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Communications and Information

DEPLOYABLE COMMUNICATIONS STANDARDS-SAFETY

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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This instruction implements policy found in Air Force Policy Directive 33-1, *Command, Control, Communications, and Computer (C4) Systems*. This publication provides policy and guidance for Ground Theater Air Control System (GTACS) units, combat communications units, Pacific Initial Communications Package (PICP) and communications squadrons supporting the Expeditionary Air Forces (EAF). By standardizing safety guidance and procedures, responsiveness of units in meeting worldwide contingencies is maximized. This publication applies to all PACAF-gained active, Air National Guard (ANG), and US Air Force Reserve (USAFR) combat communications units. This publication applies to the ANG and USAFR when published in the ANGIND 2 and USAFRIND 2.

SUMMARY OF REVISIONS

A Deployed Equipment Grounding Checklist was added to assist the Grounding Team Members when establishing a central ground system. Guidance on the use of portable generators in the field, Operational Risk Management assessment and current loads for ground cables was noted. New or revised material is indicated by a (|).

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1. General. This instruction presents safety precautions that must be considered during the planning phase in order to minimize hazards in the deployment of GTACS and Deployable Combat Communications Systems (DCCS). The data contained herein is described in deployment sequence and is arranged so that each part stands independently, with the exception of General Safety Precautions. This section also provides guidance for proper grounding and lightning protection for Communications-Electronics (C-E) equipment associated with the GTACS and DCCS. Special instructions pertinent to grounding the TYQ-23, HF systems and portable generators are also included.

2. Deployment Safety:

2.1. General Safety Precautions. The following safety precautions should be considered to reduce hazards and provide for personnel and equipment safety:

2.1.1. First Aid and Emergency Kits. First aid and emergency kits shall be inspected periodically to update contents and replace missing items in accordance with standard AF directives. First Aid kits must be approved by base medical services IAW AFOSH STD 91-66.

2.1.2. Safety Reports. Provisions for maintaining and disseminating reports of safety discrepancies, hazards and incidents/accidents shall be provided in accordance with standard AF directives.

2.1.3. Instructions. Safety instructions should include environmental and geographic considerations in accordance with AFI 91-301.

2.1.4. Operational Risk Management. The principles in AFI 91-213 and 215 should be employed when setting up and installing any grounding facilities.

2.1.5. Environmental Control Units (ECU). The power line frequency (60 Hz or 400 Hz) required by the ECU must be compatible with the power source prescribed for the operating location.

2.1.6. Training. Operations and maintenance personnel shall complete a safety training program and periodic safety refresher courses. Document safety training on AF Form 55 IAW AFOSH STD 91-301

2.1.7. CPR. Operations and maintenance personnel involved with repair, shall be trained in closed chest heart massage and mouth-to-mouth resuscitation procedures.

2.1.8. Emergency Plans Emergency plans should be prepared for personnel and equipment for catastrophic conditions.

2.1.9. Fire Protection. Firefighting equipment shall be available and identified for proper usage (class A, B, or C fires) and tagged showing service date. Personnel shall be trained annually in the use of all types of extinguishers provided.

2.1.10. Safety Placards Provide danger, warning, and caution signs in accordance with AFOSH STD 91-45. Representative messages for such signs are as follows:

2.1.10.1. DO NOT TURN ON - PERSONNEL WORKING ON EQUIPMENT

2.1.10.2. TURBINE EXHAUST

2.1.10.3. HIGH VOLTAGE

2.1.10.4. EXPLOSIVE

2.1.10.5. NO SMOKING

2.1.10.6. RADIATION HAZARD

2.1.10.7. SAFETY INTERLOCK DISABLED

2.1.10.8. HIGH NOISE AREA

2.1.10.9. HAZARD AREA - DO NOT ENTER

2.1.10.10. DANGEROUS AREA - NO PARKING

2.1.10.11. DO NOT DISCONNECT- MASTER STATION GROUND

2.1.11. Corrosive Or Toxic Agents. Materials that are or will become corrosive or will produce toxic vapors or combustible mixtures under service conditions shall be stored or installed in a manner precluding injury to personnel or damage to equipment during transit or operation. Counteractive (neutralizing) agents should be available near the location where corrosive substances are used or stored. Refer to AFI 32-2001.

2.1.12. Grounding. Grounding systems shall be established at the GTACS/DCCS location for personnel and equipment safety. Established the grounding systems in accordance with individual equipment T.0.'s and T.0. 31-10-24.

2.1.13. Lightning Protection. Lightning protection systems shall be installed in accordance with equipment technical manuals.

2.1.14. Storage Containers The contents of all storage containers shall be identified.

2.2. Siting Safety Precautions. Personnel shall observe the following safety precautions, along with applicable portions of paragraph **2.1.** for planning the siting of GTACS/DCCS equipment.

2.2.1. Electromagnetic Radiation Hazards. Electromagnetic radiation hazards exist within the GTACS/DCCS operating location. Safety precautions that must be observed include:

2.2.2. Personnel Access Routes. Operating personnel areas and shelter locations shall be limited to areas that have a power density level less than 10 mw/cm2.

2.2.3. Fuel. Storage areas and supply routes shall be limited to areas that have power density levels less than 5 w/cm2.

2.2.4. Explosives. Storage areas and supply routes should be limited to areas having power density levels that do not exceed those specified in AFMAM 91-201.

2.2.5. Antennas. Individual antennas and antenna systems, either shelter mounted or remotely located, must be sited in a manner that will insure those personnel; fuel and explosives are not exposed to electromagnetic radiation hazards.

2.2.6. Fuel Storage. Fuel tanks and bladders should be sited at terrain levels lower than other GTACS/DCCS equipment to preclude the flow of escaping fuel or vapors into personnel and equipment areas. Siting considerations should include space and access routes for resupply and the construction of diking or revetments.

2.2.7. Power Sources. Power sources should be sited in a manner, which will minimize the heat, corrosion and noise hazards to personnel and equipment. Power sources should be positioned away from vehicle access roads or helicopter landing zones to minimize foreign particle contamination.

2.2.8. Shelters and Modules. Shelters and modules should be oriented so that exit doors face away from any explosive areas located in the immediate vicinity. Provisions should be made to allow construction of protective diking and revetments and trigger screens around shelters and modules.

Siting locations should have the shelter doorways facing away from the perimeter to enhance light discipline.

2.2.9. Cables and Fuel Lines. Routing of signal and power cables should provide maximum separation between cables having dissimilar functions. Routing of signal and power cables should avoid fuel lines and fuel supply areas.

Special care should be taken with fiber optic cables. Armored cables should be protected in high traffic areas. Unarmored cables should be protected throughout the entire runs.

2.2.10. Access Routes. Routes required for personnel and vehicular traffic should be sited to avoid cables and fuel lines. When paths or roads intersect cables and fuel lines, protective bridging or burying of lines should be accomplished.

2.3. Transportation Safety Precautions. Personnel should consider the following safety precautions along with applicable portions of paragraph **2.1.** for planning GTACS/DCCS equipment transportation.

2.3.1. Fuel Storage. Stored fuel constitutes a safety hazard. Even small amounts (5-10 gallon) remaining in tanks, bladders, lines and pumps present a fire and explosion hazard. Fuel handling equipment should be drained and purged prior to being transported.

2.3.2. Vehicle Airlift. When loading vehicles on aircraft, vehicle fuel tanks shall be filled to the capacity authorized by current hazardous cargo directives.

