Preparing Activity: NASA Superseding
UFGS-26 05 71.00 40 (February 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 26 05 71.00 40

LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES

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USACE / NAVFAC / AFCEC / NASA	**UFGS-26 05 71.00 40 (August 2023)**

Preparing Activity: NASA	**Superseding** **UFGS-26 05 71.00 40 (February 2017)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 26 05 71.00 40

LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES
08/23

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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. 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 item(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).
****

PART 1 GENERAL

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to work specified in this section.

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 Reference Identifier (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.
****

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 C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2003; R 2021) Standard Specification for Gray Iron Castings
ASTM A240/A240M	(2023) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.17	(2022) Standard for Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C57.13	(2016) 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	(2014) 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

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60947-3	(2020; Corr 1 2021) Low-Voltage Switchgear and Controlgear – Part 3: Switches, Disconnectors, Switch-Disconnectors and Fuse-Combination Units
IEC 60947-4-1	(2018; INT 1 2020; Corr 2 2021) Low-voltage Switchgear and Controlgear, Part 4-1: Contactors and Motor Starters - Electromechanical Contactor and Motor Starters

IPC - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

IPC D330	(1992) Design Guide Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C78.23	(1995; R 2003) American National Standard for Incandescent Lamps - Miscellaneous Types
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 3	(2013) Molded Case Circuit Breakers and Their Application
NEMA FU 1	(2012) Low Voltage Cartridge Fuses
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 20	(2018; Reprint May 2023) UL Standard for Safety General-Use Snap Switches
UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment,

	Non-Environmental Considerations
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment

1.2 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified 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 Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification 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[, [____]]

Fabrication Drawings; G[, [____]]

Control Devices; G[, [____]]

Protective Devices; G[, [____]]

SD-03 Product Data

Fuses; G[, [____]]

Motor Controllers; G[, [____]]

Instrument Transformers; G[, [____]]

Enclosures; G[, [____]]

Circuit Breakers; G[, [____]]

Control Devices; G[, [____]]

Time Switches; G[, [____]]

Protective Relays; G[, [____]]

Indicating Instruments; G[, [____]]

Indicating Lights; G[, [____]]

SD-06 Test Reports

Final Test Reports; G[, [____]]

SD-07 Certificates

Insulating Oil; G[, [____]]

SD-08 Manufacturer's Instructions

Control Devices; G[, [____]]

Protective Devices; G[, [____]]

SD-10 Operation and Maintenance Data

Manual Motor Controllers; G[, [____]]

Magnetic Motor Controllers; G[, [____]]

Combination Motor Controllers; G[, [____]]

Circuit Breakers; G[, [____]]

Time Switches; G[, [____]]

Protective Relays; G[, [____]]

Indicating Instruments; G[, [____]]

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

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.

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

2.2 EQUIPMENT

2.2.1 Motor Controllers

Provide controllers that conform to NEMA ICS 1, NEMA ICS 2, and UL 508 for motor controllers and have thermal overload protection in each phase.

2.2.1.1 Manual Motor Controllers

Provide full-voltage, manually operated manual motor controllers for the control and protection of single-phase 60-Hz 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 V and 230 V 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 them 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. Include a single controller and indicating light in a 100 millimeter 4-inch-square wall outlet box; for flush-wiring devices, include matching corrosion-resistant steel flush cover plates. 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; 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 plates. Provide surface-mounted manual motor controllers for two-speed small wattage rating, fractional-horsepower, squirrel-cage induction motors; include two controllers, two indicating lights, and a selector switch in a NEMA 250, Type [1] [_____], general-purpose enclosure.

2.2.1.2 Magnetic Motor Controllers

a. Full-Voltage Controllers

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

The operating coil assembly must operate satisfactorily between 85 percent and 110 percent of rated coil voltage. Provide 120 V, 60 Hz motor control circuits.

Provide the controllers with two normally open and two normally closed auxiliary contacts rated according to NEMA ICS 1 and NEMA ICS 2, in addition to the sealing-in contact for the control circuits.

