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USACE / NAVFAC / AFCESA / NASA **UFGS-26 05 70.00 40 (November 2011)**

Preparing Activity: NASA **Superseding UFGS-26 05 70.00 40 (May 2011)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2013
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DIVISION 26 - ELECTRICAL

SECTION 26 05 70.00 40

HIGH VOLTAGE OVERCURRENT PROTECTIVE DEVICES

11/11

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USACE / NAVFAC / AFCESA / NASA	UFGS-26 05 70.00 40 (November 2011)
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SECTION 26 05 70.00 40

HIGH VOLTAGE OVERCURRENT PROTECTIVE DEVICES
11/11

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NOTE: This guide specification covers the requirements for circuit breakers, fuses, motor controls, and control devices. This section supports Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL, Section 26 24 16.00 40 PANELBOARDS, Section 26 24 19.00 40 MOTOR CONTROL CENTERS, and Section 33 75 00.00 40 SWITCHGEAR AND PROTECTION DEVICES; accordingly, include it to the extent applicable to project requirements. Show frame and trip ratings, interrupting ratings, and NEMA types and sizes, as well as single-line and schematic diagrams, elevations, and details on drawings.

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

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 are automatically 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 C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

ASTM INTERNATIONAL (ASTM)

ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM D3487	(2009) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus
ASTM D877	(2002; R 2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 443	(1979) NARM Standard for Solid State Relays Service

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.09	(1999; AMD 1 2005; Corr 1 2007; R 2007; Errata 2007; Amendment B 2011) Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.121	(2012) American National Standard for Switchgear-Unit Substations - Requirements
IEEE C37.13	(2008; INT 1 2009; AMD 1 2012) Standard for Low-Voltage AC Power Circuit Breakers

	Used in Enclosures
IEEE C37.16	(2009) Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC 3200 V and below) Power Circuit Breakers
IEEE C37.17	(2012) Standard for Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers
IEEE C37.90	(2005) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C57.13	(2008; INT 2009) Standard Requirements for Instrument Transformers
IEEE C63.2	(2009) Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz - Specifications
IEEE C63.4	(2009) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering
ANSI C78.23	(1995; R 2003) American National Standard for Incandescent Lamps - Miscellaneous Types
NEMA 107	(1987; R 1993) Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus (inactive)
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 3	(2013) Molded Case Circuit Breakers and Their Application
NEMA FU 1	(2002; R 2007) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2008; E 2010) Standard for Industrial Control and Systems: General Requirements

NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA SG 2	(1993) Standard for High-Voltage Fuses

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 489	(2013) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 50	(2007; Reprint Apr 2012) Enclosures for Electrical Equipment, Non-environmental Considerations
UL 508	(1999; Reprint Apr 2010) Industrial Control Equipment

1.2 SUBMITTALS

****

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, use a code of up to three characters within the submittal tags 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 reviews the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Fuses[; G][; G, [_____]]

Sample Warranty[; G][; G, [_____]]

SD-02 Shop Drawings

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

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

Control Devices[; G][; G, [_____]]

Protective Devices[; G][; G, [_____]]

SD-03 Product Data

Motor Control[; G][; G, [_____]]

Instrument Transformers[; G][; G, [_____]]

Current Transformers[; G][; G, [_____]]

Potential Transformers[; G][; G, [_____]]

Enclosures[; G][; G, [_____]]

Circuit Breakers[; G][; G, [_____]]

Control Devices[; G][; G, [_____]]

Protective Relays[; G][; G, [_____]]

Indicating Instruments[; G][; G, [_____]]

Indicating Lights[; G][; G, [_____]]

SD-06 Test Reports

Dielectric Tests[; G][; G, [_____]]

Timing Test[; G][; G, [_____]]

Insulation Power Factor Test[; G][; G, [_____]]

Final Test Reports[; G][; G, [_____]]

SD-07 Certificates

Circuit Tests[; G][; G, [_____]]

Warranty[; G][; G, [_____]]

SD-08 Manufacturer's Instructions

Control Devices[; G][; G, [_____]]

Protective Devices[; G][; G, [_____]]

SD-10 Operation and Maintenance Data

Manual Motor Controllers[; G][; G, [_____]]