2.3.3. Other Fluids. Cleaning fluids, Freon, repair solvents for inflatables, oils and greases must be segregated and transported in approved fire resistant containers in accordance with current hazardous cargo directives.

2.3.4. Helilift Operations. Helicopter lift operations present significant hazards to both flight and ground crew. Supervisors shall monitor helilift operations and be prepared to immediately cease operations or implement alternate methods when hazards to personnel or equipment become apparent.

2.3.5. Mechanical Devices. Hoist and tow equipment shall be maintained and used in accordance with applicable technical manual instructions. All prescribed devices shall be utilized in the handling, securing, and transport of shelters, pallets, power sources, cable reels, fuel systems and other equipment.

2.3.6. Atmospheric Pressures. Equipment that may become pressurized during transport shall be vented using the venting devices provided.

2.4. Assembly/Disassembly Safety Precautions. Personnel should consider the following safety precautions along with applicable portions of paragraph **2.1.** responsible for planning the assembly/ disassembly of a GTACS/DCCS sites.

2.4.1. Grounding. All GTACS/DCCS shelters and power sources shall be grounded in accordance with equipment technical manuals prior to power cable connection.

2.4.2. Lightning Protection. Lightning protection systems shall be installed in accordance with equipment technical manuals prior to power cable connection.

2.4.3. Cable Route. All signal and power cables should be routed to avoid fuel storage areas.

2.4.4. Cable Connection. Electrical circuits shall be de-energized prior to connecting or disconnecting cables. Switches shall be positioned in accordance with equipment pre-operational checkout procedures.

2.4.5. Turbine Exhaust. Turbine power source exhaust openings emit hot gases and should be pointed away from personnel areas. Warning signs that state DANGER TURBINE EXHAUST must be conspicuously posted.

2.4.6. Turbine Noise. Turbine power sources produce a high noise level. Personnel in the immediate vicinity of turbine power sources shall wear suitable aural protective devices. This area must be posted, with HIGH NOISE AREA signs.

2.4.7. Fuel Storage. Fuel storage containers shall be grounded in accordance with appropriate TOs. Warning signs shall be posted in accordance with applicable AF directives.

2.4.8. Fuel Storage Area. Dikes or revetments should be constructed around fuel storage tanks to contain any spillage.

2.4.9. Antenna and Guy Markings. All ground mounted antennas and guy cables should be conspicuously marked in a manner that reduces the hazard to personnel. Fluorescent signs and flags or tags should be used in marking the antennas and cables.

2.4.10. Antenna Radiation. Radiating antennas may present a hazard to personnel. Personnel should be alerted and appropriate precautionary measures taken prior to performing work near antennas.

2.4.11. Antenna Area. Vehicle parking and access routes must be located away from antenna areas. Antenna areas should be posted with RADIATION HAZARD and/or HIGH VOLTAGE signs as applicable.

2.4.12. Antenna Erection and Dismantling. Erection and dismantling of antennas should not be attempted during electrical or wind storms. (Only qualified personnel should ensure work is completed)

2.4.13. Shelter Positioning. Extreme care should be exercised when positioning equipment shelters. Lift slings, winch hoists and jacks should be securely attached prior to moving the shelters. Lowering and raising shelter side panels or floor panels should be accomplished with caution.

2.4.14. Shelter Storm Kits. Shelter storm kits shall be installed in accordance with the equipment TOs to reduce the hazard to the shelters from high winds.

2.4.15. Shelter Exits. Shelter exits and doors must be securely closed and air vents opened for transport.

2.4.16. Emergency Exits. All emergency exits must be kept free of obstructions both inside and outside the shelters.

2.4.17. Shelter Area. The area around vans, shelters and power sources should be kept free from oil and fuel spills and obstructions.

2.4.18. Electrical Cable Disconnects. Electrical power must be turned off prior to disconnecting electrical cables. Equipment switches shall be positioned in accordance with procedures specified in the equipment TOs.

2.4.19. Grounding Disconnects. Electrical power shall be turned off and external cables disconnected from GTACS/DCCS equipment prior to disconnecting their ground system.

2.4.20. Power Source Fuel Lines. Fuel lines at power sources should be disconnected only after power sources have been shut down and allowed to cool to the ambient temperature. Fuel lines shall be drained before reshipment and fuel disposed of in accordance with current directives.

2.4.21. Power Source Fuel Tanks. Power source fuel tanks must be drained and the fuel disposed of in accordance with current directives before reshipping or storing these items. Do not reuse drained fuel.

2.4.22. Storage Batteries. Storage batteries must be deactivated in accordance with current directives whenever equipment is to be placed in storage.

2.4.23. Personal Protective Equipment. Appropriate protective equipment/clothing must be utilized IAW AFOSH STD 91-31.

2.5. Checkout Safety Precautions. The following safety precautions should be considered by personnel responsible for planning the checkout of a GTACS/DCCS site:

2.5.1. Test Equipment Grounding. Test equipment shall be grounded during use in accordance with applicable TOs.

2.5.2. Hazardous Voltage. Voltages dangerous to personnel may be present in circuits during checkout. Personnel involved in the checkout must be made aware of this hazard and should perform these functions only when a second person is present. Danger, caution, or warning signs with appropriate messages shall be attached to all equipment presenting electrical hazard.

2.5.3. Cable Connection. Electrical power shall be turned off prior to connecting or disconnecting cables. Cables should be tagged to indicate the cable function and termination points.

2.5.4. Fuel Tank Areas. Open flames are prohibited within 50 feet of fueling operations. Fueling areas should be located a minimum of 50 feet from communications antennas and 100 feet from explosives. Appropriate signs should be logically placed and highly visible.

2.5.5. Fuel System Grounding. Fuel tanks and metallic filler hoses shall be grounded at all times in accordance with the fuel distribution system instructions. Checklist will be available to ensure compliance.

2.6. Maintenance Safety Precautions. The following safety precautions, along with applicable portions of paragraph **2.1.** should be considered by personnel responsible for planning the maintenance of a GTACS/DCCS site:

2.6.1. Personnel Hazards. Personnel performing maintenance on electrical equipment should remove jewelry, watches, and identification tags to minimize the hazard of electrical shock and burns. The supervisor shall be notified when maintenance actions involving energized electrical circuits must be performed.

2.6.2. Grounding. Measure all lightning protection and equipment grounds visually on a daily basis and monthly measurements shall be made using the techniques in TO 31-10-24.

2.6.3. High Voltage Areas. Extreme caution is required when performing maintenance operations on circuits, which might retain residual high voltage. Shorting or grounding prior to performing maintenance actions should discharge such circuits. Circuit breakers shall be tagged in accordance with AFI 91-301. Danger, caution or warning signs with appropriate messages in accordance with AFI 91-301 shall be posted or attached to equipment being maintained.

2.6.4. Fuel. Fuel systems should be checked daily for fuel leaks and spills. The residue of leaks and spills shall be immediately neutralized or removed in accordance with current directives. Daily check sheet should be located at fuel site to ensure compliance.

2.6.5. Test Equipment. Test equipment shall be grounded in accordance with applicable TO.

2.6.6. Batteries. Batteries shall be checked frequently for leaks and plugged vents in accordance with the applicable TOs.

2.6.7. Antennas. Antenna transmission lines shall be disconnected and tagged prior to initiation of maintenance or any part of an antenna/antenna system.

