup in case one unit fails or a single unit may be used if it is alarmed to a remote terminal. All redundant HVAC units should be designed in a lead-lag configuration to cycle with the primary unit in order to subject all units to equal wear.
- If two HVAC units are required to provide sufficient cooling, one additional unit should suffice for redundancy.
- Local fire codes may require an automatic shutdown circuit for HVAC units should the smoke/heat alarm activate.

3.8.1.2 EXHAUST FANS

- It is advisable to install a thermostatically-controlled exhaust fan at some sites, to remove excessive heat buildup if air conditioning units are disabled or fail.
- Locate the exhaust fan as high as possible in the structure to remove the maximum amount of heat.
- A corresponding filtered exterior cold air inlet vent with motorized louvers should be installed low on an opposing wall to allow unobstructed air flow through the site.
- The inlet of the fan **shall** be protected with a screen barrier to prevent the entry of insects, birds, or animals.

- To prevent excessive dirt and/or humidity from entering the building, the exhaust fan is intended to be used only as an emergency backup.
- Battery and generator rooms require special concerns regarding exhaust requirements. See “Battery Systems” on page 6-27 for additional information.
- Louvered entries into building or shelter may present a security risk due to ease of unauthorized entry through the louver assembly. This concern should be considered in the overall security plan for the site.
- Design of motorized louver systems **shall** comply with NFPA shutdown requirements. Exhaust fans and HVAC systems **shall** automatically shut down and the exterior wall vents automatically close during fire alarm activation and fire suppressant release. See NFPA 12 for additional information.

3.8.1.3 HEAT PUMPS

In sites where heat levels are too high for the use of wall-mounted units, commercial-grade heat pumps may be used. Appropriateness of using a heat pump system **shall** be determined by the contracted HVAC engineering firm or contractor. Heat pumps are also used in shared sites or where an exterior wall is not available for installation of a stand-alone HVAC unit. The compressor is separate from the control units and **shall** be mounted on either a pad on the roof of the structure or on a concrete pad outside the building.

Per NFPA 70-2005, Article 210.63, a 15- or 20- ampere-rated receptacle outlet is required for maintenance of the heat pump. A ground fault circuit interrupter (GFCI) receptacle is also required within 7.5 m (25 ft.) for maintenance. All units should be equipped with a start control option to avoid compressor damage during short power outages.

3.8.1.4 THERMOSTATS

Thermostats **shall** be installed in locations where room ambient temperature can be best and most evenly controlled. The placement and number of thermostats should be determined by the contracted HVAC engineering firm.

3.8.1.5 TEMPERATURE ALARM

To avoid down time and possible equipment damage due to temperature extremes, it is recommended that all sites be equipped with high and low temperature alarms. These alarms should interface with the site security system and be monitored around the clock. The sensors **shall** be accurate enough to detect temperature variations within the range of 5° to 33° C (40° to 90° F).

3.8.1.6 MAINTENANCE

It is recommended that the customer establish a preventive maintenance program with an authorized local HVAC service company to provide service and repair. The agreement should include periodic cleaning and filter replacement. The back-up HVAC unit should be periodically exercised, or alternatively, an equal-sharing duty cycle can be used.

3.9 SPECIAL CONSIDERATIONS FOR TELEPHONE CENTRAL OFFICES AND SWITCH ROOMS

The same building design requirements for general communications sites apply to switch room, iDEN Mobile Switching Office (MSO), major dispatch centers, or central office (CO) design, but on a more critical scale. For example, a CO may contain a cellular or Personal Communications Services (PCS) switch and/or centralized base station controllers. Good design is even more critical for a CO because the CO can be the overall controlling entity of an entire system, and thus can cause system-wide failure if there is a problem.

3.9.1 LIGHTNING DAMAGE PREVENTION

Although perhaps more costly, the most effective way of protecting the CO switch from lightning damage is to locate it separately from a communications site and accompanying tower at the same facility. Not only is the CO switch much more expensive to replace than typical communications equipment, but the entire system will fail if the CO switch fails. The initial extra cost of building a separate communications site at the CO location is far less expensive than revenues lost if the entire system fails due a damaged CO switch caused by a lightning strike to the radio tower.

3.9.2 POWER SOURCE PROTECTION

- Ideally, it is preferable to have separate, redundant power feeders from the power company serving the switch room. These should be fed from two different substations, so that the failure of one substation will not cut off power to the CO.
- Co-located business office function may also be considered with priority. Because most CO equipment is served by DC power systems, a large battery system, perhaps even in a redundant configuration, should be considered. This not only provides backup power in case of generator failure, it also provides a means of absorbing surges on the DC circuits that may occur if the site has to switch to generator power.
- Terminals communicating with the switch can be served by either individual UPS plants, or a centralized, overall system. This keeps switching transients from interrupting terminal operation.
- Surges transferred over the power lines during normal operation **shall** be drained by primary and secondary surge suppressors installed in a configuration that accommodates the generator circuits. See Chapter 7, “Surge Protective Devices.”
- It is recommended to have a CO, Dispatch center, etc. served by fiber optic T-1, T-3, OC-3, and higher capacities. This provides additional lightning protection by removing the copper connection from the phone company to the switch and provides optical isolation from ground potential rises (surges) that can occur on the copper connections.