Magnetic Motor Controllers[; G][; G, [_____]]

High Voltage Motor Controllers[; G][; G, [_____]]

Circuit Breakers[; G][; G, [_____]]

Protective Relays[; G][; G, [_____]]

Indicating Instruments[; G][; G, [_____]]

1.3 ADMINISTRATIVE REQUIREMENTS

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NOTE: If Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS is not included in the project specification, insert applicable requirements and delete the following paragraph.
****

[Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

] Prior to the beginning of construction submit manufacturer's equipment and performance data for the following items including use life, system functional flows, safety features, and mechanical automated details:

a. Fuses

b. Motor control

c. Instrument transformers

d. Enclosures

e. Circuit breakers

f. Control devices

g. Protective relays

h. Indicating instruments

i. Indicating lights

j. Submit connection diagrams showing the relations and connections of control devices and protective devices 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.

k. Submit fabrication drawings for control devices and protective devices consisting of fabrication and assembly details to be performed in the factory.

l. Submit manufacturer's sample warranty for review and acceptance to the Contracting Officer

1.4 QUALITY ASSURANCE

1.4.1 Predictive Testing And Inspection Technology Requirements

****
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.
****

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 MOTOR CONTROL

Provide motor controllers conforming to NEMA ICS 3, and UL 508. Provide controllers that have thermal overload protection in each phase.

2.1.1 Manual Motor Controllers

Provide full-voltage, manually operated manual motor controllers for the control and protection of single-phase 60-hertz ac small wattage rating fractional-horsepower squirrel-cage induction motors.

Provide single-throw, single- or double-pole, three-position controllers rated at not more than 750 watt rated 1 horsepower at 115- and 230-volts single phase. Include a supporting base or body of electrical insulating material with enclosed switching mechanism, yoke, thermal overload relay, and terminal connectors. Provide controllers that clearly indicate operating condition: on, off, or tripped.

Provide toggle- or key-operated type manual motor controllers as indicated and arrange so that they are lockable with a padlock in the "OFF" position.

Provide recessed manual motor controllers for single-speed, small wattage rating fractional-horsepower squirrel-cage induction motors that include a single controller and indicating light in a 100 millimeter 4-inch square wall outlet box for flush-wiring devices with matching corrosion-resistant steel flush cover plate. Provide surface-mounted manual motor controllers for single-speed, small wattage rating fractional-horsepower squirrel cage induction motors that include a single controller and indicating light in a NEMA 250, Type [1] [_____] general-purpose enclosure.

Provide recessed and surface-mounted manual motor controllers for two-speed, small wattage rating fractional-horsepower squirrel-cage induction motors that include two controllers, two indicating lights, and a selector switch in a multiple-gang wall outlet box for flush-wiring devices with matching corrosion-resistant steel flush-cover plate. Provide surface-mounted manual motor controllers for two-speed small wattage rating fractional-horsepower squirrel-cage induction motors that include two controllers, two indicating lights, and a selector switch in a NEMA 250, Type [1] [_____] general-purpose enclosure.

2.1.2 Magnetic Motor Controllers

[2.1.2.1 Full-Voltage Controllers

Provide magnetic motor controllers for the control and protection of single- and three-phase, 60-hertz, squirrel-cage induction motors with full-voltage, full magnetic devices in accordance with NEMA ICS 1, NEMA ICS 2, and UL 508.

Provide a coil assembly which operates satisfactorily between 85 and 110 percent of rated coil voltage, with 120 volts, 60 hertz motor control circuits, and with two normally open and two normally closed auxiliary contacts rated per NEMA ICS 1 and NEMA ICS 2 in addition to the sealing-in contact for control circuits. Include solderless pressure wire terminal connectors for line-and load connections to controllers.

Overcurrent protection includes three manual reset thermal overload devices, one in each pole of the controller. Provide thermal overload relays of the [melting-alloy] [bimetallic nonadjustable] type with continuous current ratings and service-limit current ratings and with a plus or minus 15 percent adjustment to compensate for ambient operating conditions.

Provide an externally operable manual-reset button to re-establish control power to the holding coil of the electromagnet. Ensure after the controller has tripped from overload, resetting the motor-overload device will not restart the motor.