Provide solderless pressure wire terminal connectors for line and load connections to the controllers.

Provide manual reset electronic thermal overload devices for overcurrent protecton, one for each pole, with contiunous current ratings and service limit ranges. Provide overload devices with plus/minus 15 percent adjustment.

Provide an externally operable manual-reset button to reestablish control power to the holding coil of the electromagnet. After the controller has tripped from overload, resetting the motor-overload device must not restart the motor.

Provide an enclosure in accordance with NEMA 250, Type [_____].

b. Reduced-Voltage Starters

Conform to the requirements for full-voltage controllers for reduced-voltage starters, except for voltage, and to the following additional requirements:

(1) Fully protect the motor during all phases of motor starting with an overload device in each motor leg. Rate the starter contacts to withstand the switching surges during selector to full voltage. Provide a starter that contains the sensing and timing devices necessary to monitor motor operation and select the correct time for selector to full voltage.

(2) Resistors and autotransformers used for starting must have ventilation. Ventilate solid-state starters for starting cycles as well as any follow-on restart-run cycles. Operate external control circuits or solid-state starters at a maximum of 120 V ac.

(3) For solid-state starters, provide adjustable starting torque from 0 percent to 50 percent of applied voltage, minimum. Provide autotransformer starters with a minimum of three taps above 50 percent reduced voltage.

2.2.1.3 Combination Motor Controllers

The following requirements are in addition to the requirements specified for magnetic motor controller:

a. Provide combination motor controllers for the control and protection of single- and three-phase, 60 Hz ac squirrel-cage induction motors

with branch-circuit disconnecting and protective devices in accordance with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.

b. For combination motor controllers, include magnetic motor controllers and molded-case circuit breakers or motor circuit protectors (MCPs) in metal enclosures in accordance with NEMA 250 or motor control center draw-out assemblies with control-power transformers, selector switches, pushbuttons, and indicating lights as follows:

(1) Provide full-voltage, full-magnetic devices as specified in this section under paragraph REMOTE-CONTROL STATION ENCLOSURES for magnetic motor controllers and enclosures.

(2) Provide magnetic breakers as specified in paragraph MANUAL MOTOR CONTROLLERS for molded-case circuit breakers. Manufacturer's standard MCPs may be used in lieu of molded-case circuit breakers.

(3) Provide control-power transformers 120 V ac maximum, selector switches, pushbuttons, and pilot lights as required.

(4) Identify combination motor controllers with identification plates affixed to the front cover of the controller.

a. Nonreversing Combination Motor Controllers

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NOTE: Nonreversing, reversing, and two-speed combination motor controllers should be selected from the following paragraphs to suit the project requirements.

****

The following requirements are in addition to the requirements for magnetic motor controllers:

(1) For the control and protection of single-speed squirrel-cage induction motors, include a magnetic controller with molded-case circuit breaker or MCPs with selector switch or start/stop pushbutton and indicating light in the cover of the enclosure.

(2) Provide rating of [single] [and] [three]-phase, single-speed, full-voltage magnetic controllers for nonplugging and nonjogging duty in accordance with NEMA ICS 1 and NEMA ICS 2.

(3) Provide wiring and connections for full-voltage, single-speed magnetic controllers in accordance with NEMA ICS 1 and NEMA ICS 2.

b. Reversing Combination Motor Controllers

The following requirements are in addition to the requirements for magnetic motor controllers:

(1) For the control and protection of single-speed squirrel-cage induction motors, include two interlocked magnetic controllers with molded-case circuit breaker or MCPs, with selector switch or forward/reverse/stop pushbutton and two indicating lights in the cover of the enclosure. Provide indicating lights to identify the forward and reverse running connection of the motor controller.

(2) Provide rating of [single] [and] [three]-phase, single-speed, full-voltage magnetic controllers for plug-stop, plug-reverse, or jogging duty in accordance with NEMA ICS 1 and NEMA ICS 2.