3.9.3 CENTRAL OFFICE LAYOUT

When first installing equipment into a new large switch room, the equipment layout **shall** be planned to allow for sufficient aisle space, but be efficient so future expansion capacity is maximized. The initial layout should be designed to accommodate the absolute maximum number of equipment racks while allowing adequate space between aisles and at end of aisles.

Minimizing the overall distances of the DC power system and the grounding layout should be a priority.

The control room housing the switch terminals should be isolated from the rest of the equipment to provide noise reduction for those continually working in this environment. This room should also be configured as an Isolated Ground Zone (IGZ).

3.10 CABLE TRAYS

This section provides requirements and installation guidelines for cable trays. Cable trays should be used to support communications cabling within buildings and shelters.

Cable trays provide proper support of cables between cabinets, relay racks and bays of equipment and help maintain adequate separation between the cable groups. The orderly separation and support of cable also simplifies maintenance. Cable management over relay racks and equipment cabinets can be accomplished by utilizing cable tray systems. These tray systems are designed to provide support, routing, parallel separation and securing of wires and cables as defined in "Cabling Requirements for Cable Trays or Ladders" on page 9-14. As defined in NFPA 70-2005, Article 392, a cable tray or tray system is a unit or assembly of units or sections and associated fittings forming a rigid structural system used to securely fasten or support cables and raceways.

NOTE: Aluminum ladders designed for climbing **shall not** be used as cable trays.

3.10.1 CABLE TRAY SELECTION

Two types of overhead cable tray systems which are suitable for use as cable support are:

- Steel stringer style ladder
- Aluminum or steel ladder style cable tray

Steel stringer style ladders come in various designs and styles. Typically they are available in C-channel, tubular and solid bar in painted or yellow zinc dichromate finishes. Stringers are typically 38.1 mm (1.5 in.) to 51 mm (2 in.) in depth, and vary in length. Rungs should be spaced at least 229 mm (9 in.) apart. Simple hardware is used to make "T" and cross connections.

"J-bolts" (threaded, formed metal rods bent into a "J" shape) **shall not** be used as fasteners for cable trays. These rods typically deform when stressed, possibly allowing cable trays to drop. Captive hardware such as threaded bolt, washers, and nuts are recommended.

Aluminum or steel cable tray systems also come in various designs and styles such as ventilated trough, solid trough and ladder type with "I" beam or C-channel siderails. The most practical is the ladder type. The major difference between the stringer style ladders and tray systems is that a tray has a siderail or wall height from 102 mm (4 in.) to 178 mm (7 in.). This load depth may be desirable for large bundles of cables or transmission line routing. The siderail height affects overall rack to cable tray to ceiling dimension restrictions as outlined in this chapter. A rung spacing of 229 mm (9 in.) is also recommended for this tray type. This type of tray system requires prefabricated Ts, bends, crosses and reducers, which must be factored into the system design.

Both types of tray are available in widths ranging from 102 mm (4 in.) to 1.06 m (42 in.). Typically, widths of 457 mm (18 in.) and 610 mm (24 in.) are used. Stacking of 457 mm (18 in.) wide trays is allowed, but ceiling height requirements and clearances **shall** be adhered to. Cable support system design **shall** provide for maintaining a spacing of 457 mm (18 in.) between trays.

The overall sizes of cables, numbers of cable, and number of cable groups required in a run **shall** be considered when specifying tray width. Account for a minimum of 152.4 mm (6 in.) loss of width for cable group spacing in itself.

NOTE: In all cases the width of the cable tray **shall not** be less than 457 mm (18 in.) and is recommended to be 610 mm (24 in.).

3.10.2 CABLE MANAGEMENT UNDER RAISED FLOORS

NOTE: Do not mix aluminum and steel tray types at a facility installation.

For wire management under raised computer floors, a welded wire mesh cable tray system is recommended. This type of tray system can be mounted to, or suspended from, raised floor pedestals or sub flooring. This tray system typically consists of high strength steel wire in the form of a 50 x 100 mm (2 x 4 in.) mesh. The finishes can be electro-plated zinc galvanized or stainless steel that are suitable for all environments. Bends can be fashioned by cutting the mesh with a bolt cutting tool and simple hardware connections to the wire mesh. Manufacturers can supply bonding terminations and outboard ground cable supports for proper tray system grounding.

3.10.3 WIRE-MESH CABLE TRAYS

In general, observe the following considerations when in selecting cable trays. See “Cable Trays” on page 5-45 for proper cable tray grounding practices. All trays whether above racks or below raised floors require the same grounding practices.