Provide enclosure conforming to NEMA 250, Type [_____].

]2.1.3 High-Voltage Motor Controllers

Provide high-voltage motor controllers for the control and protection of squirrel-cage induction motors, wound-rotor induction motors, and synchronous machines rated 2.4 through 7.2 kilovolts, three-phase, that are NEMA ICS 2, Class E2, type as required.

Unless enclosed within a switchgear or unit-substation cubicle, house high-voltage motor controllers in floor-mounted structures of the NEMA type indicated, approximately 2300 millimeter 90 inches high, 750 millimeter 30 inches wide, and 750 millimeter 30 inches deep, with suitable draw-out compartments. Include structural provisions for padlocking the doors.

Subdivide structure into low-voltage control compartment with separate door, high-voltage control compartment with separate door, ac bus compartment, and cable-entrance compartment.

Isolate controller by externally operated draw-out stabs with shutter mechanism which also opens the secondary of the control-power transformer. Provide interlocks to prevent inadvertent operation of the isolating mechanism under load, opening the medium-voltage compartment door without isolating the starter, and closing the line contactor with door open. Include an isolating switch assembly.

For overload protection, include ambient-compensated thermal overload relays and hand reset in all three phases. Utilizing solid-state multifunction overload protection is acceptable when approved.

Provide fused type controllers employing current-limiting power fuses of the interrupting rating indicated. Provide single-phase antitrip protection. On starters, employ magnetic air-break line contactors rated not less than 5 kilovolts. Provide control circuit with provisions for external testing of 120-volt control circuit and a minimum of one set of normally open and normally closed auxiliary contacts.

2.2 INSTRUMENT TRANSFORMERS

Comply with the interference requirements listed below, measured in accordance with IEEE C63.2, IEEE C63.4, and NEMA 107 for Instrument transformers.

Influence		Preferre			Radio	
Insulation Class, kV	Basic Insulation Level, kV	Nominal System Voltage, kV	Test Voltage for Potential Transformers, kV	Test Voltage for Current Transformers, kV	Voltage Level, Microvolts Dry Type	Oil Filled
0.6	10	.....	.....	0.76	250	250
1.2	30	0.208 0.416 0.832 1.04	0.132 0.264 0.528 0.66	0.76	250	250

Influence		Preferre			Radio	
Insulation Class, kV	Basic Insulation Level, kV	Nominal System Voltage, kV	Test Voltage for Potential Transformers, kV	Test Voltage for Current Transformers, kV	Voltage Level, Microvolts Dry Type	Oil Filled
2.5	45	2.40	1.52	1.67	250	250
5.0	60	4.16 4.80	2.64 3.04	3.34	250	250
8.7	75	7.20 8.32	4.57 5.28	5.77	250	250
15L or 15H	95-110	12.00 12.47 14.40	7.62 7.92 9.14	9.41	1000	250
25	150	23.00	14.60	15.70	2500	650
34.5	200	34.50	21.90	23.0	....	650
46	250	46.00	29.20	29.30	....	1250
69	350	69.00	43.80	44.00	....	1250
92	450	92.00	58.40	58.40	....	2500
115	550	115.00	73.40	73.40	....	2500
138	650	138.00	88.00	88.00	....	2500

2.2.1 Current Transformers

Provide current transformers conforming to IEEE C57.13 for installation in metal-clad switchgear. Use standard 3-A secondary transformer.

Provide [wound] [bushing] [bar] [window] type transformers.

Provide transformers that have [single] [double] secondary winding.

Provide transformers that are complete with secondary short-circuiting device.

For window-type current transformers, provide indoor dry type construction with secondary current ratings as indicated with specified burden, frequency, and accuracy.

2.2.2 Potential Transformers

Provide potential transformers conforming to IEEE C57.13 for installation in metal-clad switchgear. Use standard 120-volt secondary transformers.

Provide transformers with [single] [tapped] [double] secondary.

Provide burden, frequency, and accuracy as required.

For disconnecting potential transformers with integral fuse mountings and current-limiting fuses, provide indoor dry type two-winding construction with primary and secondary voltage ratings as required.

2.3 ENCLOSURES

2.3.1 Equipment Enclosures

Provide enclosures for equipment in accordance with NEMA 250.

