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USACE / NAVFAC / AFCESA / NASA **UFGS-26 12 19.20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change UFGS-16273 (January 2006)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 18 July 2006

Latest change indicated by CHG tags.
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DIVISION 26 - ELECTRICAL

SECTION 26 12 19.20

SINGLE-PHASE PAD-MOUNTED TRANSFORMERS

04/06

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SECTION 26 12 19.20

SINGLE-PHASE PAD-MOUNTED TRANSFORMERS
04/06

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NOTE: This guide specification covers the requirements for single-phase clam shell type and two-compartment type pad-mounted transformers of the dead-front type for exterior applications.

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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Use the following related guide specifications for power distribution equipment:
--Section 26 08 00 APPARATUS INSPECTION AND TESTING
--Section 26 12 19.10 THREE-PHASE PAD-MOUNTED TRANSFORMERS
--Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION
--Section 26 13 00.00 20 SF6 INSULATED PAD-MOUNTED SWITCHGEAR
--Section 26 11 13 SECONDARY UNIT SUBSTATIONS
--Section 26 11 16.00 20 PRIMARY UNIT SUBSTATIONS
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NOTE: TO DOWNLOAD UFGS GRAPHICS

Go to http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf.

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NOTE: This section utilizes the following energy cost and loss value tables, found on CCB following the direections above.

Do not include list of tables, or tables themselves, in project specifications. Use tables to obtain values required in Part 2 of the specification.

For SOUTHNAVFACENGCOM facilities use table SPPM-2.

TABLE NUMBER	TITLE
SPPM-1	Single Phase Pad-Mounted Transformer Loss & Impedance Data - for Energy Cost (EC) Less Than or Equal to $0.04 (1 page)
SPPM-2	Single Phase Pad-Mounted Transformer Loss & Impedance Data - for Energy Cost (EC) Greater Than $0.04 and Less Than or Equal to $0.08 (1 page)
SPPM-3	Single Phase Pad-Mounted Transformer Loss & Impedance Data - for Energy Cost (EC) Greater Than $0.08 and Less Than or Equal to $0.12 (1 page)
EC-1	Energy costs at LANTNAVFACENGCOM Activities (2 pages)

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NOTE: On drawings, show:

1. Single-line diagram showing pad-mounted transformer connectors, inserts, surge arresters, switches, fuses, current transformers with ratings, and meters as applicable.

2. Grounding plan.

3. Type and number of cables, and size of conductors for each power circuit.

4. Transformer primary and secondary voltages. (Use IEEE C57.12.00, Table 11(a), "Designation of voltage ratings of single-phase windings"). State the primary voltage (nominal) actually in service and not the voltage class.

5. Special conditions, such as altitude, temperature, and humidity; exposure to fumes, vapors, dust, and gases; and seismic requirements.

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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.

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(2004) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM D 117	(2002) Sampling, Test Methods, Specifications for Electrical Insulating Oils of Petroleum Origin
ASTM D 1535	(2001) Specifying Color by the Munsell System
ASTM D 3487	(2000) Mineral Insulating Oil Used in Electrical Apparatus
ASTM D 877	(2002e1) Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D 92	(2002b) Flash and Fire Points by Cleveland Open Cup Tester
ASTM D 97	(2004) Pour Point of Petroleum Products

FM GLOBAL (FM)

FM P7825	(2005) Approval Guide

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C12.4	(1984; R1990) Mechanical Demand Registers
IEEE C12.7	(1993; R 1999) Requirements for Watthour Meter Sockets
IEEE C2	(2005) National Electrical Safety Code
IEEE C57.12.00	(2000) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.28	(2005) Pad-Mounted Equipment - Enclosure

	Integrity
IEEE C57.12.80	(2002) Terminology for Power and Distribution Transformers
IEEE C57.12.90	(1999) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(1993; R 2003) Standard Requirements for Instrument Transformers
IEEE C57.98	(1994) Guide for Transformer Impulse Tests
IEEE C62.11	(1999) Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1KV)
IEEE Std 100	(2000) The Authoritave Dictionary of IEEE Standards Terms
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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.1	(2001) Code for Electricity Metering
NEMA C12.10	(2004) Physical Aspects of Watthour Meters
NEMA C37.47	(1981) Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses**
NEMA C57.12.25	(1990) Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with Separable Insulated High-Voltage Connectors; High Voltage, 34 500 GrdY/19 920 Volts and Below; Low-Voltage, 240/120 Volts; 167 kVA and Smaller