3. Grounding. Grounding is the provision of a low-impedance conductive path between the earth and the grounded object. Grounding has three main functions: personal safety, equipment protection, and noise reduction.

3.1. Grounding electrical equipment, shelters and large metal objects that could conduct dangerous currents provides personal safety. Grounding such items diverts dangerous currents to earth and activates protective devices (such as fuses and circuit breakers) that shut down the affected circuit.

3.2. Grounding power sources, equipment racks, shelters, and other conductive objects protects equipment. This prevents transient voltages and currents from reaching levels that could damage equipment.

3.3. Electrical noise is reduced by reducing the difference in voltage potential between equipment; and by connecting and lowering the signal reference subsystem and the earth electrode subsystem. Noise control may also require other measures, such as shielding or filtering of local noise sources.

3.4. Facility Ground System:

3.4.1. General. Use this section as the basis in constructing the ground system. Site planners should develop a deployed and in-garrison facility grounding plan based on information contained in this section, MIL-STD 188/124A, MIL-HDBK-419A, and TO 31-10-24. **Figure 1.**

*Note: 1. See **Attachment 1** for a Deployed Equipment Grounding Checklist that will assist you in your set-up of your deployed grounding system.*

Note: 2. Military standards and military handbooks are indexed in the Index of Specifications and Standards, which is available at base publishing distribution offices (PDO).

3.4.2. Grounding Team. It is recommended that the Senior Maintenance Officer or Maintenance Chief designate a minimum of three personnel as the grounding team. One of these individuals should be appointed the ground team supervisor. This team is responsible for ensuring compliance with safe grounding practices. Following this recommendation ensures a central point of contact for grounding procedures and to alleviate a haphazard or dangerous approach to setting up and maintaining a Facility Ground System. The responsibilities of this team should include but not be limited to:

3.4.2.1. Ground Team Supervisor Responsibilities:

3.4.2.1.1. Ensures the grounding plan is included with the site layout.

3.4.2.1.2. Ensures a site central ground subsystem is installed at each deployed location prior to the installation of communication-electronic equipment.

3.4.2.1.3. Conspicuously identify the central ground location with a sign that reads:

"CENTRAL GROUND-DO NOT DISCONNECT WITHOUT APPROVAL OF THE COMMANDER."

Note: Once all equipment, i.e., signal reference, lightning protection, fault protection, and earth electrode subsystems are interconnected, this becomes the facility ground system.

3.4.2.1.4. Establish a grounding logbook for the facility. This log should provide, as a minimum:

3.4.2.1.4.1. A pictorial diagram of the facility ground layout.

3.4.2.1.4.2. Ohmic value reading between equipment and ground rod.

3.4.2.1.4.3. Equipment checked, date of readings.

3.4.2.1.4.4. Equipment added to or removed from the facility ground system.

3.4.2.1.5. Ensures that separation between signal cables, power cables and lightning protection ground cables on parallel runs are separated by at least 18 inches. Signal cables may cross other cables at a 90-degree angle. This practice reduces the chance of noise being induced into the signal cables thereby degrading circuit performance.

3.4.2.2. Ground Team Responsibilities:

3.4.2.2.1. Installs and tests the deployed site central ground (earth electrode subsystem) per paragraph **3.5.** The central ground shall be tested using a null balanced earth tester (vibra ground checker). The design objective established by MIL-STD-188-124A is 10 ohms or less of resistance.

3.4.2.2.2. Ensures all equipment is properly connected to the facility ground system.

3.5. Installation of A Site Central Ground. The site central ground is the Earth Electrode Subsystem of the Facility Ground System. The earth electrode should have impedance to earth of 10 Ohms or less (design objective). The earth electrode can vary depending upon soil conditions, location of the site, and available materials.

3.5.1. Use of vertical ground rods at least 3 m (10 ft) long and 19 mm (3/4 in) in diameter for the earth electrode. Three ground rods installed in a triangle as shown in **Figure 2.** should provide an adequate earth electrode. If unable to reach the desired 10-ohm impedance, additional ground

rods can lower the resistance of the electrode. Ground rods spaced at least two rod lengths apart behave similar to parallel resistors. Two rods will have 60 percent of the resistance of one rod; three rods, 40 percent; and four rods; 33 percent. There is a point where increasing the number of rods will have only a small effect. At this point you have reached what is called,*" A point of no appreciable return"*. Lowering the resistance can in some cases be aided by adding rock salt or magnesium sulfate and water in the holes around the ground rods.

3.5.2. Install the rods for the Earth Electrode as follows: See **Figure 2.**

3.5.2.1. Select a site that is at the lowest point of the surrounding terrain. The water table should be closer to the surface here. The site should be near where the power generating equipment is to locate.

3.5.2.2. Clean the rods of any paint or grease to ensure maximum contact with the earth.

3.5.2.3. For each rod dig a hole 18 to 24 inches deep and of sufficient (see **Figure 3.**) circumference to allow connections to be made to the rod. Dig a shallow trench (10 to 12 inches deep) between the ground points.

3.5.2.4. Drive the ground rods so that they are about 6 inches below the top of the hole.

3.5.2.5. Connect the rods with 1/0 AWG bare copper wire and coat the connections with a protective compound.

3.5.2.6. Bury the connecting cables and the rods with the exception being the point at which the power systems will connect to the earth electrode.

3.5.3. Where applicable, separate Site Central Grounds may be connected together via a single 1AWG cable. This will reduce the number of 6 AWG cable runs required to a single Site Central Ground. (See **Figure 4.**)

3.5.4. Procedures for Equipment Ground Installation. Each work center should:

3.5.4.1. Prior to the installation, ensure all ground rods and ground connections are free of paint, dirt, grease and oxidation.

3.5.4.2. Ensure that ground rods are as close to the equipment shelter as possible so that the conductor will form a direct line from the equipment ground to the ground rod. Have all ground cables as short as possible with no coils. Bend radius shall not be less than 8 inches (20 cm) or less than a 90-degree angle.

3.5.4.3. Connect the equipment shelter ground to the ground rod in accordance with the equipment technical order. All stand-alone power and signal junction boxes, air conditioners, and heat exchangers should have their own ground rod. Collocated like items of equipment, receiving power from the same source, may share a single ground rod provided they are not separated by more than 3 feet from ground connection to ground rod.

