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USACE / NAVFAC / AFCEC / NASA **UFGS-26 35 33.00 40 (August 2013)**

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2014
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POWER FACTOR CORRECTION EQUIPMENT
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NOTE: This guide specification covers the requirements for metal-enclosed shunt capacitor equipment. Drawings should show voltage and kilovar ratings and mounting and connection details.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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PART 1 GENERAL

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NOTE: If Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS is not included in the project specification, applicable requirements therefore should be inserted and the following paragraph deleted.
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Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.1 REFERENCES

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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.

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2013) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 18	(2012) Standard for Shunt Power Capacitors

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C; Notice 1) Colors Used in Government Procurement

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, 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.

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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.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Connection Diagrams[; G][; G, [_____]]

Metal Enclosed Shunt Capacitor Equipment[; G][; G, [_____]]

Pole Line Capacitors[; G][; G, [_____]]

Metal Enclosed Low-Voltage Capacitors[; G][; G, [_____]]

Fabrication Drawings[; G][; G, [_____]]

Capacitor Equipment[; G][; G, [_____]]

Installation Drawings[; G][; G, [_____]]

SD-03 Product Data

Metal Enclosed Shunt Capacitor Equipment[; G][; G, [_____]]

Pole Line Capacitors[; G][; G, [_____]]

Metal Enclosed Low-Voltage Capacitors[; G][; G, [_____]]

SD-06 Test Reports

High-Voltage Tests[; G][; G, [_____]]

Insulation-Resistance Test[; G][; G, [_____]]

Capacitance Value Test[; G][; G, [_____]]

SD-07 Certificates

Certificates for Capacitor Equipment[; G][; G, [_____]]

SD-08 Manufacturer's Instructions

Capacitor Equipment [; G][; G, [_____]]

SD-10 Operation and Maintenance Data

Metal-Enclosed Shunt Capacitor Equipment[; G][; G, [_____]]

1.3 QUALITY ASSURANCE

Submit certificates for capacitor equipment showing compliance with the referenced standards contained in this section.

1.4 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

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NOTE: The Predictive Testing and Inspection (PT&I) tests prescribed in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS are MANDATORY for all [NASA] [_____] assets and systems identified as Critical, Configured, or Mission Essential. If the system is non-critical, non-configured, and not mission essential, use sound engineering discretion to assess the value of adding these additional test and acceptance requirements. See Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS for additional information regarding cost feasibility of PT&I.

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This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

PART 2 PRODUCTS

2.1 FABRICATION

Submit connection diagrams indicating the relations and connections of the following items by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Submit fabrication drawings for the following items consisting of fabrication and assembly details to be performed in the factory.

2.2 COMPONENTS

Submit catalog data and equipment and performance data for the following items including life, test, system functional flows, safety features, and mechanical automated details.

2.2.1 Metal-Enclosed Shunt Capacitor Equipment

Metal-enclosed shunt capacitor equipment for connection to 2,400-, 6,900-, and 13,200/13,800-volt, three-phase, 60-hertz circuits consists of a complete assembly of capacitor units including buses, connectors, current-limiting fuses, ventilating fans, switching devices, and controls housed in a weatherproof NEMA 3R metal enclosure in accordance with IEEE 18. Provide control and protective devices in accordance with Section 26 05 70.00 40 HIGH VOLTAGE OVERCURRENT PROTECTIVE DEVICES and Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