(3) Provide wiring and connections for full-voltage, single-speed magnetic controllers in accordance with NEMA ICS 1 and NEMA ICS 2.

c. Two-Speed Combination Motor Controllers

The following requirements are in addition to the requirements for magnetic motor controllers:

(1) For the control and protection of single- and two-winding, two-speed, three-phase, squirrel-cage induction motors, include two magnetic controllers with molded-case circuit breaker or MCPs, with selector switch or fast/slow/stop pushbutton and two indicating lights in the cover of the enclosure. Provide indicating lights to identify the high- and low-speed running connection of the motor controller.

(2) Provide rating of three-phase, two-speed, full-voltage magnetic controllers for nonplugging and nonjogging duty for constant- and variable-torque motors in accordance with NEMA ICS 1 and NEMA ICS 2.

(3) Provide rating of three-phase, two-speed, full-voltage magnetic controllers for nonplugging and nonjogging duty for constant-motors horsepower motors in accordance with NEMA ICS 1 and NEMA ICS 2.

(4) Provide rating of three-phase, two-speed, full-voltage magnetic controllers for plug-stop, plug-reverse, or jogging duty for constant-torque, variable-torque, and constant wattage-horsepower motors in accordance with NEMA ICS 1 and NEMA ICS 2.

2.2.1.4 Solid State Motor Controllers

Provide solid state [single-phase][two-phase][three-phase] motor controllers with integrated protective devices for induction motors in accordance with [IEC 60947-4-1][IEC 60947-3][and][UL 508]. Provide solid state conrollers that have a contact rating of [_____] amps and [120][208][240][480] VAC.

[Provide the controllers with [one normally open and one normally closed auxiliary contact][two normally open and two normally closed auxiliary contacts] rated according to NEMA ICS 1 and NEMA ICS 2.]

[Provide solderless pressure wire terminal connectors for line and load connections to the controllers.][Provide screw terminal wire connectors for line and load connections to the controllers.]

Provide controller with an externally operable manual-reset button to reestablish control power to the controller. Provide a controller that, after the controller has tripped from overload, resetting the motor-overload device does not restart the motor.

2.2.2 Circuit Breakers

Provide circuit breakers that conform to UL 489 and NEMA AB 3.

2.2.2.1 Molded-Case Circuit Breakers

Provide molded-case, manually operated, trip-free circuit breakers, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection as required. Completely enclose circuit breakers in a molded case, with a factory-sealed, calibrated sensing element to prevent tampering.

Locate thermal-magnetic tripping elements in each pole of the circuit breaker, and provide inverse-time-delay thermal-overload protection and instantaneous magnetic short-circuit protection. Provide an instantaneous magnetic tripping element that is adjustable and accessible from the front of the breaker on frame sizes larger than 100 A.

Size the breaker as required for the continuous-current rating of the circuit. Provide the breaker class as required.

Provide sufficient interrupting capacity of the panel and lighting branch circuit breakers to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Provide circuit breaker interrupting capacities with a minimum of [ ] amps, or as listed in the contract drawings, and that conform to NEMA AB 3.

Provide the common-trip-type multipole circuit breakers having a single operating handle and a two-position on/off indication. Provide circuit breakers with temperature compensation for operation in an ambient temperature of 40 degrees C 104 degrees F. Provide circuit breakers that have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective-type tripping (time delay, magnetic, thermal, or ground fault).

Provide a phenolic-composition breaker body capable of having such accessories as handle-extension, handle-locking, and padlocking devices attached where required.

For meter circuit disconnects, provide circuit breakers of the motor-circuit-protector type that meet the applicable requirements of NFPA 70.

For service disconnection, provide enclosed circuit-breakers with external handles for manual operation. Provide sheet-metal enclosures with hinged covers suitable for surface mounting.

2.2.2.2 Enclosed Molded-Case Circuit Breakers

For enclosed circuit breakers, provide thermal-magnetic, molded-case circuit breakers in surface-mounted, nonventilated enclosures conforming to NEMA 250 and UL 489.

Provide enclosed circuit breakers in nonhazardous locations as follows:

[a. Contain circuit breakers installed inside clean, dry locations in NEMA Type 1, general purpose, sheet-steel enclosures.