[a. Contain equipment installed inside clean, dry locations in a NEMA Type 1, general-purpose sheet-steel enclosure.

][b. Contain equipment installed in wet locations in NEMA Type 4 watertight, corrosion-resistant sheet-steel enclosure, constructed to prevent entrance of water when tested in accordance with NEMA ICS 6 for Type 4 enclosures.

][c. Contain equipment installed in industrial locations in a NEMA Type 12 industrial use, sheet-steel enclosure constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

][d. Contain equipment installed in Class I, Division I, Group A, B, C, and D, hazardous locations in NEMA Type 7 enclosures approved for the specific flammable gas or vapor that is possibly present under normal operating conditions.

][e. Contain equipment installed in Class II, Division I, Group E, F and G, hazardous locations in NEMA Type 9 enclosures approved for use where combustible dust is possibly present under normal operating conditions.

[f. Fabricate sheet-steel enclosures from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with UL 50.]

][g. Fabricate steel enclosures from corrosion-resistant, chromium-nickel steel sheet conforming to ASTM A167 Type 300 series with ASM No. 4 general-purpose polished finish, with box dimensions and thickness of sheet steel in accordance with UL 50.

][h. Provide cast-iron enclosures from gray-iron castings conforming to ASTM A48/A48M with tensile-strength classification recognized as suitable for the application. Provide cast metal enclosures that area not less than 3 millimeter 1/8-inch thick at every point, of greater thickness at reinforcing ribs and door edges, and not less than 6 millimeter 1/4-inch thick at tapped holes for conduits.

]2.3.2 Remote-Control Station Enclosures

Provide remote-control station enclosures for pushbuttons, selector

switches, and indicating lights in accordance with the appropriate articles of NEMA ICS 6 and NEMA 250.

[a. Contain remote-control stations installed in indoor, clean, dry locations in NEMA Type 1 general-purpose, sheet-steel enclosures. Contain recessed remote-control stations in standard wall outlet boxes with matching corrosion-resistant steel flush cover plate.

][b. Contain remote-control stations installed in wet locations in NEMA Type 4 watertight, corrosion-resistant sheet-steel enclosures constructed to prevent entrance of water when tested in accordance with NEMA ICS 6 and NEMA 250 for Type 4 enclosures.

][c. Contain remote-control stations installed in wet locations in NEMA Type 4 watertight, cast-iron enclosures constructed to prevent entrance of water when tested in accordance with NEMA ICS 6 and NEMA 250 for Type 4 enclosures.

][d. Contain remote-control stations installed in dry noncombustible dust-laden atmospheres in NEMA Type 12 dusttight, cast-iron enclosures with gaskets or their equivalent to prevent the entrance of dust.

][e. Contain remote-control stations installed in industrial locations in NEMA Type 12 industrial-use, sheet-steel enclosures constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

][f. Contain remote-control stations installed in industrial locations in NEMA Type 12 industrial-use, cast-iron enclosures constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

][g. Contain remote-control stations installed in Class I, Division I, Group A, B, C, and D, hazardous locations in NEMA Type 7 enclosures approved for the specific flammable gas or vapor which is possibly present under normal operating conditions.

][h. Contain remote-control stations installed in Class II, Division I, Group E, F and G, hazardous locations in NEMA Type 9 enclosures approved for use where combustible dust is possibly present under normal operating conditions.
]

****
NOTE: Select the material type most suitable to the project requirements and environmental conditions.
****

[Fabricate sheet-steel enclosures from uncoated carbon-steel sheets of commercial quality with box dimensions and thickness of sheet steel in accordance with UL 50.

][Fabricate steel enclosures from corrosion-resistant, chromium-nickel steel sheet conforming to ASTM A167, Type 300 series with ASM No. 4 general-purpose polished finish, with box dimensions and thickness of sheet steel in accordance with UL 50.

][Provide cast-iron enclosures of gray-iron castings conforming to ASTM A48/A48M, with tensile-strength classification recognized as suitable for this application. Provide cast metal enclosures that are not less than

3 millimeter 1/8-inch thick at every point, of greater thickness at reinforcing ribs and door edges not less than 6 millimeter 1/4 inch thick at tapped holes for conduit.