Provide capacitor units consisting of polypropylene film and aluminum foil sections with series-parallel connections and discharge resistors contained in hermetically sealed welded steel cases with mounting flanges, immersed in a nonflammable liquid dielectric impregnant. Capacitor housings are bonded zinc-coated steel, resistant to corrosion, weather, and abrasion. Seal two insulating bushings with clamp tunnel connectors to the case of each unit and electrically connected to the capacitor section assembly. Ensure characteristics of capacitor bushings are in accordance with IEEE 18. Provide discharge resistors that reduce the residual voltage of the capacitor unit to 50 volts or less within 5 minutes after disconnection from the source of supply. Each capacitor has an individual insulating fuse. Ensure capacitors operate satisfactorily at 135 percent of rated kilovars (kvar), 110 percent of rated voltage, and at ambient temperatures between minus 40 degrees to plus 46 degrees C minus 40 degrees to plus 115 degrees F. Ensure voltage and kvar ratings for enclosed outdoor capacitor units rated at 60-hertz is in accordance with IEEE 18. Capacitors for harmonic filter application or systems with high harmonic content are EXTREME duty, 55 degree C 131 degree F temp rating, 125 percent continuous over-voltage capability, 15kA fault handling capability, 100KA transient current withstand capability, and meets IEEE 18.

Place pad-mounted capacitor equipment in weatherproof, self-supporting, ventilated unit sheet metal compartments joined together to form a continuous structure, with hinged access doors, base and roof sections, roof seam covers, and end trims. Provide flanged access doors that close against rubber or similar weatherproof gasketing material. Provide ventilated openings with filtered louvers and stainless steel screened vents. Equip doors with latches, stops, and door-locking mechanism. Ensure base section is unit construction and supports capacitor equipment[100 millimeter 4-inches][150 millimeter 6-inches] above the concrete foundation. Design the base for jacking and skidding. Provide lifting lugs for unloading and moving equipment.

Construct sheet metal enclosures from cold-rolled carbon-steel sheets of commercial quality with stretcher-level flatness not less than 3.0 millimeter 11 gage, in accordance with ASTM A1008/A1008M. Reinforce each compartment with structural members and welded together. Grind welds to a smooth flat surface before painting. Provide capacitor equipment with a ground terminal for grounding the stationary structure and equipment.

Provide capacitor compartments with racks for mounting individual capacitor units in one, two, or three tiers, with not more than two rows of units per

tier. Enclosures having one row of units per tier are accessible from one side only.

Phase and neutral buses for the connection and interconnection of capacitor units are bare rigid solid copper busbar of rectangular cross section, insulated from the enclosure. Contact surfaces of all main bus and cable tap connections are silver plated and bolted together to ensure maximum conductivity.

Phase and neutral buses for the connection to underground cables and capacitor units are bare rigid silver plated solid copper busbar of rectangular cross-section insulated from the enclosure. Contact surfaces of all main bus connections are silver plated and bolted together to ensure maximum conductivity.

Ensure each capacitor unit is individually fused with current-limiting fuses that have an interrupting rating of 50,000 amperes and provide visual indication of fuse operation.

Provide top of capacity compartments with thermostatically controlled fans for forced-air ventilation of capacitor units. Provide each enclosure section with two cooling fans. Select fan motors that are for 115-volt, single-phase, 60-hertz current and individually fused or thermally protected. Ensure thermostats control the operation of fans within prescribed temperature limits.

For power entrance compartments, include an insulated phase and neutral bus, a short-circuiting and grounding switch, and provisions for terminating underground cables.

Mechanically interlock short-circuiting and grounding switch with all capacitor compartment doors to prevent access to capacitor units unless phase and neutral buses are short circuited and grounded. Provide a Kirk key-interlocked short-circuiting and grounding switch with the remote circuit disconnecting and protective device to ensure the proper sequence of operation.

2.2.2 Pole Line Capacitors

Ensure pole line capacitors are power line, power factor connection type for 2.4 kilovolts (kV), 5 kV, and 13.2/13.8 kV, 60 hertz and located and installed as indicated. Provide pole supporting hardware that is hot-dip galvanized steel designed for NEMA standard capacitor units. Use corrosion resistant attachment hardware. Poles supporting capacitors cannot be smaller than 200 millimeter 8 inches in diameter at the point of attachment.