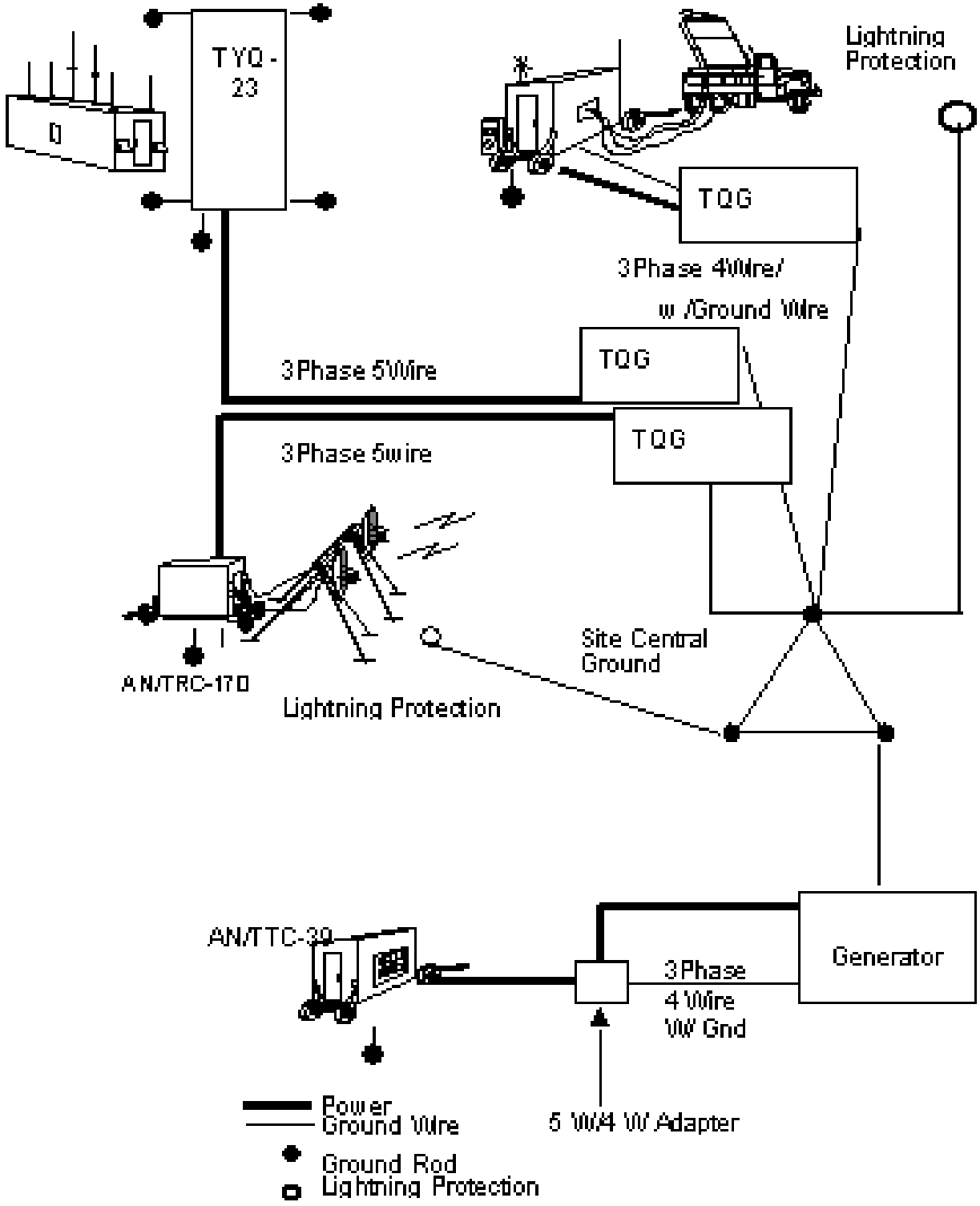
3.5.4.4. All generators should have a separate ground wire run from their ground rod back to the central ground facility. (See **Figure 4.**)

3.5.4.5. A separate ground clamp for each connection will be used on any given groundrod.

3.5.4.6. Before power is connected to equipment or shelter, use an ohmmeter to measure the equipment/shelter to ground rod resistance. This reading must be less than 1 ohm.
See **Figure 5.**

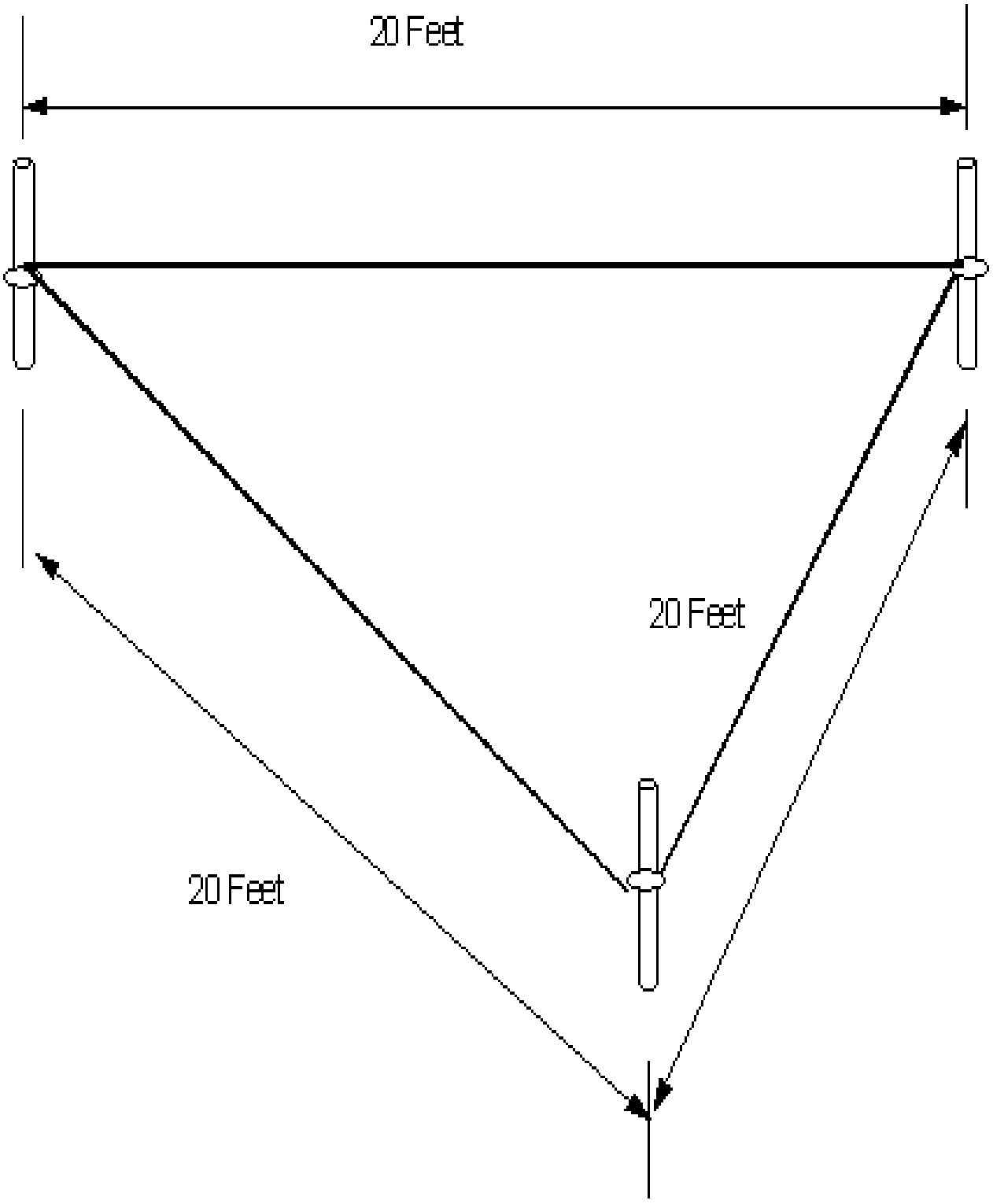
3.5.4.7. All C-E equipment using 3 phase 4-wire power cables should have a green insulated fifth wire, #6 AWG or larger, taped or strapped to the cable every 12 inches along the cable run. This wire is connected directly to the shelter ground connector or the ground lug on the 4/5-wire cable adapter. The other end is bonded to the ground connection for the power generator. This fifth wire should have no breaks in the runs of the cable length and should always be connected directly to the power source, never to a junction box. On long runs, install additional ground rods each 100 feet. When connecting power cables of different length, a 3-ft ground rod section will be used to tie the 5th wire together at the power cable connector junction. Each 5th wire should be connected to the ground rod by its own ground lug, never combine the two.