] Install remote-control stations with the centerline 1700 millimeter 66 inches above the finished floor.

2.4 CIRCUIT BREAKERS

Provide circuit breakers conforming to UL 489, UL 489, and NEMA AB 3.

2.4.1 Power Circuit Breakers

****
NOTE: Specify when or where to install breakers equipped with current-limiting fuses and requirements for coordination with other system protective devices.

Edit breaker description to suit project requirements.
****

Provide air-break type power circuit breakers enclosed in ventilated housings for those rated below 600 volts with current, voltage, and interrupting ratings as required.

Comply with IEEE C37.16 and IEEE C37.13 for power circuit breakers.

Equip power circuit breakers with [electromechanical] [static trip (solid-state)] devices with [long-time/short-time] [instantaneous] elements.Provide breakers that are electrically and mechanically trip-free in any position of the closing stroke. Include ground fault protection in either type trip device. Provide silver-plated main contacts and sintered tungsten alloy arcing contacts. Accomplish tripping by a [shunt-trip] [series-trip] device. Provide [manual] [electrical] closing operation.

Provide drawout type breakers where installed in metal housings such as unit substations. For breakers installed in isolated locations or not as units of a central distribution center, provide [switchboard] [wall] -mounted, with a correctly ventilated protective metal cover.

Supply alarms, auxiliary switches, interlocks, and similar devices as required.

Provide breakers with a removable operating handle, provision for padlocking, and position indicator.

Submit certification of factory testing of Power Circuit Breakers in accordance with IEEE C37.09.

2.4.2 Air Circuit Breakers

Provide circuit breakers that include a ground-fault system or ground-sensing relays.

2.4.2.1 Stored-Energy-Operated Type

For air circuit breakers with stored-energy-operated mechanisms, conform to

IEEE C37.121 for metal-clad switchgear rated above [600 volts] [5 kilovolts], [14.4 kilovolts] [grounded] [ungrounded].

Mount metal-clad air circuit breakers on a mobile frame with primary and secondary disconnecting devices, automatic shutters, and mechanical interlocks to allow complete removal of the unit for inspection and maintenance. Provide three-pole, single-throw, electrically operated circuit breakers, with a motor-charged spring, stored-energy mechanism, and electric release coils for tripping and closing operations.

Provide a motor-operated position-changing mechanism that moves the breaker between the test and operating position by means of a levering device. Provide interlocks to prevent the complete withdrawal of the circuit breaker from its compartment when the stored-energy mechanism is in the fully charged position. Design circuit breakers to prevent the release of stored energy unless the mechanism is fully charged.

Provide circuit breakers that have mechanically trip-free mechanisms with direct-current potential trip coils of the voltage indicated, auxiliary switches, latch-checking switches, control relays, and operation counters.

2.4.2.2 Solenoid-Operated Type

Conform to IEEE C37.121 for air circuit breakers with solenoid-operated mechanisms and the appropriate articles for metal-clad switchgear rated above [600 volts] [5 kilovolts] [14.4 kilovolts].

Mount metal-clad air circuit breakers on a mobile frame with primary and secondary disconnecting devices, automatic shutters, and mechanical interlocks to allow complete removal of the unit for inspection and maintenance. Provide three-pole single-throw circuit breakers, with solenoid-operated tripping/closing mechanism designed for operation on a direct-current station battery power supply or direct from an emergency ac power system of [_____] voltage.

Rate mechanism closing coils for 125 volts and operable at voltages as low as 90 volts. Rate mechanism trip coils for 125 volts and operable at voltages as low as 70 volts. Provide operating mechanism for ac control circuits by the manufacturer for [_____] voltage.

Provide circuit breakers with mechanically trip-free mechanisms including auxiliary switches, latch-checking switches, control relays, and operation counters. The use of solid-state tripping devices is acceptable.

2.4.3 Oil Circuit Breakers

For oil circuit breakers, use control voltage as indicated with a tripping mechanism consisting of a magnet acting as a trigger to release a latch, permitting the breaker to open. Provide a pneumatic operating system with compressors and reservoirs as needed. Integrate tripping/closing control with the breakers.