- Noting the amount of cables to be supported by each run, cable tray width **shall** be selected to provide 50.8 mm (2 in.) minimum separation between cables or cable groups. 457 mm (18 in.) trays or double-deck ladders may have to used in some cases.
- Steel stringer and steel tray systems **shall** utilize an extended post to attached grounding conductors. This post should extend 102 mm (4 in.) to 152.4 mm (6 in.) either horizontally or vertically from the siderail of the tray, with no less than 457 mm (18 in.) of spacing between posts.
- If AC power cables are to be run in cable trays, cable separation and special considerations **shall** be maintained.
- The size, weight, and projected expansion of the system **shall** be considered to ensure proper tray usage. The “hang”' test **shall not** be used.
- The number and function of conductors to be placed within a cable tray **shall** be considered before procuring cable trays.
- It is recommended that only cable trays specifically designed for communications purposes be used (as opposed to standard electrical cable trays).

- A rung type cable tray may be more suitable in instances when only a single line of supports is available and cables can be laid in from a specific side.
- A solid bottom cable tray with a hinged cover may be desirable for use between a tower and building, to provide complete enclosure of the cables and minimize the potential for damage and vandalism. Unless specifically designed to also function as an ice bridge, a cable tray **shall not** be used instead of a standard ice bridge.

3.10.4 CABLE TRAY LAYOUT AND DESIGN

In general, the following considerations must be observed when preparing the layout of cable trays:

- If the building has a sprinkler system, ensure the cable trays do not block the sprinklers. Cable trays **shall not** be placed under smoke detectors or sprinkler heads.
- The cable tray system **shall** be designed to accommodate cable distribution throughout the equipment area. Continuity of the cable tray system and support for the cables **shall** be maintained.
- The cable tray system **shall** use the proper sections as designed by the manufacturer. Straight sections, elbows, tees, dropouts, and expansion connectors **shall** be used as required within the system.
- The cable tray system **shall** be designed with suitable strength and rigidity to provide adequate support for all contained wiring.
- Due to thermal contraction and expansion, cable tray systems may require the use of expansion connectors.
- Cable trays and troughs may extend through walls or floors providing the installation is made so that the possible spread of fire or products of combustion will not be substantially increased.
- Openings through fire resistant walls, partitions, floors, or ceilings **shall** be firestopped using an approved method to maintain the fire resistance rating.
- Cable tray systems **shall** be designed for installation at heights that provide clearances adequate to install the necessary equipment with provisions for expansion.
- Factors such as ceiling height, light fixture locations, cable entry ports, equipment location and minimum cable bending radius must be considered during design and layout.
- Cable trays should not be placed under lights or electrical fixtures or boxes.
- A minimum of 152.4 mm (6 in.) between the top of an equipment rack/cabinet and the bottom of the cable tray **shall** be maintained.
- A minimum of 305 mm (12 in.) above the top of the cable tray and the ceiling **shall** be maintained. The above two dimensions are required at all new sites. If at an existing site with a lower ceiling, good engineering practices are required
- When AC power distribution is to be combined with the cable tray system, the AC power raceway **shall not** be supported by or supported from the cable tray system unless the cable tray system is manufactured and approved for this purpose. The AC power raceway may be supported by a trapeze arrangement with the cable tray attached to the top of the trapeze and the AC power raceway attached to the bottom of the trapeze. The trapeze arrangement is supported from the ceiling and/or sidewalls.
- The entire system **shall** be rigid, immovable and properly secured in place. Manufacturer's specifications as well as the NFPA 70-2005, Article 392 and any other applicable national, state, jurisdictional, and local codes **shall** be followed.

3.10.5 CABLE TRAY INSTALLATION

Observe the following general considerations when installing cable trays:

- Cable trays **shall** be securely supported to the ceiling and/or wall such that they are immovable. These supports **shall** provide a strength and working load capacity sufficient to meet the load requirement of the cable tray system.
- Horizontal and vertical supports should provide an adequate bearing surface for the cable tray and should have provisions for hold-down clamps or fasteners. There may be additional requirements for active seismic areas (Moment Magnitude 3 or greater), such as wooden headers at wall connections. It is recommended in these cases that cable tray ends be attached to walls using a 50.8 mm x 102 mm (2 x 4 in.) wooden header. The header may be nailed along the wall approximately 305 mm (12 in.) below the ceiling. This provides a blunt attachment point which will prevent the somewhat sharp ends of cable trays from penetrating the walls. Seams between multiple cable tray sections run across a room should be staggered so that if a seam fails, the entire cable ladder system will not fail.
- A support **shall** be located within 610 mm (2 ft.) of each side of an expansion connector. Cable tray systems **shall not** be used as incidental support for other raceways or equipment.
- Cable trays **shall** be positioned such that they are easily accessible with sufficient space provided above and around the cable tray to permit adequate access for installation and maintenance of cables.
- Cable trays **shall not** have any sharp edges, burrs or projections that may damage cables.
- All cable tray sections **shall** be electrically bonded together by an approved method and connected to the building ground system. (See Figure 3-8.) See “Cable Trays” on page 5-45 for additional information. The cable tray system **shall** be grounded to the room single point ground position (MGB) only.
- Manufacturers' specifications relating to the installation of cable trays as well as NFPA 70-2005, Article 392 and any other applicable national, state, jurisdictional, and local codes **shall** be followed.

