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USACE / NAVFAC / AFCEA UFGS-16341N (February 2003)  
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Preparing Activity: NAVFAC Superseding  
UFGS-16341N (March 2001)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

Latesst change not indicated by CHG tags

References are in agreement with UMRL dated 25 June 2004

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SECTION 16341N

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02/03

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SECTION 16341N

SF6 INSULATED PAD-MOUNTED SWITCHGEAR  
02/03

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NOTE: This guide specification covers the requirements for SF6 insulated, dead-front, enclosed and non-enclosed, pad-mounted switchgear with load and fault interrupting switched ways, with maximum ratings of 600 amperes and 38 kV, 60 Hz.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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NOTE: This guide specification can be used for subsurface (vault) applications with appropriate modifications.

Use the following related guide specifications for power distribution equipment:

- Section 16081 APPARATUS INSPECTION AND TESTING
- Section 16272 THREE-PHASE PAD-MOUNTED TRANSFORMERS
- Section 16273 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS
- Section 16301N OVERHEAD TRANSMISSION AND DISTRIBUTION
- Section 16302N UNDERGROUND TRANSMISSION AND DISTRIBUTION
- Section 16360 SECONDARY UNIT SUBSTATIONS
- Section 16361N PRIMARY UNIT SUBSTATIONS

--Section L-16303N UNDERGROUND ELECTRICAL WORK

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NOTE: The following information shall be indicated  
on the project drawings:

1. Site Plan showing location, space available, and  
desired arrangement of switchgear.

2. Single-line diagram showing: nominal system  
voltage; number and configuration of switched ways;  
type, number, and size of conductors for each  
circuit; and method of power cable termination (200  
ampere loadbreak connectors, or 600 ampere deadbreak  
connectors). Individually identify each switched way  
as load or fault interrupter and single-pole or  
three-pole tripping.

3. Grounding Detail with ground rods, ground loop  
and interconnecting cables when interconnecting with  
other grounding systems or if multiple switches are  
provided.

4. Special conditions, such as altitude,  
temperature and humidity, exposure to fumes, vapors,  
dust, and gases.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: Issue (date) of references included in  
project specifications need not be more current than  
provided by the latest guide specification. Use of  
SpecsIntact automated reference checking is  
recommended for projects based on older guide  
specifications.

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The publications listed below form a part of this specification to the  
extent referenced. The publications are referred to within the text by the  
basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C57.12.29 (1999) Pad-Mounted Equipment - Enclosure  
Integrity for Coastal Environments

ASTM INTERNATIONAL (ASTM)

ASTM A 167 (1999) Stainless and Heat-Resisting  
Chromium-Nickel Steel Plate, Sheet, and  
Strip

ASTM D 1535 (2001) Specifying Color by the Munsell  
System

ASTM D 2472 (2000) Sulfur Hexafluoride

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2002) National Electrical Safety Code

IEEE C37.60 (2003) Requirements for Overhead, Pad Mounted, Dry Vault and Submersible Automatic Circuit Reclosers and Fault Interrupters for Alternating Current Systems Up to 38 kV

IEEE C62.11 (1999) Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1KV)

IEEE Std 386 (1995) Separable Insulated Connector Systems for Power Distribution Systems Above 600V

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2003) Acceptance Testing Specifications

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60265-1 (1998) High Voltage Switches - Part 1: Switches for Rated Voltages Above 1 kV and Less Than 52 kV

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C37.72 (1987) Manually-Operated, Dead-Front Padmounted Switchgear with Load Interrupting Switches and Separable Connectors for Alternating-Current Systems

NEMA C57.12.28 (1999) Pad-Mounted Equipment - Enclosure Integrity

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NFPA 70B (2002) Electrical Equipment Maintenance

UNDERWRITERS LABORATORIES (UL)

UL 467 (1993; Rev thru Feb 2001) Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

\*\*\*\*\*  
**NOTE: Include Section 16081, "Apparatus Inspection and Testing" on all projects involving medium voltage and specialized power distribution equipment.**  
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Section 16050N BASIC ELECTRICAL MATERIALS AND METHODS and Section 16081 APPARATUS INSPECTION AND TESTING, apply to this section, with the additions and modifications specified herein.

### 1.3 DEFINITIONS

#### 1.3.1 Switched Way

A switched way is considered a three-phase circuit entrance to the bus through a switch. For single-phase switches, it is a single-phase entrance to the bus through a switch.

### 1.4 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings[; G][; G, [\_\_\_\_\_]]

SD-03 Product Data

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**NOTE:** Include the following paragraph when the switchgear will have fault interrupting switched ways.