Figure 1. Typical Facility GTACS Ground Layout.



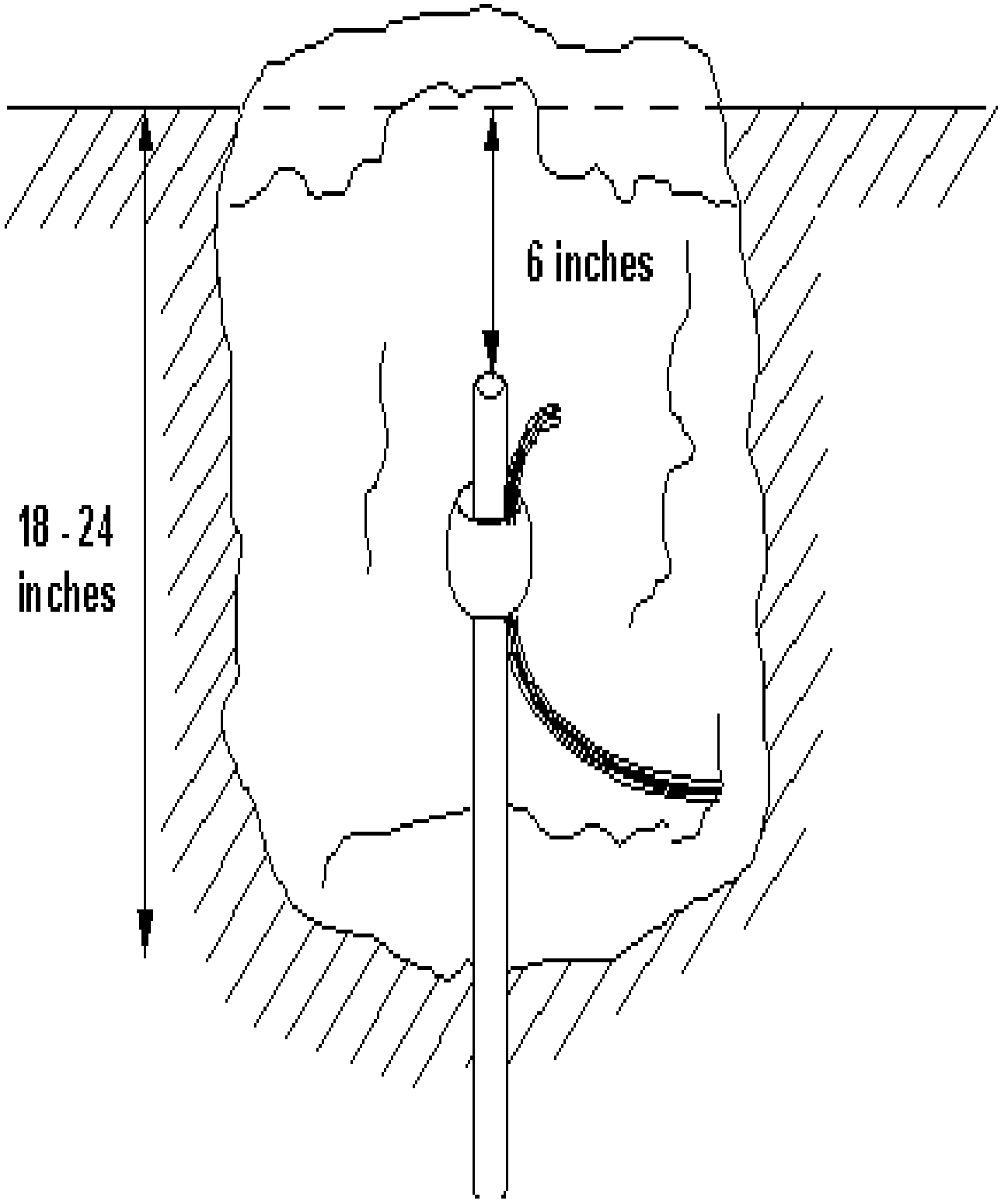
Note: This drawing is provided as an example.

Figure 2. Ground Rod Installation.



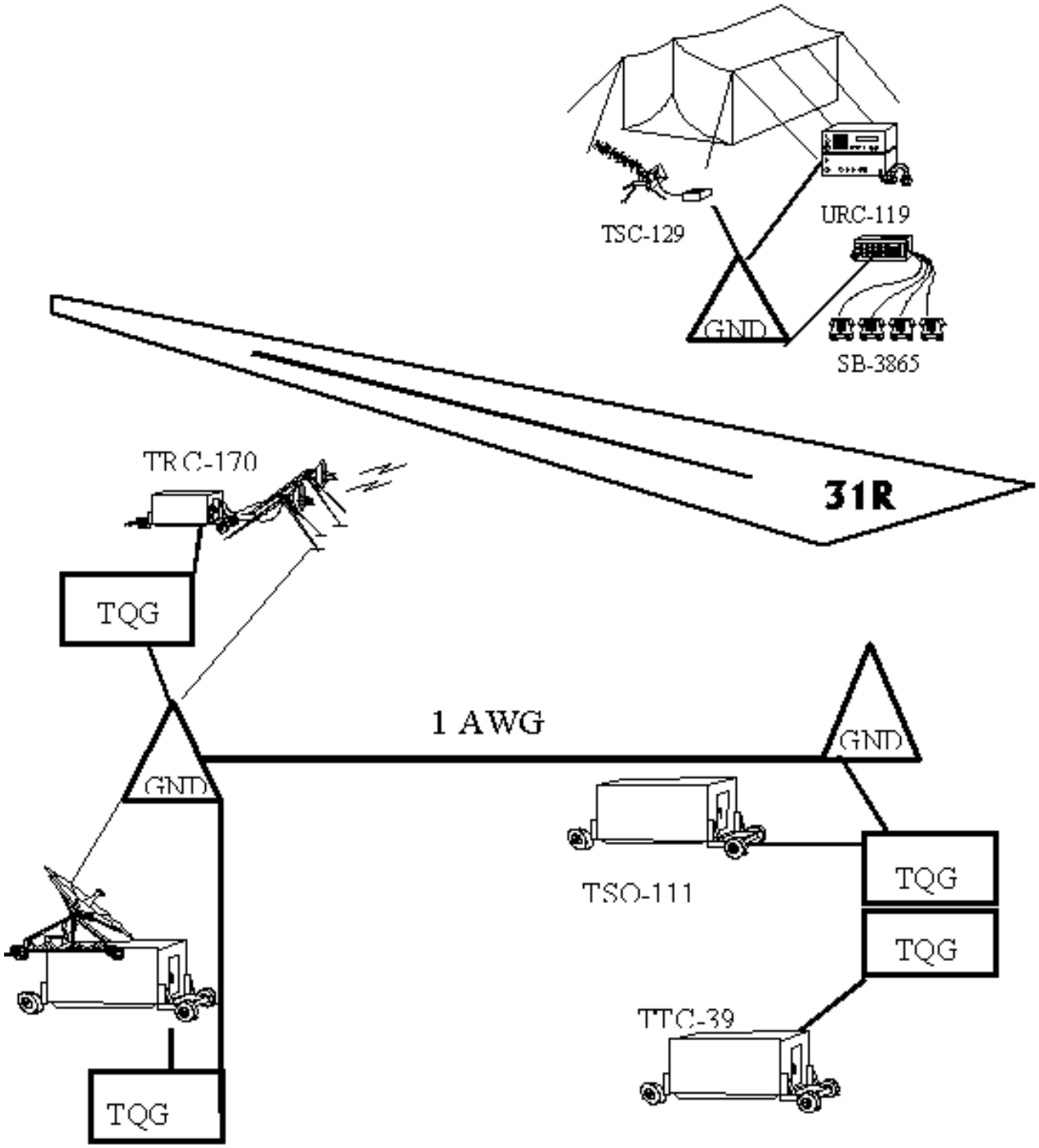
Note: This drawing is provided as a typical installation.

Figure 3. Earth Electrode Installation.



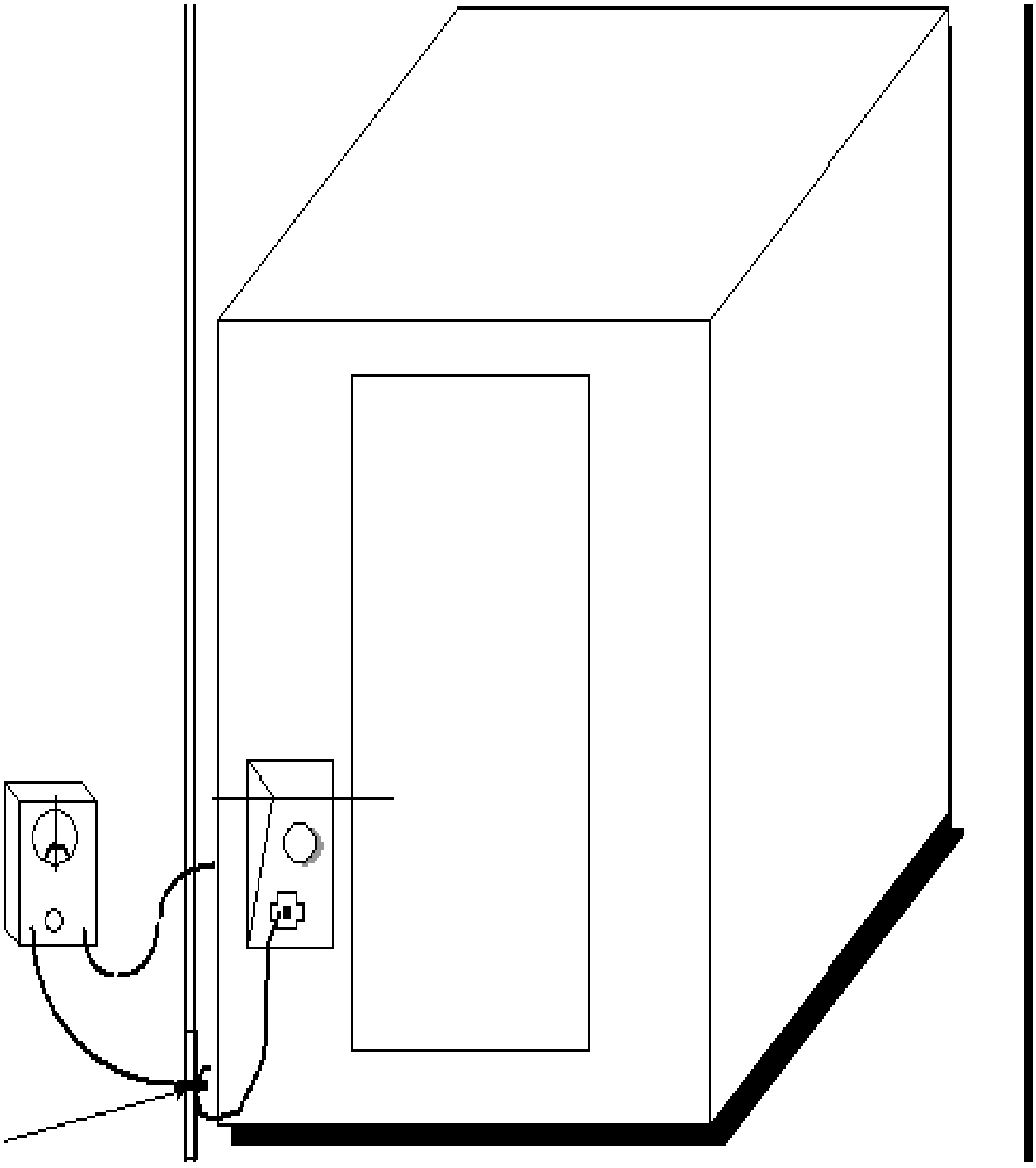
Note: This drawing is provided as a typical installation.

Figure 4. Typical TAB/Initial Comm Ground Layout. (PICP, DAOC, CBCS)



Note: This drawing is provided as an example.

Figure 5. Shelter to Rod Resistance Test.



Note: 1. All C-E equipment using 5-wire power cables and generators with 5-wire power connector outputs will not be required to run the ground separate.

Note: 2. This drawing is provided as an example.

3.5.4.8. Use a minimum of a #6 AWG copper conductor or equivalent to connect the generator ground connection and ground rod to the site central ground. Place a ground rod each 100 feet on long ground runs. The following are current load handling capabilities for ground cables:

3.5.4.8.1. # 6 AWG is good for current load 200 Amps or less

3.5.4.8.2. # 4 AWG is good for current load 201- 400 Amps

3.5.4.8.3. # 2 AWG is good for current load 401- 500 Amps

3.5.4.8.4. # 1 AWG is good for current load 501- 600 Amps

3.5.4.8.5. # 1/0 AWG is good for current load 601- 800 Amps

3.5.4.9. Ensure the ground team verifies the facility ground system for proper connection before power is applied to individual C-E equipment. Ensure equipment that is to be connected or disconnected from the facility grounding system is electrically isolated from both power and other equipment. Individual checks on generators, wideband systems, and so forth, may be made before tie-in to the facility grounds.

CAUTION: Ensure the ground cables between generators and facility ground systems are never connected or disconnected without the generator being powered down. The cable potentially carries a significant current when the generator is on-line and powered up.

CAUTION: Ensure individual equipment connections are made to the facility ground system prior to connecting power cable or internal connections to equipment.

CAUTION: Ensure power cable and all inter-van cables are removed from individual pieces of equipment prior to disconnecting them from the facility ground system.

3.5.4.10. Verify that the ground sheath on each 407L cable is only connected at one end. This can be verified by opening the 407L connector and seeing that the ground shields are only connected at only one end, otherwise you have an AC ground loop. This will be very noticeable once on-line by the amount of noise on your circuits.

3.5.4.11. Equipment connected to a common signal cable must also be connected to a common ground. This ground may be provided through the power source.

3.6. Lightning Protection.

3.6.1. Equipment providing lightning protection should be installed properly in accordance with technical orders and MIL-HDBK-419A.

3.6.2. Equipment with lightning protection that is not electrically tied to the site central ground system should be connected to the site central ground system by a #6 AWG (or equivalent) cable from the air terminal ground rod. This cable should be as short as possible with no coils or sharp turns.