Provide three phase distribution-voltage breakers with all three interrupters mounted in the same tank. Provide transmission-voltage oil circuit breakers with the phase interrupters mounted in separate tanks.

Equip circuit-breaker bushings with bushing current transformers and standard secondary taps. Provide taps that are terminated outside the tank housing on terminal blocks and identified for short circuiting.

Enclose operating mechanism in a waterproof housing mounted on the breaker framework with heaters to prevent condensation of moisture. Provide a mechanically trip-free breaker mechanism.

Equip each breaker with complete relaying and controls. Provide relaying consisting of instantaneous and overcurrent time-delay relays plus others as indicated and controls consisting of a reclosing relay, control switch, indicating lights, ammeters, and as approved. Install relays and controls in a control cabinet mounted on the breaker housing (solid-state type is acceptable) or install remotely. Provide an externally operable manual trip device.

Supply each oil circuit breaker with tank-lowering and tank-lifting devices. Where applicable, provide a tank drain valve and an oil level indicator on each tank.

Conform to ASTM D3487 for oil used in the oil circuit breakers.

Factory test oil circuit breakers in accordance with IEEE C37.09

2.5 FUSES

Provide a complete set of fuses for all switches and switchgear. Provide fuses that have a voltage rating of not less than the circuit voltage.

Make no change in continuous-current rating, interrupting rating, and clearing or melting time of fuses unless written permission has first been secured.

Provide nonrenewable cartridge type fuses for ratings 30 amperes, 125 volts or less. Provide renewable cartridge type fuses for ratings above 30 amperes 600 volts or less with time-delay dual elements, except where otherwise indicated. Conform to NEMA FU 1 for fuses.

Install special fuses such as extra-high interrupting-capacity fuses, fuses for welding machines, and capacitor fuses where required. Plug fuses are not permitted.

Provide power fuses on ac systems above 600 volts in accordance with NEMA SG 2.

Label fuses showing UL class, interrupting rating, and time-delay characteristics, when applicable. Additionally, clearly list fuse information on equipment drawings.

Provide porcelain fuse holders when field-mounted in a cabinet or box. Do not use fuse holders made of such materials as ebony asbestos, Bakelite, or pressed fiber for field installation.

2.6 PROTECTIVE RELAYS

2.6.1 Overcurrent Relays

Conform to IEEE C37.90 for overcurrent relays.

For protection against phase and ground faults provide single-phase nondirectional removable induction type overcurrent relays with built-in testing facilities designed for operation on the dc or ac control circuit

indicated.

Provide ground-fault overcurrent relays with short-time inverse time characteristics with adjustable current tap range as required.

Provide phase-fault overcurrent relays with varied inverse-time characteristics with adjustable current tap range as required and indicating instantaneous-trip attachments with adjustable current range as required.

Semiflush-mount case with matching cover to the hinged instrument panel.

Provide solid-state static-type trips for low-voltage power circuit breakers in accordance with EIA 443 and IEEE C37.17.

Provide a trip unit that employs a combination of discreet components and integrated circuits to provide the time-current protection functions required in a modern selectively coordinated distribution system.

Provide complete system selective coordination by utilizing a combination of the following time-current curve-shaping adjustments: ampere setting; long-time delay; short-time pickup; short-time delay; instantaneous pickup; and ground fault.

Provide switchable or easily defeatable instantaneous and ground fault trips.

Make all adjustments using non-removable, discrete step, highly reliable switching plugs for precise settings. Provide a sealable, transparent cover over the adjustments to prevent tampering.

Furnish trip devices with three visual indicators to denote the automatic tripping mode of the breaker including: overload; short circuit; and ground fault.

Wire trip unit to appropriate terminals whereby an optional remote automatic trip accessory can be utilized to provide the same indication.

Make available for use a series of optional automatic trip relays for use with the trip unit to provide remote alarm and lockout circuits.

Provide all trip units with test jacks for in-service functional testing of the long-time instantaneous and ground fault circuits using a small hand-held test kit.

2.6.2 Directional Overcurrent Relays

Provide directional overcurrent relays in accordance with IEEE C37.90.