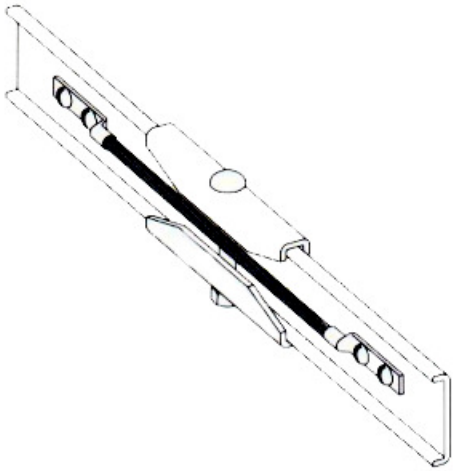


FIGURE 3-8 CABLE TRAY BONDING CONDUCTOR

3.10.6 CABLE TRAY SAFETY CONSIDERATIONS

Cable tray systems **shall not** be installed at heights or in positions that **shall** pose a hazard to service personnel working within the site.

At no time **shall** the cable tray system be used as an incidental support or walkway.

Threaded support rods **shall not** extend below the tray bottom further than the required fittings and **shall** include appropriate protective end caps.

3.11 LIGHTING

All lighting **shall** follow the applicable requirements of NFPA 70-2005, Article 410, and any other applicable national, state, jurisdictional, and local code requirements. Interior lighting requirements are based upon a number of considerations, including:

- Adequate lighting for a safe and efficient work environment. Placement should assure illumination behind tall rack cabinets.
- Energy efficient design
- Low heat generation characteristics
- Exterior lighting requirements are concerned with lighting for points of entry and exit from the building and for perimeter security.
- Lighting on remote sites can be seen for miles at night and in some cases, may cause objections from neighbors. To address these issues, on-demand systems such as infrared proximity sensors and twist-knob timers are highly recommended. Bright lights (including lights used on photocell controllers) can, in some cases, produce neighbor and environmentalist complaints.
- In all cases, incandescent or fluorescent lighting may be used.

3.11.1 GENERAL INTERIOR LIGHTING SPECIFICATIONS

In locations that are considered hazardous because the atmosphere does or may contain gas, vapor or dust in explosive quantities, special application fixtures **shall** be used. These fixtures **shall** be rated for use in Class I, II and III, Division 1 and classified areas. These fixtures **shall** comply with NFPA 70-2005, Articles 500 through 506.

In applications where fixtures are susceptible to dislodgment, or where tube breakage may represent a hazard to personnel or equipment, shatterproof fluorescent tubes or safety tubes **shall** be used. Seismic and industrial practices require that fluorescent lamp protectors be installed over lighting to prevent falling glass or accidental damage to lamps.

If incandescent lighting is used, industrial-grade protective covers **shall** be used.

3.11.2 INTERIOR LIGHTING QUALITY

Interior lighting **shall** produce a minimum of 500 Lux (50 foot-candles) measured 1 m (39.4 in.) above the finished floor in the middle of all aisles between cabinets or racks. See ANSI/TIA/EIA 569-B for additional information.

3.11.3 EMERGENCY INTERIOR LIGHTING

- Emergency backup lighting units **shall** be installed to activate immediately upon loss of all AC power in all equipment shelters and tenant improvement equipment rooms within a building.
- Each unit **shall** be equipped with a self-test button or switch.
- Each unit **shall** have a minimum of two lamps. Lamps may be sealed beam or tungsten halogen.
- Batteries **shall** be sealed, maintenance free, and provide a minimum of 90 minutes of emergency power.
- All emergency lights **shall** be UL approved and meet all OSHA, NFPA 101, and any other applicable national, state, jurisdictional, and local life safety code requirements.
- Emergency lights installed in harsh environments **shall** meet all requirements for NEMA 1, 2, 3, 3R, 3S, 4, 4X, and 12 ratings.
- The lights **shall** be located to illuminate any and all doorways and exits.
- Exits **shall** be labeled with illuminated signs reading EXIT. Pathways to exits **shall** be marked.
- Emergency lighting within high-rise buildings may require that it be powered from a house power source, and that the emergency lighting be connected to the house master alarm system.