2.2.3 Metal-Enclosed Low-Voltage Capacitors

Metal-enclosed capacitors for 600-volt circuits and below consist of individual enclosed units with insulators, connectors, and hardware housed in a protective enclosure. Ensure individual cells are fused and provided with discharge resistors to reduce voltage to 50 volts or less in 1 minute.

Operate capacitor banks within a range of minus 40 degrees to plus 46 degrees C minus 40 degrees to plus 115 degrees F. Impregnate capacitor cells with a nonflammable (PCB-free) dielectric. Provide capacitor banks in banks with welded, 1.9 millimeter, 14-gage, ASTM A1008/A1008M steel, zinc coated. All other requirements are as required for high-voltage installation. Paint color is in accordance with FED-STD-595.

2.2.4 Prevention of Corrosion

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NOTE: For all outdoor applications and all indoor applications in a harsh environment refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS. High performance coatings are specified for all outdoor applications because ultraviolet radiation will break down most standard coatings, causing a phenomena known as chalking, which is the first stage of the corrosion process. For additional information contact The Coatings Industry Alliance, specific suppliers such as Keeler and Long and PPG, and NACE International (NACE).
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Protect metallic materials against corrosion. Ensure equipment has the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS.

2.3 FACTORY TESTING

Tests on capacitor equipment includes electrical and mechanical operational tests and dielectric tests. Conduct dielectric tests in accordance with Testing Standards of IEEE 18 with 60-hertz withstand voltage rating equal to that of the switching device.

Certified copies of previous tests on similar equipment under actual conditions may be submitted for impulse tests, and short-circuit tests in lieu of factory tests on actual units furnished.

PART 3 EXECUTION

3.1 INSTALLATION

Install and connect capacitor equipment in accordance with the manufacturer's installation instructions.

Make ground connections to a driven ground rod or counterpoise, as indicated.

Submit installation drawings for the capacitor equipment. Include in drawings details of equipment room layout and design.

3.2 FIELD TESTING

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NOTE: If the specified system is identified as critical, configured, or mission essential, use Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS to establish predictive and acceptance testing criteria, above and beyond that listed below.
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Perform PT&I tests and provide submittals as specified in Section

01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Disconnect main bus of high-voltage capacitor equipment from the circuit cables, and ground the capacitors and the equipment enclosure before conducting insulation and high-voltage tests.

For the main bus of capacitor equipment, conduct an insulation-resistance test with a 5000-volt insulation test set for units 5 KV and above, 2,500-volt insulation-resistance test set for units 2.4 kV to 5 kV, and 1,000 volts for units 600 volts and below.

Apply tests for not less than 5 minutes and until three equal consecutive readings, 1 minute apart, are obtained. Record readings every 30 seconds during the first 2 minutes and every minute thereafter. Minimum acceptable resistance is 100 megohms.

Upon satisfactory completion of the insulation-resistance test, subject main bus to a high-voltage DC (Hi-pot) test. Test voltage is equal to 75 percent of the factory test values and applied for 1 minute.

Upon satisfactory completion of all bus testing, confirm the capacitor's value by performing a capacitance value test. Discharge the capacitor and measure the capacitance per the manufacturer's instructions. Satisfactory measurement is between 100 percent and 110 percent of nameplate. Values between 90 percent and 100 percent, and 110 percent and 120 percent require investigation. Values outside these limits indicate shorted groups of internal layers and the capacitor considered defective.

Upon satisfactory completion of the capacitance test, subject the capacitor to a dielectric strength test using a DC voltage of 75 percent of the original factory test voltage. Test voltage should be held for 10 seconds. During application of test voltage listen for any indication of internal arcing. If any is heard the unit is defective.

Upon satisfactory completion of the dielectric test, remeasure the capacitance of the capacitor to insure no damage had occurred during the dielectric test. Results cannot vary more than the manufacturer's IEEE tolerance.

Final acceptance depends upon the satisfactory performance of the equipment under test. Do not energize capacitor equipment until the recorded test data has been approved by the Contracting Officer. Provide final test reports to the Contracting Officer. Submit reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --