
USACE / NAVFAC / AFCEC / NASA UFGS-26 05 00.00 40 (August 2016)

Preparing Activity: NASA Superseding
UFGS-26 05 00.00 40 (August 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2017

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 05 00.00 40

COMMON WORK RESULTS FOR ELECTRICAL

08/16

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DEFINITIONS
- 1.3 SUBMITTALS
- 1.4 QUALITY CONTROL
 - 1.4.1 Predictive Testing and Inspection Technology Requirements

PART 2 PRODUCTS

- 2.1 EQUIPMENT
 - 2.1.1 Conduits and Raceways
 - 2.1.1.1 Rigid Steel Conduit
 - 2.1.1.2 Electrical Metallic Tubing (EMT)
 - 2.1.1.3 Flexible Metallic Conduit
 - 2.1.1.4 Intermediate Metal Conduit
 - 2.1.1.5 Rigid Nonmetallic Conduit
 - 2.1.1.6 Wireways and Auxiliary Gutters
 - 2.1.1.7 Surface Raceways and Assemblies
 - 2.1.2 Cable Trays
 - 2.1.3 Wire and Cable
 - 2.1.4 Switches
 - 2.1.4.1 Safety Switches
 - 2.1.4.2 Toggle Switches
 - 2.1.5 Receptacles
 - 2.1.6 Outlet Boxes, Pull Boxes and Junction Boxes
 - 2.1.7 Panelboards
 - 2.1.8 Circuit Breakers
 - 2.1.9 Lamps and Lighting Fixtures
 - 2.1.10 Manufacturer's Nameplate
 - 2.1.11 Warning Signs
 - 2.1.12 Dry-Type Distribution Transformers

PART 3 EXECUTION

3.1 PREPARATION

- 3.2 INSTALLATION
 - 3.2.1 Conduits, Raceways and Fittings
 - 3.2.1.1 Rigid Steel Conduit
 - 3.2.1.2 Electrical Metallic Tubing (EMT)
 - 3.2.1.3 Flexible Metallic Conduit
 - 3.2.1.4 Intermediate Conduit
 - 3.2.1.5 Rigid Nonmetallic Conduit
 - 3.2.1.6 Wireway and Auxiliary Gutter
 - 3.2.1.7 Surface Raceways and Assemblies
 - 3.2.1.8 Cable Trays
 - 3.2.1.9 Splices and Connectors
 - 3.2.2 Wiring
 - 3.2.3 Safety Switches
 - 3.2.4 Wiring Devices
 - 3.2.4.1 Wall Switches and Receptacles
 - 3.2.4.2 Device Plates
 - 3.2.5 Boxes and Fittings
 - 3.2.6 Lamps and Lighting Fixtures
 - 3.2.7 Panelboards
 - 3.2.8 Dry-Type Distribution Transformers
 - 3.2.9 Field Fabricated Nameplates
 - 3.2.10 Identification Plates and Warnings
 - 3.2.11 Posted Operating Instructions
- 3.3 FIELD QUALITY CONTROL

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEC / NASA UFGS-26 05 00.00 40 (August 2016)

Preparing Activity: NASA Superseding
UFGS-26 05 00.00 40 (August 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2017

SECTION 26 05 00.00 40

COMMON WORK RESULTS FOR ELECTRICAL 08/16

NOTE: This guide specification covers the
requirements for common to all electrical sections.

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

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 will automatically

be 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 SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7 (2017) Minimum Design Loads for Buildings
and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM D709 (2017) Standard Specification for
Laminated Thermosetting Materials

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 480 (1981) Toggle Switches

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.28 (2014) Standard for Pad-Mounted Equipment
- Enclosure Integrity

IEEE C57.12.29 (2014) Standard for Pad-Mounted Equipment
- Enclosure Integrity for Coastal
Environments

IEEE Stds Dictionary (2009) IEEE Standards Dictionary: Glossary
of Terms & Definitions

INTERNATIONAL CODE COUNCIL (ICC)

ICC/ANSI A117.1 (2009) Accessible and Usable Buildings and
Facilities

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI Z535.1 (2006; R 2011) American National Standard
for Safety--Color Code

ANSI/NEMA OS 1 (2013) Sheet-Steel Outlet Boxes, Device
Boxes, Covers, and Box Supports

ANSI/NEMA OS 2 (2013) Nonmetallic Outlet Boxes, Device
Boxes, Covers, and Box Supports