3.11.4 EXTERIOR LIGHTING

- One exterior light **shall** be installed near the door to provide lighting for personnel entering and exiting an equipment shelter. The fixture **shall** be type NEMA 3, weather resistant and suitable for general outdoor application.
- If floodlights are installed to provide yard/perimeter security lighting, the following requirements **shall** be met:
  - UL approved Quartz and High Pressure Sodium lighting elements **shall** be used.
  - Mercury Vapor and Metal Halide lamps **shall not** be used. These lamps can cause serious skin burns and eye inflammation from short-wave ultraviolet radiation if the outer envelope of the lamp is broken or punctured.
  - An automatic photo-control switch, with a manual override, can be used to turn the lights on at dusk and off at dawn if desired.
  - Fixtures **shall** meet NEMA heavy duty type classification and be UL listed for use in wet locations.

3.12 FIRE PROTECTION/SAFETY

- The primary intent in suppressing a fire at a communication site is to protect lives. Equipment protection is secondary. If the fire is expected to be entirely suppressed by a manual extinguisher, then the suppression effort can be made, but in no circumstances **shall** fire suppression be attempted in order to save equipment when personnel safety is at risk. In all cases for occupied shared buildings, the fire department and tenants **shall** be notified immediately of the fire.
- Fire extinguishers can represent an important segment of any overall fire protection program. However, a proper fire suppression program success depends upon the following general conditions:

- The extinguishers are of the proper type and size for a fire that may occur.
- The extinguishers are properly located and identified.
- The extinguishers are in working order and properly maintained.
- Employees have a clear understanding of their functional operation.
- Safety awareness has been made available.

3.12.1 REFERENCE PUBLICATIONS

The following are suggested reference publications regarding fire suppression systems:

- NFPA Fire Code, Volume 1
- NFPA 10
- NFPA 12 Standard on CO_2 extinguishing systems
- NFPA 13 Standard for installation of sprinkler systems
- NFPA 17 Standard for Dry Chemical Extinguishing system
- NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems
- CAN4-S503-M83 Standard for CO_2 fire extinguishers
- CAN4-S504-77 Standard for Dry Chemical fire extinguishers
- ULC-S504-77 Standard for Dry Chemical fire extinguishers
- ANSI/UL 154 Standard for CO_2 fire extinguishers
- ANSI/UL 299 Standard for Dry Chemical extinguishers

3.12.2 TRAINING AND PROPER USAGE

Site personnel **shall** be familiar with the proper usage of the fire protection equipment provided at the site. Documentation supplied with the equipment **shall** be made available to personnel. Responsible personnel **shall** fully understand the content of such documentation.

More complicated systems, such as an installed automatic system, should be supported with training supplied by the vendor.

3.12.3 MINIMUM REQUIRED FIRE EXTINGUISHERS

All installations **shall** have a minimum of two correctly installed portable fire extinguishers on the premises before equipment is installed. At a minimum, the following size and classification of portable extinguishers are required:

- 9 kg (20 lb.), Class ABC, dry chemical extinguisher (for general fire fighting)
- 3.2 - 4.5 kg (7 - 10 lb.), Class BC, Carbon Dioxide (CO_2) extinguisher (for equipment fire fighting) or FE-36™ 4.54 kg (10 lb.)

Review the requirements of NFPA 10 or applicable jurisdictional/ local regulations to determine the need for additional extinguishers based on site size and special considerations. Depending on the size of the site building, additional extinguishers may be required.

3.12.4 REQUIRED STANDARDS FOR PORTABLE FIRE EXTINGUISHERS

Portable fire extinguishers **shall** be listed and labeled, meet or exceed all the requirements of the fire test standards, and meet the appropriate performance standards listed below.

- Fire Test Standards: ANSI/UL 711, CAN/ULC-S508-M90
- Performance Standards:
  - Carbon Dioxide Types: ANSI/UL 154, CAN/ULC-S503-M90
  - Dry Chemical Types: ANSI/UL 299, CAN/ULC-S504-M86
- In an electronic equipment enclosure or room, an FE-36 (or equivalent) or CO_2-type extinguisher is required. These extinguisher types minimize secondary damage caused by dry chemical agents used in most Class ABC extinguishers. The dry chemical agents contain very fine alkaline-based powders that can cause severe equipment damage due to corrosion. The potential for damage is not just limited to the involved equipment, but may affect all other electronic equipment in the enclosure. The dry chemical extinguishers can also obscure visibility in a closed room, making egress difficult. The dry chemical extinguisher should be considered as the second line of defense if the fire cannot be extinguished with an FE-36 or CO_2-type extinguishers.