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-90/027F	(1993) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms

EPA 712-C-98-075 (1996) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"

UNDERWRITERS LABORATORIES (UL)

UL 467 (2004) Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

****
NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment.
****

Section 26 08 00 APPARATUS INSPECTION AND TESTING appl ies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

1.4 SUBMITTALS

****
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 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Include the bracketed option on "CIEE and 074 review" for NAVFAC Atlantic and SOUTHNAVFACENGCOM projects respectively. For other projects, submittal review shall be performed by the designer of record; If submittal review by NAVFAC Atlantic or SOUTHNAVFACENGCOM is specifically desired, the responsible Government agency must coordinate with the respective Code CIEE or 074 during the design process. Add appropriate information in Section 01 33 00 "Submittal Procedures" to coordinate with the special requirements.

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[[Code CIEE, NAVFAC Atlantic][Code 074, Southern Division, Naval Facilities Engineering Command] will review and approve submittals in this section requiring Government approval.] As an exception to this paragraph, transformers manufactured by ABB in Jefferson City, MO; by Cooper Power Systems in Waukesha, WI; by ERMCO in Dyersburg, TN; or by Howard Industries in Laurel, MS need not submit the entire submittal package requirements of this contract. Instead, the following items shall be submitted:

a. A certification, from the manufacturer, that the technical requirements of this specification shall be met.

b. An outline drawing of the transformer with devices identified (paragraph entitled "Pad-Mounted Transformer Drawings," item a).

c. ANSI nameplate data of the transformer (paragraph entitled "Pad-Mounted Transformer Drawings," item b).

****

NOTE: Use "will" on SOUTHNAVFACENGCOM projects. Coordinate with paragraph entitled "Source Quality Control."

****

d. Routine and other tests (paragraph entitled "Routine and Other Tests"), shall be conducted by the manufacturer and [may][will] be witnessed by the Government (paragraph entitled "Source Quality Control"). Provide transformer test schedule required by submittal item "SD-11 Closeout Submittals". Provide certified copies of the tests.

e. Provide acceptance test reports required by submittal item "SD-06 Test Reports".

f. Provide operation and maintenance manuals required by submittal item "SD-10 Operation and Maintenance Data".

SD-02 Shop Drawings

Pad-mounted transformer drawings[; G][; G, [_____]]

SD-03 Product Data

Single-phase pad-mounted transformers (dead-front)[; G][; G, [_____]]

Submittal shall include manufacturer's information for each component, device, and accessory provided with the transformer.

SD-06 Test Reports

Acceptance checks and tests[; G][; G, [_____]]

SD-07 Certificates

Transformer losses[; G][; G, [_____]]

Submit certification from the manufacturer indicating conformance with the paragraph entitled "Specified Transformer Losses."

SD-09 Manufacturer's Field Reports

Pad-mounted transformer design tests[; G][; G, [_____]]

Pad-mounted transformer routine and other tests[; G][; G, [_____]]

SD-10 Operation and Maintenance Data

Transformer(s), Data Package 5[; G][; G, [_____]]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Transformer test schedule[; G][; G, [_____]]

1.5 QUALITY ASSURANCE

1.5.1 Pad-Mounted Transformer Drawings

Drawings shall indicate, but not be limited to the following:

a. An outline drawing, including front, top, and side views.

b. ANSI nameplate data.

****
NOTE: Navy policy requires that facilities be metered. If exception is taken, coordinate with paragraphs entitled "Additions to Operation and Maintenance Manuals" and "Metering." On "Clam Shells," coordinate with optional metering paragraph.
****

[c. Elementary diagrams and wiring diagrams with terminals identified of meter and current transformers.]

d. One-line diagram, including switch(es)[, current transformers, meters,] and fuses.

e. Manufacturer's published time-current curves (on full size logarithmic paper) of the transformer high side fuse.