\*\*\*\*\*

[ Electronic Overcurrent Control Curves[; G][; G, [\_\_\_\_]]]

SF6 Insulated Pad-mounted Switchgear[; G][; G, [\_\_\_\_]]

Insulated High-Voltage Connectors[; G][; G, [\_\_\_\_]]

Surge Arresters[; G][; G, [\_\_\_\_]]

Each submittal shall include data on switches and associated accessories. Each submittal shall include manufacturer's information for each component, device and accessory provided with the equipment.

SD-06 Test Reports

Acceptance Checks and Tests[; G][; G, [\_\_\_\_]]

SD-07 Certificates

Paint Coating System[; G][; G, [\_\_\_\_]]

SD-09 Manufacturer's Field Reports

Switchgear design and production tests[; G][; G, [\_\_\_\_]]

SD-10 Operation and Maintenance Data

SF6 Insulated Pad-mounted Switchgear Operation and Maintenance, Data Package 5[; G][; G, [\_\_\_\_]]

Submit in accordance with Section 01781 OPERATION AND MAINTENANCE DATA.

1.5 QUALITY ASSURANCE

1.5.1 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

- a. Overall dimensions, weights, plan view, and front view
- b. Ratings
- c. Single-line diagram.

1.5.2 Paint Coating System

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**NOTE:** Select ANSI C57.12.29 when specifying stainless steel enclosures.

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Submit [NEMA C57.12.28] [ANSI C57.12.29] paint coating system performance requirement tests.

[1.5.3 Electronic Overcurrent Control Curves

Provide time-current characteristic curves (on full size logarithmic paper) and instruction manuals for the electronic overcurrent control.

]1.6 MAINTENANCE

1.6.1 SF6 Insulated Pad-mounted Switchgear Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01781, "Operation and Maintenance Data."

PART 2 PRODUCTS

2.1 SF6 INSULATED PAD-MOUNTED SWITCHGEAR

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NOTE: Add reference to IEC 60265-1 for projects located in Europe only after verifying that at least three manufacturers of this switchgear comply with this standard.

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NEMA C37.72[, IEC 60265-1]

2.1.1 Ratings and Test Requirements

The voltage rating of the switchgear shall be [15.5 kV] [27 kV] [38 kV] [as indicated]. The corresponding ratings associated with the required switchgear voltage rating shall be as follows:

\*\*\*\*\*

NOTE: The following optional ratings are available for switchgear assemblies, however, specifying these will require proprietary justification.

1. Optional short-time and short-circuit interrupting current ratings of 16,000 rms symmetrical amperes is available for both two and three position switchgear assemblies.

2. Optional short-time current rating of 25,000 rms symmetrical amperes is available for switchgear assemblies configured with load interrupting switched ways only.

3. For Norfolk Naval Shipyard projects, select optional 25,000 rms symmetrical amperes short-time current rating for switchgear assemblies that are to be installed on the 11.5 kV system.

\*\*\*\*\*

Rated Maximum Voltage, kV	[ 15.5	]	[ 27	]	[ 38]
Rated Withstand Impulse Voltage, kV BIL	[ 95	]	[ 125	]	[ 150]



Continuous and Load Interrupting Current, A	[ 600 ]	[ 600 ]	[ 600 ]
Short-Time Current, kA rms Sym	[ 12 ]	[ 12 ]	[ 10 ]
[Short-Circuit interrupting Current, kA rms Sym	[ 12 ]	[ 12 ]	[ 12 ]

Switched ways shall be rated for the required continuous and load interrupting current.[ Short-circuit interrupting current rating applies to fault interrupting switched ways only.]

## 2.1.2 Switchgear Construction

\*\*\*\*\*  
**NOTE: For LANTDIV projects select "three position switch: Open, Closed, Ground."**  
 \*\*\*\*\*

Switch contacts and cable entrance terminations shall be contained in an SF6 filled stainless steel tank. Switchgear shall be shipped factory filled with SF6 gas conforming to ASTM D 2472. Switchgear shall be configured with[ load interrupting][ and][ fault interrupting] switched ways as indicated. Switchgear shall have front accessible terminations suitable for cables entering from below[ with the manual operating provisions mounted on the rear].[ Switch contact positions for switched ways shall be visible through viewing windows in the SF6 tank located adjacent to the manual operating provisions.] Provide gas pressure gage in viewable location from switch operating handle. Each switched way shall have [three position switch; Open, Closed, Ground][provisions for grounding].

### 2.1.2.1 Pad-mounting Provisions

\*\*\*\*\*  
**NOTE: Choose stainless steel enclosure where environmental conditions are not suitable for mild steel or where a higher level of corrosion protection is desired. Select ANSI C57.12.29 when enclosure is required to be stainless steel.**  
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Provide [non-]enclosed switchgear suitable for installation on a concrete pad. Switchgear[ support frame][ enclosure base][ enclosure] shall be fabricated of ASTM A 167 type 304 or 304L stainless steel.[ Enclosure base shall include any part of the switchgear enclosure that is within 75 mm 3 inches of concrete pad.] Paint [switchgear tank and support frame][enclosure including base] ASTM D 1535 Munsell 7GY3.29/1.5 green. Paint coating system shall comply with [NEMA C57.12.28][ANSI C57.12.29] regardless of equipment material.

### [2.1.3 Load Interrupting Switched Ways

Load interrupter switched ways shall provide[ single-pole][ three-pole group operated] switching[ as indicated].

### ] [2.1.4 Fault Interrupting Switched Ways

\*\*\*\*\*  
**NOTE: 1. Do not provide switchgear units configured with fault interrupting switched ways where the system available fault current is greater than 16,000 rms symmetrical amperes.**  
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2. Do not provide switchgear units configured with  
fault interrupting switched ways at the Norfolk  
Naval Shipyard.

\*\*\*\*\*

IEEE C37.60. Provide non-fused, non-reclosing, manual reset, vacuum interrupters consisting of vacuum bottles and a spring assisted operating mechanism. Each fault interrupting switched way shall utilize internally mounted current transformers and an electronic overcurrent control to provide[ single-pole][ three-pole ganged] tripping[ as indicated] for single-phase[ and three-phase] faults. The electronic overcurrent control shall have provisions for a wide variety of field selectable time-current characteristic curves with ten field selectable trip levels through a current range of[ 300][ 600] amperes.[ Fault interrupting switched ways shall have provisions for remote tripping via an external dry contact device[ as indicated]. Provide[ 120 Vac][ 48 Vdc] remote trip control power as indicated.]

] 2.1.5 Key Interlock

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NOTE: Add requirements for key interlock if needed.  
Provide details of interlock system on the drawings.

\*\*\*\*\*

Provide key interlock system as indicated on the drawings.

] 2.1.6 Dead-Front High-Voltage Bushings

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NOTE: Two types of cable entrances are available:  
600 ampere deadbreak apparatus bushings and 200  
ampere loadbreak bushings. Choose the bushing,  
inserts and connector appropriate for each of the  
specific applications.

If available fault is greater than 10,000 rms  
symmetrical amperes or if cable size is greater than  
No. 4/0 AWG, do not use 200 A loadbreak elbow  
connectors.

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IEEE Std 386. [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL].  
Provide[ 600 ampere one-piece deadbreak apparatus bushings][ and][ 200  
ampere bushing wells with bushing well inserts] for each switched way[ as  
indicated].

\*\*\*\*\*

NOTE: Include standoff bushings only when the  
Activity requires the additional items.

\*\*\*\*\*

- [a. Parking stands: Provide a parking stand near each dead-front  
bushing.[ Provide insulated standoff bushings for parking of  
energized load-break connectors on each parking stands.]]

## 2.2 Insulated High-Voltage Connectors

IEEE Std 386. Provide corresponding connector for each switched way. Connectors shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

- [a. 200 Ampere loadbreak connector ratings: Voltage: [15 kV, 95 kV BIL] [25 kV, 125 kV BIL] [35 kV, 150 kV BIL]. Short time rating: 10,000 rms symmetrical amperes.]

\*\*\*\*\*  
**NOTE: For LANTDIV projects, provide 200 ampere  
bushing interface on all 600 ampere connectors.**  
\*\*\*\*\*

- [b. 600 Ampere deadbreak connector ratings: Voltage: [15 kV, 95 kV BIL] [25 kV, 125 kV BIL] [35 kV, 150 kV BIL]. Short time rating: 40,000 rms symmetrical amperes. [ Connectors shall have 200 ampere bushing interface [ for surge arresters] [ as indicated]. ]]

\*\*\*\*\*  
**NOTE: Include the following paragraph only when the  
activity requires additional grounding elbows and  
feed-thru inserts.**  
\*\*\*\*\*

- [c. Provide [ [one] [\_\_\_\_] set[s] of three grounding elbows] [ and] [ [one] [\_\_\_\_] set[s] of three feed-thru inserts]. [Grounding elbows] [ and ] [feed-thru inserts] shall be delivered to the Contracting Officer.]

## [2.3 Surge Arresters

IEEE C62.11, rated [ [ 3] [ 6] [ 9] [ 10] [ 12] [ 15] [\_\_\_\_] kV] [ as indicated], fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Provide arresters on switched ways as indicated.

## ]2.4 SF6 Refill Cylinders

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**NOTE: Include the following paragraph only when the  
activity requires additional SF6 refill cylinders.**  
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Provide [two] [\_\_\_\_] SF6 refill cylinders, minimum size of 6 pounds of SF6; include regulator, valves, and hose for connection to the fill valve of the switch.

## ]2.5 SOURCE QUALITY CONTROL

### 2.5.1 Switchgear Design and Production Tests

\*\*\*\*\*  
**NOTE: Include IEEE C37.60 when the switchgear will  
have fault interrupting switched ways.**  
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NOTE: Add reference to IEC 60265-1 for projects located in Europe only after verifying that at least three manufacturers of this switchgear comply with this standard.

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Furnish reports which include results of design and production tests performed according to NEMA C37.72[, IEC 60265-1][ and IEEE C37.60]. Production tests shall be performed by the manufacturer on each switchgear assembly to ensure that design performance is maintained in production.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

### 3.2 GROUNDING

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NOTE: Where rock or other soil conditions prevent obtaining a specified ground value, other methods of grounding should be specified. Where it is impractical to obtain indicated ground resistance values, the designer should make every effort, within reason, to obtain ground resistance values as near as possible to the indicated values.

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NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms. When work, in addition to that indicated or specified, is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

#### 3.2.1 Grounding Electrodes

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NOTE: For LANTNAVFACENGCOM projects, use Section 16303N, "Underground Electrical Work" in lieu of Section 16302N, "Underground Transmission and Distribution."

\*\*\*\*\*

Provide driven ground rods as specified in Section [16302N UNDERGROUND TRANSMISSION AND DISTRIBUTION] [\_\_\_\_\_] [ at each corner of switchgear pad] [ as indicated].

#### 3.2.2 Switchgear Grounding

Connect #4/0 bare copper conductor ground loop, not less than 610 mm 24 inches below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide #4/0 bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

#### 3.2.3 Connections

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**NOTE: LANTNAVFACENGCOM Projects should use  
LANTNAVFACENGCOM Section 16303N in lieu of Section  
16302N.**

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Make joints in grounding conductors and ground loop by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in [Section 16302N UNDERGROUND TRANSMISSION AND DISTRIBUTION] [\_\_\_\_\_].

#### 3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

#### 3.3 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount switch on concrete slab. Slab shall be at least 300 mm 12 inches thick, reinforced with a 152 x 152 - MW19 x MW19 6 x 6 - W2.9 x W2.9 mesh, placed uniformly 100 mm 4 inches from the top of the slab. Slab shall be placed on a 150 mm 6 inch thick, well-compacted gravel base. Top of concrete slab shall be approximately 100 mm 4 inches above finished grade. Edges above grade shall have 15 mm 1/2 inch chamfer. Slab shall be of adequate size to project at least 200 mm 8 inches beyond equipment.

Stub up conduits, with bushings, 50 mm 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with switch cable training areas. Concrete work shall be as specified in Section 03300N CAST-IN-PLACE CONCRETE.

#### 3.4 FIELD QUALITY CONTROL

##### 3.4.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS and referenced ANSI standards.

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

##### 3.4.1.1 Switchgear

###### a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate information with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Check for proper anchorage, alignment, required area clearances, and grounding.
- (4) Perform mechanical operator tests in accordance with manufacturer's instructions.
- (5) Verify that insulating SF6 gas pressure is correct.
- (6) Inspect all indicating devices for proper operation.

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**NOTE: Include the following option when key interlocking is specified.**

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[(7) Test interlock systems for proper operation and sequencing.]

b. Electrical Tests

(1) Perform contact-resistance tests.

[(2) Trip fault interrupters by operation of overcurrent control[ and remote trip].]

(3) Perform insulation-resistance tests.

(4) Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.

[(5) Set fault interrupter overcurrent control in accordance with government provided settings. Request settings from government, in writing, a minimum of 30 days prior to scheduling electrical tests.]

3.4.1.2 Grounding System

a. Visual and Mechanical Inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.4.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that devices are in good operating condition and properly performing the intended function. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times for checks and

tests.  
-- End of Section --