3.12.5 FIRE EXTINGUISHER INSTALLATION

When installing fire extinguishers, the following requirements **shall** be observed:

- Portable fire extinguishers **shall** be maintained in a fully charged and operable condition, and stored in their designated places at all times when they are not being used.
- Fire extinguishers **shall** be conspicuously located where they are readily accessible and immediately available in the event of a fire. Preferably, extinguishers **shall** be located along normal paths of travel, including exits from areas.
- Fire extinguisher locations **shall** be clearly marked. Acceptable means of identifying the fire extinguisher locations include arrows, lights, signs, or coding of the wall or column.
- If more than one fire extinguisher is located in the same location and they are intended for different classes of fires, the intended use of each extinguisher **shall** be marked conspicuously to aid in the choice of the proper extinguisher at the time of a fire.
- Cabinets housing fire extinguishers **shall not** be locked.
- Fire extinguishers **shall not** be obstructed from view.
- Portable fire extinguishers (other than wheeled types) **shall** be securely installed in the hanger or in the bracket supplied or placed in cabinets or wall recesses. The hanger or bracket **shall** be securely and properly anchored to the mounting surface in accordance with the manufacturer's instructions.
- Fire extinguishers installed under conditions where they are subject to dislodgment **shall** be installed in brackets specifically designed to retain the extinguisher.

- Fire extinguishers having a gross weight not exceeding 18.14 kg (40 lb.) **shall** be installed so the top of the fire extinguisher is not more than 1.53 m (5 ft.) above the floor. Fire extinguishers having a gross weight greater than 18.14 kg (40 lb.) (excluding wheeled types) **shall** be so installed that the top of the fire extinguisher is not more than 1.07 m (3.5 ft.) above the floor. In no case **shall** the clearance between the bottom of the fire extinguisher and the floor be less than 102 mm (4 in.).
- Extinguisher operating instructions **shall** be located on the front of the extinguisher and be clearly visible. Hazardous materials identification systems (HMIS) labels, six-year maintenance labels, hydrotest labels, or other labels **shall not** be located or placed on the front of the extinguisher.
- Fire extinguisher mounted in cabinets or wall recesses **shall** be placed so that the fire extinguisher operating instructions face outward. The location of such extinguishers **shall** be conspicuously marked.

3.12.6 FIXED FIRE DETECTION, ALARM, AND SUPPRESSION SYSTEMS

WARNING

Fixed or portable fire suppression systems using water shall not be used in communication sites.

This section specifies minimum requirements for fire detection, alarm, and suppression systems. For additional requirements, see NFPA 12, NFPA 2001, and any other applicable national, state, jurisdictional, and local code requirements that may apply. Specifically, fixed systems comprise the following:

- Detection systems
- Alarm systems
- Automatic suppression systems

Any work involving installation of these systems **shall** be performed only by personnel skilled in this work (typically a contractor specializing in these systems). This section is provided to aid personnel charged with purchasing, inspecting, testing, approving, operating, and maintaining this equipment in their consultations with an appropriate, contracted fire protection engineering firm.

Some communications equipment systems include detectors and alarms that transmit to centralized control centers within the system itself. High-rise buildings often utilize a second dedicated facility alarm and can be included as part of a central alarm system connected to the local fire department.

3.12.6.1 AUTOMATIC FIRE DETECTION

Automatic fire detection **shall** be accomplished by any listed or approved method or device capable of detecting and indicating heat, flame, smoke, combustible vapors, or an abnormal condition in the controlled area that is likely to produce fire. On large installations the fire detection system **shall** consist of a combination ionization smoke detector and a rate compensated fixed temperature thermal detector. This type of two-loop detection system will provide a positive verification of a fire condition and the earliest possible pre-alarm notification. The detector units **shall** conform to UL 268 standards (or equivalent requirements for the site area). If the fire detection system is the type that shuts off power to the installation, battery operated emergency light sources **shall** be provided in the affected areas.

3.12.6.2 AUTOMATIC ALARMS

Automatic alarms or indicators (or both) indicate the operation of the system, hazards to occupants, or failure of any supervised device. The type (audible or visual), number, and location of these devices **shall** be such that their purpose is satisfactorily accomplished. As a minimum, the fire alarm system **shall** give an initial warning signal for evacuation of occupants and for confirmation of a fire condition. A secondary alarm system **shall** sound, indicating the automatic discharge of a fire-extinguishing agent. The system **shall** have a time delay function between the two warning signals which can be adjusted to provide adequate time for evacuation or abort procedures.

3.12.6.3 SITE ALARM SWITCH FORM

Site alarms are defined as any action, reaction, or determinations associated with diagnostics, security, or emergency. All equipment providing alarms will send alarms from the equipment utilizing dry-contact closures. The dry contact closures will conform to Form-C configuration, providing Common, Normally-Open, and Normally-Closed contacts. The outputs will not be referenced to either ground or any voltage potential.

3.12.6.4 AUTOMATIC SUPPRESSION SYSTEMS

Automatic suppression systems automatically discharge fire-extinguishing agents when a fire condition is detected. With use of control panels, directional valves and flow control equipment, these systems can be used to protect against one or more hazards or groups of hazards. Where two or more hazards may be simultaneously involved in the fire by reason of proximity, both hazards **shall** be protected with separate individual systems and the combination arranged to operate simultaneously. The other option is that they could be protected with a single system that **shall** be sized and arranged to simultaneously discharge on all potentially involved hazards that have indicated an alarm condition. A qualified fire protection engineer **shall** be consulted when designing automatic extinguishing systems.