][b. Contain circuit breakers installed in unprotected outdoor locations, in NEMA Type 3R, weather-resistant sheet-steel enclosures that are splashproof, weatherproof, sleetproof, and moisture-resistant.

][c. Contain circuit breakers installed in wet locations, in NEMA Type 4,

watertight corrosion-resistant, sheet-steel enclosures constructed to prevent entrance of water.

][d. Contain circuit breakers 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 1 for Type 4 enclosures.

][e. Contain circuit breakers installed in dry, noncombustible, dust-laden atmospheres in NEMA Type 5, dusttight, corrosion-resistant sheet steel enclosures, with gaskets or their equivalent to prevent the entrance of dust.

][f. Contain circuit breakers installed in dry, noncombustible, dust-laden atmospheres in NEMA Type 5, dusttight, cast-iron enclosures, with gaskets or their equivalent to prevent the entrance of dust.

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

][h. Fabricate steel enclosures from corrosion-resistant sheet-steel, conforming to ASTM A240/A240M, 300-series, corrosion-resistant steel. Enclosure dimensions and thickness of the sheet steel must conform to UL 50.

][i. Provide cast-iron enclosures of gray-iron castings conforming to ASTM A48/A48M with tensile-strength classification 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, and not less than 6 millimeter 1/4 inch thick at tapped holes for conduits.

]2.2.3 Fuses

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

Make no change in continuous-current rating, interrupting rating, or clearing or melting time of fuses unless written permission is first obtained from the Contracting Officer.

Provide nonrenewable-cartridge-type fuses for ratings 30 A, 125 V or less. Provide renewable-cartridge-type fuses for ratings above 30 A 600 V or less with time-delay dual elements, except where otherwise indicated. Fuses must conform to NEMA FU 1.

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

Label fuses showing UL class, interrupting rating, and time-delay characteristics, when applicable.

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.

2.2.4 Control Devices

2.2.4.1 Magnetic Contactors

Provide magnetic contactors in accordance with NEMA ICS 1 and NEMA ICS 2 as required for the control of low-voltage, 60-Hz, tungsten-lamp loads, fluorescent-lamp loads, resistance-heating loads, and the primary windings of low-voltage transformers.

Provide core-and-coil assembly that operates satisfactorily with coil voltage between 85 percent and 110 percent of its voltage rating.

Provide contactors that are designed with a normally open holding-circuit auxiliary contact for control circuits, with a rating in accordance with NEMA ICS 1 and NEMA ICS 2.

Furnish solderless pressure wire terminal connectors, or make available for line and load connections to contactors in accordance with NEMA ICS 1 and NEMA ICS 2.

Provide magnetic contactors with a rating in accordance with NEMA ICS 1 and NEMA ICS 2.

2.2.4.2 Control-Circuit Transformers

Provide control-circuit transformers within the enclosure of magnetic contactors and motor controllers when the line voltage exceeds 120 V. Provide an encapsulated dry-type, single-phase, 60-Hz transformer, with a 120 V (or 24 V) isolated secondary winding.

Do not provide a transformer with a rated primary voltage less than the rated voltage of the controller, or a rated secondary current less than the continuous-duty current of the control circuit.

Provide voltage regulation of the transformer such that, with rated primary voltage and frequency, the secondary voltage is not less than 95 percent nor more than 105 percent of rated secondary voltage.

Provide a source of supply for control-circuit transformers at the load side of the main disconnecting device. Protect the secondary winding of the transformer and control-circuit wiring against overloads and short circuits, with fuses selected in accordance with NEMA ICS 6. Ground the secondary winding of the control-circuit transformer in accordance with NEMA ICS 6.

2.2.4.3 Magnetic Control Relays

Provide magnetic control relays for energizing and de-energizing the coils of magnetic contactors or other magnetically operated devices, in response to variations in the conditions of electric control devices in accordance with NEMA ICS 1, and NEMA ICS 2.

Provide units with core-and-coil assembly that operates satisfactorily with coil voltages between 85 percent and 110 percent of their voltage rating.

Provide relays that are designed to accommodate normally open and normally closed contacts.

Provide [120] [_____] V, 60-Hz, Class [AIB] [_____] magnetic control relays with a continuous--contact rating of 10 A, and with current-making and -breaking ability in accordance with NEMA ICS 1 and NEMA ICS 2, two normally open and two normally closed.

[Provide relays that are socket mount type. For each socket mount relay provide compatible relay socket and socket retention device. Sockets are to have finger-safe [screw termminal][spring compression type] wire connection points.]

2.2.4.4 Solid State Control Relays

Provide solid state control relays in accordance with NEMA ICS 1, and NEMA ICS 2.

Relays are to be [SPDT][DPDT][_____] type. Provide relays with contact ratings suitable for the circuit current rating. Relays are to be [DIN rail mount][socket mount][screw or bolt mount] type.

2.2.4.5 Pushbuttons and Switches

****
NOTE: Specify electrically held, magnetic latch, plug-in, or hermetically sealed.
****

a. Pushbuttons

For low-voltage ac full-voltage magnetic pushbutton controllers, provide heavy-duty, oiltight NEMA 250, Type [12] [_____], momentary-contact devices rated 600 V, with pilot light, and with the number of buttons and the marking of identification plates as shown. Furnish pushbutton color code in accordance with NEMA ICS 6.

Provide pushbuttons that are designed with normally open, circuit-closing contacts; normally closed circuit-opening contacts; and two-circuit normally open and normally closed circuit-closing and -opening contacts and that pushbutton-contact ratings are in accordance with NEMA ICS 1 and NEMA ICS 2, with contact designation A600.

Identify pushbuttons in remote-control stations with identification plates affixed to the front cover in a prominent location. Identify the system being controlled on the identification plate.

b. Selector Switches

Provide heavy-duty, oiltight, maintained-contact selector switches for low-voltage control circuits, with the number of positions and the marking of identification plates in accordance with NEMA ICS 1 and NEMA ICS 2.

Identify selector switches in remote-control stations with engraved identification plates affixed to the front cover in a prominent location. Identify the system being controlled on the identification plate.

c. Ammeter Selector Switches

Provide rotary, multistage, snap-action-type ammeter selector switches for switchgear in accordance with UL 20. Use silver-plated contacts rated for 600 V, ac or dc. Provide a manually operated, four-position selector

switch rated for 600 V, 20 A, minimum. The switch is to select the display of current readings on each bus of the main bus from a single indicating instrument. Mount the ammeter switch on the hinged front panel of the switchgear compartment, with engraved escutcheon plate. Completely isolate the switch from high-voltage circuits.

Provide a [pistol-grip] [oval]-type selector switch handle.

d. Voltmeter Selector Switches

Provide rotary, snap-action-type voltmeter selector switches for switchgear in accordance with UL 20. Use silver-plated contacts rated for 600 V ac or dc. Provide manually operated, four-position switches designed to select the display of voltage readings on each phase of the main bus from a single indicating instrument. Mount the voltmeter switch on the hinged front panel of the switchgear compartment, with engraved escutcheon plate. Completely isolate the switch from high-voltage circuits.

Provide a [pistol-grip] [oval]-type selector switch handle.

e. Miscellaneous Switches

Provide float, limit, door, pressure, proximity, and other types of switches in accordance with IPC D330 and of the types and classes indicated.

2.2.5 Finish

****

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 phenomenon known as chalking, which is the first stage of corrosion. For additional information, contact the Coatings Industry Alliance, specific suppliers such as Keeler and Long and PPG, and NACE International (NACE).

****

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 or abrasive action) and all outdoor installations, refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS.

2.3 COMPONENTS

2.3.1 Instrument Transformers

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

Insulaton Class kV	Basic Insulation Level kV	Nominal System Voltage kv	Preferred Test Voltage for Potential Transformers kV	Test Voltage for current Transformer kV	Radio Influence Voltage Level, Microvolts Oil Type or Dry Type
0.6	10	----	----	0.76	250

2.3.1.1 Current Transformers

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

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

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

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

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

2.3.1.2 Potential Transformers

For potential transformers, conform to IEEE C57.13 for installation in metal-clad switchgear. Use standard 120-volt secondary transformers.

