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USACE / NAVFAC / AFCEA / NASA            UFGS-16341N (February 2003)  
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Preparing Activity:    NAVFAC            MasterFormat™ 2004 - 26 13 00.00 20  
   Superseding  
   UFGS-16341N (March 2001)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

Latesst change not indicated by CHG tags

References are in agreement with UMRL dated 23 June 2005

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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

\*\*\*\*\*

NOTE: This paragraph is used to list the  
publications cited in the text of the guide  
specification. The publications are referred to in  
the text by basic designation only and listed in  
this paragraph by organization, designation, date,  
and title.

Use the Reference Wizard's Check Reference feature  
when you add a RID outside of the Section's  
Reference Article to automatically place the  
reference in the Reference Article. Also use the  
Reference Wizard's Check Reference feature to update  
the issue dates.

References not used in the text will automatically  
be deleted from this section of the project  
specification when you choose to reconcile  
references in the publish print process.

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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 (2004) 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 (2005) National Electrical Code

NFPA 70B (2002) Electrical Equipment Maintenance

UNDERWRITERS LABORATORIES (UL)

UL 467

(2004) 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.  
\*\*\*\*\*

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

\*\*\*\*\*

NOTE: Review submittal description (SD) definitions  
in Section 01330 SUBMITTAL PROCEDURES and edit the  
following list to reflect only the submittals  
required for the project. Submittals should be kept  
to the minimum required for adequate quality control.

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,  
Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force  
and NASA projects, or choose the second bracketed  
item for Army projects.

\*\*\*\*\*

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

SD-03 Product Data

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

[ Electronic Overcurrent Control Curves; G]

SF6 Insulated Pad-mounted Switchgear; G

Insulated High-Voltage Connectors; G

Surge Arresters; 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

SD-07 Certificates

Paint Coating System; G

SD-09 Manufacturer's Field Reports

Switchgear design and production tests; G

SD-10 Operation and Maintenance Data

SF6 Insulated Pad-mounted Switchgear Operation and Maintenance,  
Data Package 5; 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

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

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

\*\*\*\*\*  
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.  
\*\*\*\*\*

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.**

\*\*\*\*\*

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.  
  
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

\*\*\*\*\*  
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

\*\*\*\*\*  
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.  
\*\*\*\*\*

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

\*\*\*\*\*  
**NOTE: Include the following paragraph only when the  
activity requires additional SF6 refill cylinders.**  
\*\*\*\*\*

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.  
\*\*\*\*\*

\*\*\*\*\*  
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.  
\*\*\*\*\*

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

\*\*\*\*\*  
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.  
\*\*\*\*\*

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

\*\*\*\*\*  
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

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

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.

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

[(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 --