If an overhead sprinkler system is used, the “dry pipe” type **shall** be used. Upon detection of a fire condition, this type of system removes source power to the room and then opens a master valve to fill the overhead sprinklers. These systems sometimes use a primary suppressor such as CO_2, releasing before the sprinkler system is activated. Dry pipe systems can have enough of a delay so that a manual reset can be provided, if allowable. This system is preferable to a “wet” type system, which has the chance of water leakage and resultant equipment damage, and can possibly use rancid water that has been stored in overhead pipes for long periods.

If power connections are made beneath raised floors, waterproof electrical receptacles and connections **shall** be used in all types of installations.

3.12.7 WARNING SIGNS

Appropriate warning signs **shall** be affixed outside of areas where concentrations of extinguishing gases can accumulate. This should not be limited to just protected spaces but in the adjacent areas where the gases could migrate or leak (such as the storage room for the gas containers, adjacent rooms and hallways). There **shall** be a warning sign posted at the entrance to the protected area and inside the protected space.

3.12.8 POWER SOURCES

The primary power source for the fire extinguishing system's operation and control **shall** have the capacity for intended service and **shall** be reliable. Where failure of the primary power source would jeopardize the protection provided, a secondary (standby) power source **shall** supply energy to operate the system for a period of 24 hours and be capable of operating the extinguishing system continuously for the full designed discharged period. The secondary (standby) power **shall** automatically transfer to operate the system within 30 seconds of the loss of primary power.

3.12.9 FIXED SYSTEMS COMPARISON

If a new system is being installed or an existing fixed fire-extinguishing system is being replaced, always check with local fire prevention authorities and a competent fire protection engineer first. Be ready to supply information about the material composition of the building or housing structure, occupancy of the structure, environment, and equipment that needs to be protected. Ask for their recommendations on the type of extinguishing systems needed, along with any advantages and disadvantages of a particular system.

Some of the more common fixed systems currently used at communication sites are listed in Table 3-2. The advantages and disadvantages of each type are also described.

TABLE 3-2 FIRE SUPPRESSION SYSTEMS

Type	Advantages	Disadvantages
Water Extinguishing (Water Sprinkler)	• Upon detection of a fire condition, a “dry pipe” type of system removes source power to the room and then opens a master valve to fill the overhead sprinklers. (The “dry pipe” system is preferable to a “wet pipe” system, which has the chance of water leakage and resultant equipment damage and possible electrical shock.)· • No adverse environmental impact.	• If power connections are made beneath raised floors, waterproof electrical receptacles and connections are required. • Either type of water sprinkler system could cause electronic equipment damage and will require an extensive cleanup effort. • Upon discharge, system downtime can be lengthy.
Clean Agent Extinguishing System		
FE-13™ (HFC-23)	• Environmentally friendly replacement of Halon™ 1301-based systems. • Advantage over CO_2 systems, due to FE-13 lack of oxygen displacement characteristic. • Electrically nonconductive and residue-free. No cleanup is required after discharge and system downtime can be kept to a minimum. • The storage cylinder(s) may be stored away from the protected area. • Storage cylinders can be stored in a wide range of temperatures; containers need not be stored in protected places at room temperature. • System recharge is less expensive than alternative fluorocarbon agents.	• May not be readily attainable or easily refilled in certain areas. • Typically much more costly to purchase and maintain than water systems. • When released under fire conditions hydrofluoric acid (HF) can be produced.

TABLE 3-2 FIRE SUPPRESSION SYSTEMS (CONTINUED)

Type	Advantages	Disadvantages
FM-200™ (HFC-227ea)	• Environmentally friendly replacement of Halon 1301-based systems. • Less toxic than Halon 1301. • Electrically nonconductive and residue-free; no cleanup is required after discharge. System downtime can be kept to a minimum. • When compared with Halon 1301, FM200 systems require minimal additional floor storage space.	• System recharge can be more expensive than other types of extinguishing agents. • When released under fire conditions hydrofluoric acid (HF) can be produced.
INERGEN™ (IG-541)	• Environmentally friendly replacement of Halon 1301-based systems. It has no Ozone Depleting Potential, Global Warming Potential, or Atmospheric Lifetime. • No toxic or corrosive decomposition products. • Electrically nonconductive and residue-free; no cleanup is required after discharge. System downtime can be kept to a minimum. • Because INERGEN is stored as a gas, it can be stored at a substantial distance form the risk area, where more space is available.	When compared with Halon 1301 and FM200 systems, INERGEN systems require more cylinders and additional floor storage space.