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

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.

2.3.2 Enclosures

2.3.2.1 Equipment Enclosures

Provide enclosures for equipment in accordance with NEMA 250.

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

][Contain equipment that is installed in wet or outdoor locations in a NEMA Type 4, watertight, corrosion-resistant, sheet-steel enclosure. Construct the enclosure to prevent entrance of water when tested in accordance with NEMA ICS 6 for Type 4 enclosures.

][Contain equipment that is installed in machine rooms or equipment rooms in a NEMA Type 12, industrial-use, sheet-steel enclosure. Construct the enclosure to prevent the entrance of dust, lint, fibers, and flyings and

the seepage of oil and coolant.

][Contain equipment that is installed in Class I, Division 1, 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.

][Contain equipment that is installed in Class II, Division 1, 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.

][Fabricate sheet-steel enclosures from uncoated carbon sheet-steel of commercial quality and the box dimensions and thickness of sheet-steel conform to UL 50.

][Fabricate steel enclosures from corrosion-resistant, chromium-nickel sheet-steel conforming to ASTM A240/A240M Type 300 series with ASM No. 4, general-purpose, polished finish and the box dimensions and thickness of sheet steel conform to UL 50.

][Provide cast-iron enclosures from gray-iron castings conforming to ASTM A48/A48M with a tensile-strength classification recognized as suitable for the 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, and not less than 6 millimeter 1/4 inch thick at tapped holes for conduits.

]2.3.2.2 Remote-Control Station Enclosures

Provide remote-control station enclosures for pushbuttons, selector switches, and indicating lights in accordance with NEMA ICS 6 and NEMA 250.

[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 plates.

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

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

][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.

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

][Contain remote-control stations installed in industrial locations in NEMA Type 12, industrial-use, cast-iron enclosures. Construct enclosures to

prevent the entrance of dust, lint, fibers, and flyings and the seepage of oil and coolant.

][Contain remote-control stations installed in Class I, Division 1, 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.

][Contain remote-control stations installed in Class II, Division 1, 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.

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

][Fabricate steel enclosures from corrosion-resistant, chromium-nickel sheet-steel, conforming to ASTM A240/A240M, Type 300 series with ASM No. 4, general-purpose, polished finish and the box dimensions and thickness of the sheet steel conform to 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, and 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.

2.3.3 Time Switches

Provide time switches for the control of tungsten-lamp loads, fluorescent-lamp loads, resistive-heating loads, motors, and magnetically operated devices, consisting of a motor-driven time dial and switch assembly in a NEMA 250, Type 1, general-purpose enclosure.

Provide motor drives consisting of 120-V, single-phase, 60-Hz, heavy-duty, self-starting synchronous motors directly connected to the time dial through a geartrain operating mechanism. Provide a spring-wound stored-energy source of reserve power that automatically operates the mechanism for a period of at least 12 hours in case of electric power failure and that the spring automatically rewinds electrically in not more than 3 hours after electric power is restored.

Include a heavy-duty, general-purpose, precision snap-action switch conforming to UL 20 for the switch mechanism, with provisions for manual "OFF" and "ON" operation of the switch.

Provide time switches for the control of 120/240-V, two- and three-wire, single-phase, 60-Hz circuits and 120/208-V, three-phase, four-wire, 60-Hz circuits, with a continuous-current tungsten-lamp load rating of 35 A.

[Provide 24-hour time dials with adjustable on and off trippers for repetitive switching operations at the same time each day. Calibrate the dials in 15-minute intervals over a 24-hour period around its circumference. Provide dials that make one revolution in the 24-hour

period. Make provision to defeat the switching operation over weekends or up to 6 preselected calendar days each week. Provide time dials that have a minimum "ON" time setting of not more than 20 minutes, and are fully adjustable upward in 15-minute intervals throughout each day.