3.7. Grounding Mobility Kit. Each unit should establish and maintain a kit for installing a central grounding system or systems upon deployment. Quantities should be tailored to meet mission

requirements for all systems requiring grounding but not limited to existing systems. Kit or kits should provide for contingencies such as leap concept, whereby a portion of the unit stays in-place while the other part is directed to re-deploy to establish a new tech site (i.e., EC range threat simulators and stand-alone C-E employment). Minimum recommended items are listed in **Table 1.**

3.7.1. The Grounding Kit items should be maintained in sufficient quantities to meet mobility requirements. All materials should be kept in-garrison in a "hands-off" status ready for deployment. Work centers should maintain an adequate supply of grounding materials for its individual equipment needs.

3.7.2. NO-OX-ID-A compound should be applied to grounding system connections on deployments lasting more than 30 days.

Note: NO-OX-ID-A compound will not be applied to the terminals on the vans

3.8. Procedures for Ground Installation while In-Garrison:

3.8.1. An in-garrison facility ground should be installed by base civil engineers. If the unit has installed the facility ground, maintenance and certification of the facility ground should be by base civil engineering. In either situation, the unit is responsible for an annual inspection and test of the facility ground. **Figure 1.** should be used as an aid in development of the fixed facility layout. The central grounding point shall be identified with a danger sign, which reads:

"CENTRAL GROUND-DO NOT DISCONNECT WITHOUT APPROVAL OF THE COMMANDER."

3.8.2. Each work-center supervisor ensures:

3.8.2.1. All equipment in operation is grounded IAW applicable technical orders.

3.8.2.2. Each ground connection is free of paint, dirt, grease, and oxidation.

3.8.2.3. A separate ground clamp is used for each connection made on a ground rod.

3.8.2.4. Equipment is connected to the facility grounding system as required. Place and connect a ground rod every 100 feet for long ground runs.

3.8.2.5. Equipment connected or disconnected from the facility grounding system is electrically isolated from both power and other equipment prior to being connected to disconnected.

3.8.2.6. Use of NO-OX-ID-A, NSN 8030-00-598-5915, as specified in TO 31-10-24 on connections and clamps.

Note: NO-OX-ID-A should not be applied to the terminals of shelters and vans.

Table 1. Materials List

Item	Item
Rod, (10' X 3/4") (see para **3.8.2.12.**)	Flat Bastard File with handle
#6 AWG Wire as a minimum (equipment ground runs)	100' Tape measure
1/0 AWG Wire, (central ground systems)	Wire brush
Sliding or Slip Hammer	Emery paper
Clamp, Grounding 3/4"	Insulated gloves
Safety goggles	Magnesium Sulfate
Hammer, sledge	NO-OX-ID-A compound
Vibra-ground Checker	"CENTRAL GROUND-DO NOT
Box wrench set	DISCONNECT" sign for central ground

Note: 1. *The above items are needed in such quantities so as to provide all grounding team members with the necessary tools and equipment to install a proper central ground facility and connections to equipment.*

Note: 2. *The Magnesium sulfate will be necessary to decrease earth electrode subsystem resistance. Determination of use and quantity needed will be made by the site commander, engineer or designated representative.*

3.8.2.7. Measure shelter/equipment to ground rod resistance, using an ohmmeter, as it is added to the station ground system. This reading must be 1 ohm or less. Ensure power is off to equipment under test prior to taking this measurement. This check should be made each time the equipment is removed and then reconnected to the system ground. (See **Figure 5.**)

3.8.2.8. Ensure that all mobile equipment in operation is connected to the in-garrison facility ground and all lightning protection equipment is installed IAW TOs and MIL-HDBK-419A.

3.8.2.9. Take action to ensure that civil engineers install lightning protection to provide a 1:1 cone of protection for the radar in accordance with TO 31-10-24.

3.8.2.10. Notify base civil engineering of any lightning protection discrepancies.

3.8.2.11. Perform an annual inspection on the facility ground to ensure that deterioration of the components, e.g., rods, cable, etc., has not occurred.

3.8.2.12. The 5/8" by 3 ft ground rod sections (three 3 ft rods coupled together make 9 ft), NSN 5975-00-878-3791, is a suitable substitute to the 10 ft. ground rods as a part of the grounding kit.

4. Special Grounding Instructions:

4.1. AN/TYQ-23 Modular Control Element (MCE) Ground Points. There are five ground points on the AN/TYQ-23 shelter where ground straps are to be attached. One ground strap at the Power Entry Panel, and one at each corner of the shelter. (Reference **Figure 1.**)

4.1.1. The ground point at the Power Entry Panel establishes the ground for the shelter and power distribution system. This is the shelter safety grounding point for the shelter fault protection system. With this ground installed and a five wire power cable connected to a properly grounded power source, the TYQ-23 can be powered up for operation. The TYQ-23 can be operated without any other grounds attached.

4.1.2. The four ground points provided at the shelter corners are static drains and form a key part of the counterpoise for the antennas mounted on the roof of the shelter. The UHF and VHF antennas are designed to be a Direct Current (DC) short circuit via their tilt-base assemblies and the skin of the shelter to earth ground. That is why they do not require lightning arresters at their bases. At their operating frequencies they present nominal 50-ohm impedance to their respective radio ports. The efficiency of any antenna is directly related to the quality of the ground that it is attached to. In the roof mounting configuration the skin of the shelter actually becomes part of the antenna. The length of the path to ground from the antenna base will affect the performance of the antenna. The shorter this ground path is the better the results. The second reason this ground path should be short as possible is the possibility of lightning strike. It is a fundamental principle that all antennas are lightning attractors. This is because of the static charge that builds up as a result of electrical storm activity as well as the transmission of radio frequency energy. The shorter the path is to earth ground the lower the charge of static energy.

4.2. High Frequency (HF) Whip Antenna Grounding:

4.2.1. The HF whip antenna is a different type of design. The radiating elements are isolated from the ground via the antenna coupler. That is why a lightning arrestor is installed in the base of this antenna assembly. The groundside of this lightning arrestor is the tilt-base assembly with its attachment points on the skin of the shelter. This antenna is probably the most susceptible to lightening strike of the suite. The skin of the shelter also forms a part of this antenna since it is the only path to earth ground. The shorter this path to ground the better the HF antenna will work.

4.2.2. The radio equipment will function normally without the corner static drains but the occurrence of radio frequency interference (RFI) will increase particularly when the HF whip antenna is used. These ground points are even more critical when the shelter is mounted on the XM-1022 mobilizer and operating. When mounted on the mobilizer the shelter has no direct contact with the earth surface other than through the ground cables. It is extremely important the cables be kept as short as possible when the shelter is mounted on the mobilizer.

4.2.3. In regions where it is rocky and it is difficult to drive the rods to an adequate depth, the use of multiple short ground rods at each point is recommended. When driving multiple grounds, remember to space the rods a distance equal to twice the length of the rod in the ground, i.e., 3-foot rods should be spaced 6 feet apart. Nothing less than a three-foot rod would be considered acceptable.

4.3. Portable Generators: For units that use portable generators in the field to power electrical Punjars or other small devices, the National Electrical Code standard (The reference is 250-6 Portable and Vehicle Mounted Generators) does not mention having a ground wire attached to a ground stake. But for safety purposes you should as a minimum; check to see that the ground of the plug has a good connection to the chassis. If the generator provides a ground lug then use a ground wire #6 AWG connected to a three foot section ground stake. This should remove any doubt for possible shock. If the generator is sitting in sand, static potential could be a factor, take precaution to avoid, as sand does not

conduct. Look at your surrounding area for good acid soil. If the generator does not have a ground lug, it is the opinion of this office to add one. Bottom line, you can never be too safe when it comes down to protecting yourself and others from electrical shock.