For directional overcurrent relays for protection against reverse-power faults provide single-phase induction type with adjustable time-delay and instantaneous trip attachments. Provide removable type relays with inverse-time directional and overcurrent units with built-in testing facilities.

Semi-flush mount case with matching cover to the hinged instrument panel.

2.6.3 Reclosing Relays

For reclosing relays, conform to IEEE C37.90.

Design reclosing relays to reclose circuit breakers that have tripped from overcurrent. Provide device that automatically recloses the breaker at adjustable time intervals between reclosures and then locks out the breaker in the open position if the fault persists. Provide circuit breaker that remains closed and the reclosing relay resets automatically and is ready to start a new sequence of operation if the fault disappears after any reclosure.

Provide removable reclosing relays with built-in testing facilities and consisting of a timing unit rated at 120/240 volts, single-phase, ac and solenoid and contactor units with dc rating as indicated. Arrange contacts for one instantaneous reclosure and two subsequent reclosures at 15 and 45 seconds, respectively. Set time dial for 60-second drum speed.

Semi-flush mount case with matching cover to the hinged instrument panel.

2.6.4 Undervoltage Relays

For undervoltage relays, conform to IEEE C37.90.

Provide three-phase induction type undervoltage relays including inverse timing with adjustable high- and low-voltage contacts and calibrated scale for protection against loss of voltage, undervoltage, and overvoltage. Equip relays with indicating contactor and voltage switches to provide electrically separate contact circuits. Provide relays that are removable with built-in testing facilities and that are suitable for operation on 120-volt ac circuits with contacts that are suitable for operation on dc or ac control circuits.

Semi-flush mount case with matching cover to the hinged instrument panel.

2.7 INDICATING INSTRUMENTS

2.7.1 Ammeters

For ammeters, conform to ANSI C39.1.

Provide switchboard indicating ammeters of approximately 115 millimeter 4-1/2 inches square with 250-degree scale and recessed cases suitable for flush mounting. Furnish white dials with black figures and black pointers. Mount instruments on the hinged front panel of the switchgear compartment completely isolated from high-voltage circuits. Provide standard 5-ampere type meter for a zero to full-scale normal movement, 60 hertz.

2.7.2 Voltmeters

For voltmeters, conform to ANSI C39.1.

Provide a switchboard indicating voltmeters that is approximately 115 millimeter 4-1/2-inches square with 250-degree scale and recessed cases suitable for flush mounting. Furnish white dials with black figures and black pointers. Mount instruments on the hinged front panel of the switchgear compartment completely isolated from high-voltage circuits. Provide standard 120-volt type voltmeter for a zero to full-scale normal

movement, 60 hertz.

2.7.3 Watt-Hour Meters/Wattmeters

For watt-hour meters, wattmeters, and pulse initiation meters conform to ANSI C12.1.

Provide three-phase induction type switchboard wattmeters for use with instrument transformers with two stators, each equipped with a current and potential coil. Provide meter that is rated for 5 amperes at 120 volts and is suitable for connection to three-phase, 3- and 4-wire circuits. Provide instrument complete with potential indicating lamps, light-load and full-load adjustments, phase balance, power-factor adjustments, four-dial clock register, ratchets to prevent reverse rotation, and built-in testing facilities.

Provide pulse initiating meters for use with demand meters or pulse recorders that are suitable for use with mechanical or electrical pulse initiators. Provide mechanical load imposed on the meter by the pulse initiator that is within the limits of the pulse meter. Provide load as constant as practical throughout the entire cycle of operation to ensure accurate meter readings. Provide pulse initiating meter that is capable of measuring the maximum number of pulses at which the pulse device is nominally rated. Consider pulse initiating meter to be operating properly when a kilowatt hour check indicates that the demand meter kilowatthours are within limits of the watthour meter kilowatthours.

Locate pulse initiating meters such that components sensitive to moisture and temperature conditions are minimized. Take precautions to protect sensitive electronic metering circuitry from electromagnetic and electrostatic induction.

Furnish removable meters with draw out test plug and furnish contact devices to operate remote impulse-totalizing graphic demand meters.

Semi-flush mount case with matching cover to the hinged instrument panel.

2.7.4 Graphic Demand Meters

For impulse-totalizing graphic demand meters conform to ANSI C12.1.