][Provide 7-day-type time dials with adjustable on and off trippers for programmed switching operations for each day in the week. Provide a dial that makes one revolution in not more than 2 1/2 hours, and is fully adjustable upward in 2-hour intervals throughout each day. Calibrate the dial in 2-hour intervals for each day and for each day in the week around its circumference.

][Provide astronomic-type time dials that automatically change settings each day, in accordance with the seasonal time changes in sunrise and sunset. Provide astronomic-type dials that have adjustable on and off trippers, for repetitive switching operations at solar time each day and at each day in the year and that make one revolution in a 24-hour period. Provide time dials that are designed to operate in the "ON" position at sunset and be fully adjustable upward in 15-minute intervals throughout each day, and that indicate the day and month of the year. Calibrate the dials in 15-minute intervals over a 24-hour period around its circumference. Provide a method to defeat the switching operation over weekends or up to 6 preselected calendar days each week.

]2.3.4 Protective Relays

2.3.4.1 Overcurrent Relays

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

Conform relays 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. Provide attachments that indicate instantaneous trip with adjustable current range as required.

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

Provide complete system-selective coordination by using 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 nonremovable, 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 the trip unit to the appropriate terminals so that an optional, remote, automatic trip accessory can be used 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 handheld test kit.

2.3.4.2 Directional Overcurrent Relays

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

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

2.3.4.3 Undervoltage Relays

Provide undervoltage relays that 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. 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 V ac circuits, with contacts that are suitable for operation on dc or ac control circuits.

2.3.5 Indicating Instruments

2.3.5.1 Ammeters

[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 a standard 5-ampere-type meter for a zero-to-full-scale normal movement, 60 Hz.

]2.3.5.2 Voltmeters

[Provide switchboard indicating voltmeters that are 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 a standard 120-volt-type voltmeters for zero-to-full-scale normal

movement, 60 Hz.

]2.3.5.3 Watt-Hour Meters/Wattmeters

Provide watt-hour meters, wattmeters, and pulse initiation meters conforming 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 a meter rated for 5 A at 120 V and suitable for connection to three-phase, three- and four-wire circuits. Provide the 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.

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

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 plugs and furnish contact devices to operate remote impulse-totalizing graphic demand meters.

2.3.5.4 Graphic Demand Meters

Provide impulse-totalizing graphic demand meters conforming to ANSI C12.1.

Provide impulse-totalizing graphic demand meters that are suitable for use with switchboard watt-hour meters and include the following: 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 an 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 a capillary pen containing a 1-month ink supply. Provide roll charts with a 31-day continuous record of operation capacity.

2.3.5.5 Specialty-Type Meters

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 at least 180 degrees. Do not use edgewise meters for circuit current and voltage measurements.

2.3.6 Indicating Lights

2.3.6.1 General-Purpose Type

Provide [LED][incandescent] [oiltight][NEMA 1][NEMA 3R][NEMA 4X][_____] instrument devices with [threaded base with collar][bayonet mount][panel mount] in accordance with ANSI C78.23. Provide indicating lights that are color-coded in accordance with NEMA ICS 6 are rated for use with [120VAC][24VDC] circuits. Provide lights that are [16mm square or rount][22mm diameter][30mm diameter][_____] in size. Provide lights that have "press-to-test' feature.

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

2.3.6.2 Switchboard Indicating Lights

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

[2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

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NOTE: Most equipment in this Section does not require factory testing.
****

]PART 3 EXECUTION

3.1 INSTALLATION

Clearly list fuse information on equipment drawings.

Install control devices and protective devices that are not factory-installed in equipment, in accordance with the manufacturer's recommendations. Field-adjust the devices. Perform operation tests on the control and protective devices. Conform requirements for installation of control and protective devices to NFPA 70, NEMA ICS 1, and NEMA ICS 2.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

Demonstrate the operation and controls of protective devices of non-factory-installed equipment.

Verify tap settings of instrumentation, potential, and current transformers.

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 the results of the recorded test data have been approved by the Contracting Officer. Provide final test reports with a cover letter/sheet clearly marked with the system name, date, and the words final test reports to the Contracting Officer for approval.

-- End of Section --