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Transformer(s) Operation and Maintenance Data

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

1.6.1.1 Additions to Operation and Maintenance Data

In addition to requirements of Data Package 5, include the following on the actual transformer(s) provided:

a. An instruction manual with pertinent items and information highlighted

b. An outline drawing, including front, top, and side views

c. Prices for spare parts and supply list

d. Routine and field acceptance test reports

e. Fuse curves for primary fuses

****
NOTE: Use the following bracketed option for two-compartment type transformers and when providing a demand meter in a clam shell type transformer.
****

[f. Information on meter, CT's, and fuse block]

g. Actual nameplate diagram

h. Date of purchase

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

****
NOTE: For NAVFAC Atlantic projects, change Section 33 71 02.00 20 UNDERGROUND TRANSMISSION AND DISTRIBUTION to Section L-16303N UNDERGROUND ELECTRICAL WORK (typical throughout this specification).
****

Products and materials not considered to be pad-mounted transformers and related accessories are specified in [Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION,] [Section 33 71 02.00 20 UNDERGROUND TRANSMISSION AND DISTRIBUTION,] [and] [Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM].

2.2 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS (DEAD-FRONT)

****
NOTE: According to IEEE Std 386, 200 ampere separable insulated connectors normally used on dead-front pad-mounted transformers have both a fault closure and a short-time current rating of 10,000 amperes. Therefore, from a safety standpoint, dead-front configurations which utilize these connectors should only be used at system locations which have available fault currents of less than 10,000 rms symmetrical amperes.

Portions of the 4.16 kV system at Dam Neck, VA and all of the 11.5 kV system at Norfolk Naval Shipyard, VA have a fault capability in excess of 10,000 amps. Therefore, 200 amp separable insulated connectors and load-break switches can not be used on pad-mounted transformers in these locations. In these locations use 600 amp separable insulated connectors with a short time rating of 25,000 rms symmetrical amperes.

Normally use single compartment (clam shell) transformers. If two-compartment transformers are required, their use shall be approved by the cognizant EFD or EFA.

****

NEMA C57.12.25, IEEE C57.12.28 and as specified herein.

2.2.1 Compartment Construction

[a. Single compartment: Shall be Type 1 as defined by NEMA C57.12.25 with combination high- and low-voltage compartment. Compartment shall be of the clam shell type with lockable (having pad-locking provisions) hinged cover and single-point latching.]

[b. Two compartment: The high- and low-voltage compartments shall be separated by steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.]

2.2.1.1 High Voltage

****

NOTE: Current policy is to use oil-immersed fuses in series with current limiting fuses to achieve better protection and obtain life cycle cost benefits. Do not use dry-well canister fuses.

Do not provide standoff bushings unless this transformer is the only dead-front transformer on the base. Public works normally carries standoff bushings in their vehicles. Provide protective caps when providing standoff bushings and to cover unused bushing well inserts when not providing surge arresters.

****

****

NOTE: Use two bushing wells for phase-to-neutral systems and four bushing wells for phase-to-phase systems. Coordinate with transformer voltage designations in paragraph entitled "Transformer Type and Ratings." If feed through applications are required, special transformer compartment sizing may be necessary.

****

High-voltage portion shall contain the incoming line, insulated high-voltage load-break connectors, bushing well inserts,[feed-through

inserts,] [two][four] high-voltage bushing wells configured for loop feed application, access to oil-immersed fuses,[dead-front surge arresters,] tap changer handle, connector parking stands[with insulated standoff bushings,][protective caps,] and ground pad.

****

NOTE: The following paragraph is based on 200 ampere connectors. If transformer primary load current is greater than 200 amperes or if primary cable size is greater than No. 4/0 AWG, designer shall determine the appropriate connector system.

****

a. Insulated high-voltage load-break connectors: IEEE Std 386, rated [15][_____] kV, [95][_____] kV BIL. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connectors and inserts shall be the product of a single manufacturer. Connector shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

b. Bushing well inserts[and feed-through inserts]: IEEE Std 386, 200 amperes, [15][_____] kV class. Provide a bushing well insert for each bushing well unless indicated otherwise.[Provide feed-through inserts as indicated.]

c. Provide bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. Bayonet fuse links shall sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing which closes when the fuse holder is removed and an external drip shield. Warning shall be conspicuously displayed adjacent to the bayonet fuse(s) cautioning against removing or inserting fuses unless the transformer has been de-energized and the tank pressure has been released.

   Bayonet fuse assembly: 150 kV BIL.

   Oil-immersed current-limiting fuses: NEMA C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.

[d. Surge arresters: IEEE C62.11, rated [3][6][9][10][12][15][_____] kV, fully shielded, dead-front metal-oxide-varistor, elbow type with resistance-graded gap suitable for plugging into inserts as indicated.]

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

[f. Protective caps: IEEE Std 386, 200 amperes, [15][25][_____] kV class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushing well inserts[and insulated standoff bushings].]

2.2.1.2 Low Voltage

****
NOTE: Installation of circuit breakers in the transformer is not recognized by ANSI standards, and limits accessibility by covering lugs, gages, and accessories. Do not use.
****

Low-voltage portion shall contain low-voltage bushings with NEMA spade terminals, accessories,[metering,] stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, and ground pad.

a. Accessories shall include drain plug, fill plug, pressure relief device and a liquid level sight gage.

[b. Metering

****
NOTE: For single compartment (clam shell type) transformers, provide self-contained meter base at corresponding facility, such as individual housing unit or lift station, and specify in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. If requested by the activity, provide kilowatt demand meter within the transformer.

For two-compartment type transformers, use watthour meters.
****

[1. NEMA C12.10. Metering for single compartment transformers: Provide an electronic kilowatt demand meter mounted in the low-voltage portion of the pad-mounted transformer as indicated.

(a) Meter: Provide kilowatt demand meter coordinated to ratios of current transformers and transformer secondary voltage. Meter shall indicate the highest demand load over a 15-minute interval conforming to IEEE C12.4. Meter accuracy shall be within plus or minus one percent. Provide correct multiplier on face of meter.

(b) Meter fusing: Provide a fuse block mounted in the secondary side containing one fuse per phase to protect the voltage input to the meter. Size fuses as recommended by the meter manufacturer.

(c) Metering assembly: Provide complete system including all devices required.]

[2. NEMA C12.10. Metering for two-compartment transformers: Provide a socket-mounted electronic programmable outdoor watthour meter, surface mounted flush against the side of the low-voltage compartment as indicated. Meter shall either be programmed at the factory or shall be programmed in the field. When field programming is performed, turn field programming device over to the Contracting Officer at completion of project. Meter shall be coordinated to system requirements.

****
NOTE: When Section 23 09 54.00 20, "Direct Digital

Control Systems" is used, coordinate meter requirements. Form 4S, in text below, is for single-phase, three-wire systems, for other system configurations, designer shall determine the appropriate form designation.

****

(a) Design: Provide meter designed for use on a single-phase, three-wire, [240/120][480/240] volt system with two current transformers. Include necessary KYZ pulse initiation hardware for energy monitoring and control system (EMCS)[as specified in Section 23 09 54.00 20 DIRECT DIGITAL CONTROL SYSTEMS].

(b) Coordination: Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

(c) Class: 20
Form: 4S, accuracy: plus or minus 1.0 percent
Finish: Class II

(d) Cover: Polycarbonate and lockable to prevent tampering and unauthorized removal.

(e) Kilowatt-hour register: five digit electronic programmable type

(f) Demand register

(1) Provide solid state

(2) Meter reading multiplier: Indicate multiplier on the meter face.

(3) Demand interval length: shall be programmed for [15][30][60] minutes with rolling demand up to six subintervals per interval.

(g) Meter fusing: Provide a fuse block mounted in the secondary side containing one fuse per phase to protect the voltage input to the meter. Size fuses as recommended by the meter manufacturer.

(h) Socket: IEEE C12.7. Provide NEMA Type 3R, box-mounted socket having automatic circuit-closing bypass and having jaws compatible with requirements of the meter. Cover unused hub openings with blank hub plates. Paint box Munsell 7GY3.29/1.5 green to match the pad-mounted transformer to which the box-mounted socket is attached. The Munsell color notation is specified in ASTM D 1535.]

3. Current transformers IEEE C57.13. Provide butyl-molded window type current transformers with 600-volt insulation, 10 kV BIL and mount on the low-voltage bushings. Route current transformer leads in a location as remote as possible from the power transformer secondary cables to permit current measurements to be taken with hook-on-ammeters. Provide two current transformers per power transformer with characteristics listed in the following table.

****

NOTE: The following guidelines for specifying current transformers are based on the standard current transformer primary rating which is just below the full load current of the power transformer.

1. Select the appropriate current transformer (CT) ratio, continuous-thermal-current rating factor (RF) at 30 degrees C and ANSI metering accuracy class values based on transformer kVA size and secondary voltage. Example: for a 50 kVA transformer at 240 volts - select 200/5, 4.0, 0.3 through B-0.1.

	(VOLTS)				
	240			480	
kVA	CT Ratio	RF	Meter Class	CT Ratio	RF	Meter Class
10	200/5,	4.0,	0.3 thru B-0.1	200/5,	4.0,	0.3 thru B-0.1
15	200/5,	4.0,	0.3 thru B-0.1	200/5,	4.0,	0.3 thru B-0.1
25	200/5,	4.0,	0.3 thru B-0.1	200/5,	4.0,	0.3 thru B-0.1
37.5	200/5,	4.0,	0.3 thru B-0.1	200/5,	4.0,	0.3 thru B-0.1
50	200/5,	4.0,	0.3 thru B-0.1	200/5,	4.0,	0.3 thru B-0.1
75	300/5,	3.0,	0.3 thru B-0.2	200/5,	4.0,	0.3 thru B-0.1
100	400/5,	4.0,	0.3 thru B-0.2	200/5,	4.0,	0.3 thru B-0.1
167	600/5,	3.0,	0.3 thru B-0.5	300/5,	3.0,	0.3 thru B-0.2

2. Incorporate the appropriate values in table.

****

NAME	KVA	SEC. VOLT	CT RATIO	RF	METER ACC. CLASS
[T1]	[50]	[240]	[200/5]	[4.0]	[0.3 thru B-0.1]
[T2]	[75]	[480]	[200/5]	[4.0]	[0.3 thru B-0.1]]

2.2.2 Transformer Type and Ratings

****

NOTE: Use the following guidelines for specifying transformers.

1. Previously the use of mineral oil filled transformers were recommended wherever possible. The recent availability of biodegradable electrical insulating and cooling liquids may have altered that recommendation. For NAVFAC Atlantic, choose less-flammable transformer liquids as specified below for all projects unless there is a specific requirement to do otherwise. Where adequate distance from structures cannot be attained, consult NAVFAC design manuals and UFC 3-600-01, "Design: Fire Protection Engineering for Facilities." Silicon-filled and R-temp filled transformers shall not be used for less-flammable requirements.

2. Use IEEE C57.12.00, Table 11(a), voltage designations, such as "4160 V - 240/120 V" for

transformers connected phase-phase on the primary side, or "4160GrdY/2400 V - 240/120 V" for transformers connected phase-neutral on the primary side. Coordinate the number of bushing wells (either two or four depending on phase-to-neutral, or phase-to-phase systems) with the primary voltage.

3. Tap ratings may vary from those indicated, especially in lower kVA ratings.

4. Specify the following transformer information under the appropriate column headers in the table below: Name, Location, kVA Rating, BIL(kV) Rating (coordinate with primary voltage), Minimum Tested Impedance and Audible Sound Level.

5. Select impedance value in accordance with technical note under paragraph entitled "Specified Transformer Losses.

6. Determine the appropriate audible sound level from the following information.

kVA	DECIBELS (MAX)
10	48
15	48
25	48
37.5	48
50	48
75	51
100	51
167	55

****

a. [Oil-insulated][Less flammable liquid-insulated], two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

b. Transformer voltage ratings: [_____] V - [240/120][480/240] V.

c. Tap changer shall be externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage.

d. Transformer(s) shall have characteristics per the following table:

NAME	LOCATION	KVA	BIL (KV)	MIN TESTED IMP (Percent at 85 Degree C)	DB (MAX)
[T1]	[AMTC Site 1]	[50]	[60]	[___]	[48]
[T2]	[AMTC Site 2]	[75]	[60]	[___]	[51]

****

NOTE: Use "lifting lugs" on two-compartment and "recessed stainless steel lifting provisions" on clam shell type transformers. Delete the "access handhole" on clam shell type transformers.

****

e. Transformer shall include[lifting lugs and provisions for jacking under base][recessed stainless steel lifting provisions]. The transformer base construction shall be suitable for using rollers or skidding in any direction.[Provide transformer top with an access handhole.][Transformer shall have its kVA rating conspicuously displayed on its enclosure.] The transformer shall have an insulated low-voltage neutral bushing with NEMA spade terminal, and with removable ground strap.

2.2.3 Specified Transformer Losses

****

NOTE: Steps to specifying transformer losses.

1. Print Tables SPPM-1, SPPM-2, SPPM-3, and EC-1 as applicable (directions included at the front of this specification).

2. Obtain energy cost for the specific activity from the cognizant EFD or PWC. Energy costs should be based on the cost of energy without the demand charge factors scaled in. Use Table EC-1 for energy costs at the NAVFAC Atlantic activities indicated. Use Table SPPM-2 for energy costs at all SOUTHNAVFACENGCOM activities. (Additional tables will be added for other EFD's as the information becomes available.