Provide impulse-totaling graphic demand meters that are suitable for use with switchboard watt-hour meters and that include a two-circuit totalizing relay, cyclometer for cumulative record of impulses, four-dial totalizing kilowatt-hour register, synchronous motor for timing mechanism, torque motor, and chart drive. Provide a positive chart-drive mechanism consisting of chart spindles and drive sprockets that maintains the correct chart speed for roll strip charts. Provide instrument that records as well as indicates on clearly legible graph paper the 15-minute integrated kilowatt demand of the totalized system.

Furnish the motive power for advancing the register and pen-movement mechanism with a torque motor. Provide capillary pen containing a 1-month ink supply. Provide a 31-day continuous record of operation roll charts.

Semi-flush mount case with matching cover to the hinged instrument panel.

2.7.5 Specialty-Type Meters

For specialty meters conform to ANSI C39.1. Specialty-type meters are panel meters applicable to specific situations, such as pyrometers and dc parameter meters that conform to the panel layout specified. Provide meter scales that are not less than 180 degrees. Do not use edgewise meters for circuit current and voltage measurements.

2.8 FACTORY TESTING

Submit certification of factory tests on control and low voltage protective devices in accordance with the manufacturer's recommendations.

Conduct short-circuit tests in accordance with Section 2 of NEMA ICS 1 and submit to the Contracting Officer.

Submit certification of factory tests on power, high-voltage, and oil circuit breakers in accordance with IEEE C37.09.

2.9 INDICATING LIGHTS

2.9.1 General-Purpose Type

For indicating lights, provide oiltight instrument devices with threaded base and collar for flush-mounting, translucent convex lens, candelabra screw-base lampholder, and 120-volt, 6-watt, Type S-6 incandescent lamp in accordance with ANSI C78.23. Provide indicating lights color coded in accordance with NEMA ICS 6.

Provide indicating lights in remote-control stations when pushbuttons and selector switches are out of sight of the controller.

2.9.2 Switchboard Indicating Lights

For switchboard indicating lights, provide the manufacturer's standard transformer type units [120-volt input] [_____] utilizing low-voltage lamps and convex lenses of the colors indicated. Provide indicating lights that are capable of being relamped from the switchboard front. Indicating lights utilizing resistors in series with the lamps are not permitted, except in direct-current control circuits. Provide lights that have a press-to-test feature.

2.10 FINISH

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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 breaks 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. Provide equipment with 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.

PART 3 EXECUTION

3.1 INSTALLATION

Install control devices and protective devices that are not factory installed in equipment in accordance with the manufacturer's recommendations and field adjusted and operation tested. Conform to NFPA 70, NEMA ICS 1, NEMA ICS 2, and NEMA ICS 3 requirements for installation of control and protective devices.

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.

Demonstrate to operate as indicated control and protective devices not factory installed in equipment.

Ratio and verify tap settings of instrumentation, potential, and current transformers.

Give circuit breakers rated 15KV and above a timing test to verify proper contact speed, travel, bounce, and wipe.

Give oil and high-voltage circuit breakers and their bushings an insulation power factor test to establish condition monitoring baselines.

Perform and submit dielectric tests on insulating oil in oil circuit breakers before the breakers are energized. Test oil in accordance with ASTM D877, and provide breakdown voltage that is not less than 25,000 volts. Provide manufacturer certification that the oil contains no PCB's and affix a label to that effect on each breaker tank and on each oil drum containing the insulating oil.

Field adjust reduced-voltage starting devices to obtain optimum operating conditions. Provide test meters and instrument transformers that conform to ANSI C12.1 and IEEE C57.13.

Do not energize control and protective devices until recorded test data has been approved. Submit final test 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."

3.3 OPERATION AND MAINTENANCE MANUALS

No less than [30] [_____] days prior to final testing and inspection, submit Operation and Maintenance Manuals to the Contracting Officer for the following equipment:

a. Manual motor controllers

b. Magnetic motor controllers

c. High voltage motor controllers

d. Circuit breakers

e. Protective relays

f. Indicating instruments

3.4 WARRANTY

No less than [30] [_____] days prior to project completion, submit warranty to the Contracting Officer for final review.

-- End of Section --