5. Grounding and Safety References. The following quick references are provided for your use. Also refer to http://afpubs.hq.af.mil/ for further information on safety.

5.1. Grounding and Safety -- AFOSH STD 91-50, TO 31-1-75, TO 31-10-24, AFI 32-1065, TO 31-1-75, para 1-23, AFMAM 91-201.

5.2. General Industrial Operations (Battery Storage) -- AFOSH STD 91-66

5.3. NO-OX-ID-A Special Compound -- TO 31-10-24

5.4. Painting Connections -- TO 31-10-24

5.5. Power Tools -- AFOSH STD 91-10

5.6. Test, Measurement, and Diagnostic Equipment (TMDE) -- AFOSH STD 91-90, TO 00-25-234, TO 31-1-75, TO 33-1-32

5.7. Grounding Rods/Sticks -- AFOSH STD 91-50, TO 31-1-75

5.8. Safety Placards -- AFOSH STD 91-45

5.9. Military Standards for Grounding, Bonding, and Shielding -- MIL-STD 188/124A, MIL HDBK-419A

5.10. Compendium of C4 Terminology -- AFDIR 33-121

5.11. Fuels

5.11.1. Hydrocarbons Fuels-General AFOSH STD 91-38

5.11.2. Flammable and Combustible Liquids AFOSH STD 91-43

5.12. Material Handling and Storage Equipment -- AFOSH STD 91-46

5.13. AFOSH Program Roles and Responsibilities -- AFI 91-301, -302

5.14. Personal Protective Equipment -- AFOSH STD 91-31

5.15. USAF Mishap Prevention Program -- AFI 91-202

5.16. Safety Investigation and Reports -- AFI 91-204

5.17. Operational Risk Management -- AFI 91-213, -215

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Attachment 1
DEPLOYED EQUIPMENT GROUNDING CHECKLIST

CAUTION: Ensure the ground cables between generators and facility ground systems are never connected or disconnected without the generator being powered down. The cable potentially carries a significant current when the generator is online and powered up.

CAUTION: Ensure individual equipment connections are made to the facility ground system prior to connecting power cable or internal connections to equipment.

CAUTION: Ensure power cable and all inter-van cables are removed from individual pieces of equipment prior to disconnecting them from the facility ground system.

Note: Unless stated otherwise, all references are from PACAFI 33-103, dated 6 February 1998.

A1.1. Preparation

A1.1.1. Did the Senior Maintenance Officer or Maintenance Chief designate a minimum of three personnel as the grounding team with one of these individuals appointed the ground team supervisor? Ref: **3.4.2.**

A1.1.2. Are all personnel trained and certified on the proper use of the Vibra-ground Checker? Ref: **3.5.**

A1.1.3. Is a sign conspicuously posted at the central ground location, which reads:

"CENTRAL GROUND-DO NOT DISCONNECT WITHOUT APPROVAL OF THE COMMANDER." Ref: 3.4.2.1.3.

A1.1.4. Has a grounding kit been established containing sufficient quantities of the following items? Ref: **3.7.** and **Table 1.**

Rod, (10' X 3/4")(See para **3.8.2.12.**)
Wire 1/0 AWG, 24' lengths 100' (central Gnd)
#6 AWG Wire as a minimum for equipment Gnd
Sliding or Slip Hammer
Clamp, Grounding 3/4"
Safety goggles
Hammer, sledge
Box wrench set
NO-OX-ID-A Compound
Flat Bastard File with handle
Tape measure
Wire brush
Emery paper
Insulated gloves
Magnesium Sulfate
Sign for central ground
Vibra-ground Checker

A1.2. Site Central Ground

A1.2.1. Is the central ground established in an area lower than surrounding terrain? Ref: **3.5.2.1.**

A1.2.2. Are ground rods placed in a triangular configuration with a separation of at least twice the length of the ground rod? Ref: **3.2.**

Note: Star grounding grid may also be used. See TO 31-10-24, Figure 10-10.

A1.2.3. Is a site central ground established with impedance to earth of 10 Ohms or less?

Note: The earth electrode can vary depending upon soil conditions, location of the site, and available materials. Ref: Para. ***3.5.****,* ***Figure 2.****.*

A1.2.4. Is a hole dug for each rod 18 to 24 inches deep and of sufficient circumference to allow connections to be made to the rod? Ref: **3.5.2.3.**, **Figure 3.** In terrain where this will be impossible to put the ground rods below the ground level, provide protection to the central ground through the use of flags, sand bags or what ever you have to prevent the connection from being disconnected and eliminate a tripping hazard to personnel.

A1.2.5. Are ground rods driven 6 inches below the top of the hole mentioned above? Ref: **3.5.2.4.**, **Figure 3.**

A1.2.6. Was a shallow trench (10 to 12 inches deep) dug between the ground points on central ground in which to bury the interconnecting ground wire? Ref: **3.5.2.3.**

A1.2.7. Are the ground rods connected with 1/0 AWG bare copper wire and connections coated with a NO OX protective compound? Ref: **3.5.2.5.**

A1.3. General Site Grounding

A1.3.1. For deployments over 30 days, is NO-OX-ID-A compound applied to grounding system connections? Ref: **3.7.2.**

A1.3.2. Is a minimum 6 AWG copper wire used to connect equipment to ground? REF: TO 31-10-24, Par. 10-7a.

A1.3.3. Are equipment items sharing the same ground rod within three feet of the rod? Ref: **3.5.4.2.**

A1.3.4. When grounding a transportable shelter, is ground rod placed between 2 – 6 feet from power panel in the lowest terrain? Ref: TO 31-10-24, Par., 10-5b.

A1.3.5. Are separate ground clamps used for each connection made on any given ground rod? Ref: **3.5.4.5.**

A1.3.6. For long runs of ground cable, are ground rods connected every 100 feet? Ref: **3.5.4.7.**

A1.3.7. Did the ground team verify good and proper connection to each equipment item prior to power being applied? Ref: **3.5.4.9.**

A1.3.8. Are all shelters and equipment with a common power source connected to a common ground? Ref: TO 31-10-24, Par., 10-7a.

A1.3.9. Are there separation of at least 18 inches between signal cables, power cables, and lightning protection ground cables on parallel runs? Ref: **3.4.2.1.5.**

A1.3.10. Do signal cables crossing over non-signal cables cross at a 90-degree angle? Ref: **3.4.2.1.5.**

A1.3.11. Are all ground cables as short as possible with no coils? Do they have a bend radius of less than 8 inches with bends less than 90 degrees? Ref: **3.5.4.2.**

A1.3.12. Was a resistance measurement of 1 ohm or less made from each equipment item grounded and ground rod? Ref: **3.5.4.6.**

A1.3.13. Are all ground rods checked visually on a daily basis? Ref: Para **2.6.2.**

A1.3.14. Is a grounding logbook established for the facility? Does the log provide the following? Ref: **3.4.2.1.4.** – **3.4.2.1.4.4.**

A1.3.15. A pictorial diagram of the facility ground layout?

A1.3.15.1. Ohmic value reading between equipment and ground?

A1.3.15.2. Equipment checked, date of readings?

A1.3.15.3. Equipment added to or removed from the facility ground system?