3. Use Tables SPPM-1, SSPM-2, and SSPM-3 to specify losses and impedances for transformers based on energy cost range, and transformer primary and secondary voltages.

4. Perform fault current calculations to verify that distribution equipment is coordinated with impedance specified.

****

No-load losses (NLL) in watts at 20 degrees C, and load losses (LL) in watts at 85 degrees C, shall be as follows:

NAME	KVA	"NLL"	"LL"
[T1]	[ ]	[ ]	[ ]
[T2]	[ ]	[ ]	[ ]

The values for the specified losses shall be used for comparison with the losses determined during the routine tests. If the routine test values for no-load losses exceed the specified no-load losses by more than 10 percent, or the total losses exceed the specified total losses (sum of no-load and load losses) by more than 6 percent, the transformer is unacceptable.

2.3 INSULATING LIQUID

****

NOTE: For NAVFAC Atlantic, choose less-flammable transformer liquids for all projects unless there is

a specific requirement to do otherwise.
****

[a. Mineral oil: ASTM D 3487, Type II, tested in accordance with ASTM D 117. Provide identification of transformer as non-PCB and Type II mineral oil on the nameplate.]

[b. Less-flammable transformer liquids: NFPA 70 and FM P7825 for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D 92 and a dielectric strength not less than 33 kV tested per ASTM D 877. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

The fluid shall be a biodegradable electrical insulating and cooling liquid classified by UL and approved by FM as "less flammable" fluids. The fluid shall meet the following fluid properties:

1. Pour point: ASTM D 97, less than -15 degree C

2. Aquatic biodegradation: EPA 712-C-98-075, 100%

3. Trout toxicity: OECD Test 203, zero mortality of EPA 600/4-90/027F, pass]

2.4 LIQUID-FILLED TRANSFORMER NAMEPLATES

Distribution transformers shall be provided with nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

2.5 CORROSION PROTECTION

****
NOTE: Use stainless steel bases and cabinets for most applications. In hostile environments, the additional cost of totally stainless steel tanks and metering may be justified. Manufacturer's standard construction material is acceptable only in noncoastal and noncorrosive environments. Modifications are required to the specification when either of the above conditions apply. Choose the second main bracketed option for hostile environments.
****

[[Front sill, hood, and tank base of single compartment transformers shall be corrosion resistant and shall be stainless steel, no less than No. 13 U.S. gage, conforming to ASTM A 167, Type 304 or 304L. Base shall include any part of pad-mounted transformer that is within 37.5 mm 1.5 inches of concrete pad.][Base and cabinets of two compartment transformers shall be corrosion resistant and shall be stainless steel, conforming to ASTM A 167, Type 304 or 304L. Base shall include any part of pad-mounted transformer that is within 75 mm 3 inches of concrete pad.]Paint bases, cabinets, and tanks Munsell 7GY3.29/1.5 green. Paint coating system shall comply with IEEE C57.12.28. The Munsell color notation is specified in ASTM D 1535.][Entire transformer assembly, including tank and radiator, base, enclosure, and metering enclosure shall be fabricated of stainless steel conforming to ASTM A 167, Type 304 or 304L. Form enclosure of stainless steel sheets. Paint entire transformer assembly Munsell 7GY3.29/1.5 green.

Paint coating system shall comply with IEEE C57.12.28. The Munsell color notation is specified in ASTM D 1535.]

2.6 WARNING SIGNS

Provide warning signs for the enclosures of pad-mounted transformers having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 178 by 255 mm 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 50 mm 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

[b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 355 by 255 mm 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 75 mm 3 inch high white letters on a red and black field.]

2.7 SOURCE QUALITY CONTROL

****
NOTE: Use "reserves the right to" on all projects, except those for SOUTHNAVFACENGCOM.
****

2.7.1 Transformer Test Schedule

The Government [reserves the right to][will] witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

1. The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

3. Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.

4. Dated calibration labels shall be visible on all test equipment.

5. Calibrating standard shall be of higher accuracy than that of the instrument tested.

6. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

   (a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

   (b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.7.2 Design Tests

IEEE C57.12.00, and IEEE C57.12.90. Section 5.1.2 in IEEE C57.12.80 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for[each of] the specified transformer(s). Design tests shall have been performed prior to the award of this contract.

a. Tests shall be certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (ONAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests shall include the primary windings only of that transformer.