3.13 SAFETY EQUIPMENT

The following safety equipment **shall** be permanently located inside all equipment shelters and in or within close proximity to tenant improvement equipment rooms:

- First aid kits
- Eye wash station
- Battery safety equipment including personal protection equipment in any area with wet cell batteries
- Construction/installation safety equipment
- Safety markings and barriers

NOTE: It is strongly recommended that all employees obtain formal training and certification in First Aid and cardiopulmonary resuscitation (CPR).

3.13.1 FIRST AID KIT

- Because many communications facilities are located in areas far from medical help, a first aid kit **shall** be present at every site.
- All first aid kits, case, and contents **shall** meet or exceed the specifications of ANSI Standard Z308.1.
- All first aid kits **shall** be mounted in a conspicuous, easily-accessible location.
- The first aid kit case **shall** be durable, rustproof, and allow for wall mounting.

3.13.2 TYPICAL BATTERY SAFETY KIT

Where required by OSHA or applicable jurisdictional or local codes, the following equipment **shall** be supplied:

- A lightweight, acid resistant bib type apron **shall** be permanently stored on site near the battery plant. The fabric **shall** be acid, caustic, puncture, and flame resistant.
- An acid resistant, full face shield, **shall** be permanently stored on site near the battery plant. The shield **shall** meet all requirements of ANSI Z87.1. Protective eye wear that does not provide full face protection **shall not** be allowed.
- One pair of acid resistant gloves **shall** be permanently stored on site near the battery plant. These gloves **shall** be of sufficient length to cover the hand, wrist, and forearm for protection from chemical splash.
- One 0.5 kg (1 lb.) box of baking soda or equivalent acid neutralizing compound **shall** be permanently stored on site near the battery plant.
- Water is to be provided to mix with the baking soda.
- An OSHA-approved emergency eyewash station **shall** be permanently mounted near the battery plant. The eyewash station **shall** use an isotonic saline wash capable of neutralizing acids or caustics and **shall** be able to flush the eye for 15 minutes. A plumbed eyewash station and a shower should be provided in battery areas if possible.

NOTE: Discard and replace bottled eyewash solution according to the expiration date on the bottle.

3.14 ON SITE COMMUNICATIONS

It is required that some form of two-way communications be available at each facility, for safety reasons as well as for performing maintenance and troubleshooting. Most outages occur after hours and normally only one technician is dispatched to perform repairs. Cellular phones may only be used if there is known coverage at the location.

- Important numbers **shall** be posted on or near the entrance door such as but not limited to:
  - Police, ambulance and fire personnel
  - Site owner

- For maintenance and troubleshooting, a telephone or microwave orderwire is invaluable, if monitored. In most cases the technician must contact a central support group and/or a computer in order to obtain help. Many new systems require a communications link to download the operational information in order for the equipment to function.
- Note that neither a mobile radio in a maintenance vehicle nor a personal portable radio should routinely be used for onsite communications requirements.
- On-site communication between personnel on the ground and any personnel working on a tower **shall** be maintained at all times.

3.15 SIGNAGE

An equipment room entrance door, roof entrance door, shelter, enclosure, tower or site compound **shall** be posted with signs identifying the site and providing notices and warnings. The types of site signage **shall** be in accordance with national, state, and jurisdictional/local regulations.

Signs containing general required notices, along with spaces for custom information, are commercially available and should be used. Warning signs containing the appropriate information and symbols are also commercially available and should be used.

3.15.1 MINIMUM REQUIRED SIGNAGE

At a minimum, sites which are not continuously supervised **shall** post the following:

- Authorized Personnel Only - No Trespassing

  Mandatory legal requirements exist in which signage must be conspicuously posted to warn against unauthorized access to the site. Appropriate signage **shall** be posted during all phases of site planning, construction, and operation.
- Responsible Entity Identification
  - The site **shall** have conspicuous signage identifying the site operating entity and providing appropriate contact information.
  - Permit or licensing information (as assigned by the Federal Communications Commission or other equivalent) **shall** also be included.
- Battery Area Signage

WARNING

NFPA signs advising the fire department of battery electrolyte reactivity with water shall be posted.

  - Appropriate signage **shall** be present on doors leading to battery rooms and within the room itself, notifying personnel of explosion, chemical, and electrical hazards within the area.
  - "NO SMOKING" signs **shall** be prominently displayed in the battery room and on the exterior of the battery room entry door. Smoking, and any other spark-producing materials or activities, **shall** be strictly prohibited in this area.

3.15.2 ADDITIONAL SIGNAGE

- Depending on the site's function, additional signage may be required. These signs typically notify of potential hazards associated with authorized or unauthorized site entry.
- Engineering personnel designing the site **shall** be aware of conditions that may be present at the site that could warrant warning signage. Such conditions are, but are not limited to, high voltage and RF energy emissions hazards.
- See Appendix A for additional information regarding EME signage.