   1. IEEE C57.12.90, paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.

   2. State test voltage levels.

   3. Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" requirement for the lifting and moving devices test means a test report confirming that the lifting device being used is capable of handling the weight of the specified transformer in accordance with NEMA C57.12.25.

e. Pressure: "Basically the same design" for the pressure test means a pad-mounted transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

2.7.3 Routine and Other Tests

IEEE C57.12.00. Routine and other tests shall be performed by the manufacturer on[each of] the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery

of equipment to the project site. Required tests shall be as follows:

a. Cold resistance measurements (provide reference temperature)

b. Polarity

c. Ratio

d. No-load losses (NLL) and excitation current

e. Load losses (LL) and impedance voltage

f. Dielectric

   1. Impulse

   2. Applied voltage

   3. Induced voltage

g. Leak

h. Dissolved gas analysis (DGA)

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 GROUNDING

****

NOTE: For SOUTHNAVFACENGCOM projects, delete this paragraph and its subparagraphs, and use optional paragraph entitled "Transformer Grounding" instead.

****

****

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 the indicated ground resistance values, 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 grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02.00 20 UNDERGROUND TRANSMISSION AND DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Pad-Mounted Transformer Grounding

****
NOTE: Ensure plans show the secondary neutral grounding conductor sized in accordance with NFPA 70 and the primary neutral grounding conductor when required.
****

Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in Section 33 71 02.00 20 UNDERGROUND TRANSMISSION AND DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

[3.3 TRANSFORMER GROUNDING

****
NOTE: For SOUTHNAVFACENGCOM projects, use this paragraph in lieu of the previous paragraph entitled "GROUNDING."
****

Provide a 1/0 bare copper-ground girdle around transformer. Girdle shall be buried 305 mm one foot deep and placed 915 mm 3 feet laterally from the transformer enclosure. Connect girdle to enclosure at two opposite places using 1/0 copper. Exothermically weld joints.

]3.4 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect pad-mounted transformers furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

[3.4.1 Meters and Current Transformers

NEMA C12.1.

]3.5 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

[3.6 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 9 meters 30 feet apart.

]3.7 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****
NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the requirement is located. Include construction requirements for concrete slab only if slab is not detailed in drawings. At some activities, curbs or raised edges may also be required around liquid filled transformer.
****

Mount transformer on concrete slab. Unless otherwise indicated, the slab shall be at least 200 mm 8 inches thick, reinforced with a 152 by 152 mm MW19 by MW19 6 by 6 inches - W2.9 by 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 the 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 the equipment.

Stub up conduits, with bushings, 50 mm2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas. Concrete work shall be as specified in Section 03 30 00.00 20 CAST-IN-PLACE CONCRETE.

3.8 FIELD QUALITY CONTROL

3.8.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.8.1.1 Pad-Mounted Transformers

a. Visual and mechanical inspection

1. Compare equipment nameplate information with specifications and approved shop drawings.

2. Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

3. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

4. Verify correct liquid level in tanks.

5. Perform specific inspections and mechanical tests as recommended by manufacturer.

6. Verify correct equipment grounding.

7. Verify the presence of transformer surge arresters.

b. Electrical tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

2. Verify that the tap-changer is set at specified ratio.

3. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

[3.8.1.2 Current Transformers

****
NOTE: Coordinate use of current transformers and meter testing paragraphs with equipment specified in PART 2.
****

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify correct connection.

4. Verify that adequate clearances exist between primary circuits and secondary circuit.

5. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

6. Verify that required grounding and shorting connections provide good contact.

b. Electrical tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

2. Perform insulation-resistance test.

3. Perform a polarity test.

4. Perform a ratio-verification test.

][3.8.1.3 [Kilowatt Demand Meter][Watthour Meter]

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify tightness of electrical connections.

b. Electrical tests

[1. Calibrate watthour meters according to manufacturer's published data.]

2. Verify that correct multiplier has been placed on face of meter, where applicable.

3. Verify that current transformer secondary circuits are intact.

]3.8.1.4 Grounding System

a. Visual and mechanical inspection

1. Inspect ground system for compliance with contract plans and specifications.

****
NOTE: Delete "Electrical tests" below for SOUTHNAVFACENGCOM projects.
****

b. Electrical tests

1. 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.

2. 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.

3.8.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times of checking and testing.

-- End of Section --