NEMA 250 (2014) Enclosures for Electrical Equipment
(1000 Volts Maximum)

NEMA FB 1	(2014) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA PB 1	(2011) Panelboards
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2016) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA VE 1	(2017) Metal Cable Tray Systems
NEMA WD 1	(1999; R 2015) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2016) Wiring Devices Dimensions Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3) National Electrical Code
---------	--

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-222	(2005G; Add 1 2007; Add 2 2009; Add 3 2014; Add 4 2014; R 2014; R 2016) Structural Standards for Steel Antenna Towers and Antenna Supporting Structures
---------	---

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Reprint Aug 2017) UL Standard for Safety Flexible Metal Conduit
UL 1242	(2006; Reprint Mar 2014) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 489	(2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 506	(2017) UL Standard for Safety Specialty Transformers
UL 6	(2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel

UL 797 (2007; Reprint Mar 2017) UL Standard for
Safety Electrical Metallic Tubing -- Steel

UL 870 (2016) UL Standard for Safety Wireways,
Auxiliary Gutters, and Associated Fittings

1.2 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.
- b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.
- [c. Vertical assembly: A vertical assembly is a pole, tower or other such support, mounting hardware, arms, brackets and the load. Load can be a luminaire, siren, loudspeaker or other device. All components of a vertical assembly will be rated by the manufacturer to withstand [217][_____] kilometer/hour [150][_____] mph wind loading in accordance with [ASCE 7][TIA-222].

]1.3 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, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Use the "S" Classification only in SD-11 Closeout Submittals. An "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with

Section 01 33 29 SUSTAINABILITY REPORTING.

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

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists

SD-03 Product Data

Conduits and Raceways; G[, [____]]

Wire and Cable; G[, [____]]

Splices and Connectors; G[, [____]]

Switches; G[, [____]]

Receptacles; G[, [____]]

Outlet Boxes, Pull Boxes and Junction Boxes; G[, [____]]

Circuit Breakers; G[, [____]]

Panelboards; G[, [____]]

Lamps and Lighting Fixtures; G[, [____]]

Dry-Type Distribution Transformers; G[, [____]]

SD-06 Test Reports

Continuity Test; G[, [____]]

Phase-Rotation Tests; G[, [____]]

Insulation Resistance Test; G[, [____]]

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

1.4 QUALITY CONTROL

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 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 have been installed properly and contain no identifiable defects that shorten the design life of a system and its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the 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 EQUIPMENT

Provide the standard cataloged materials and equipment of manufacturers regularly engaged in the manufacture of the products. For material, equipment, and fixture lists submittals, show manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

2.1.1 Conduits and Raceways

2.1.1.1 Rigid Steel Conduit

Provide hot dipped galvanized rigid steel conduit complying with UL 6. Except where installed underground, or in corrosive areas, provide polyvinylchloride (PVC), or painted with bitumastic coated rigid steel conduit in accordance with NEMA RN 1.

Use threaded fittings for rigid steel conduit.

Use solid gaskets. Ensure conduit fittings with blank covers have gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Provide covers with captive screws and are accessible after the work has been completed.

2.1.1.2 Electrical Metallic Tubing (EMT)

Ensure EMT is in accordance with UL 797 and is zinc coated steel. Provide zinc-coated couplings and connectors that are raintight, gland compression type with insulation throat. Crimp, spring, or setscrew type fittings are

not acceptable.

2.1.1.3 Flexible Metallic Conduit

Ensure flexible metallic conduit is galvanized steel and complies with UL 1.

Ensure fittings for flexible metallic conduit are specifically designed for such conduit.

Provide liquidtight flexible metallic conduit with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Ensure fittings for liquidtight flexible metallic conduit are specifically designed for such conduit.

2.1.1.4 Intermediate Metal Conduit

Ensure intermediate metal conduit is galvanized steel and complies with UL 1242.

2.1.1.5 Rigid Nonmetallic Conduit

Ensure rigid nonmetallic conduit complies with NEMA TC 2 and NEMA TC 3 with a wall thickness not less than Schedule 40.

2.1.1.6 Wireways and Auxiliary Gutters

Ensure wireways and auxiliary gutters are a minimum 100 by 100 millimeter 4 by 4-inch trade size conforming to UL 870.

2.1.1.7 Surface Raceways and Assemblies

Ensure surface metal raceways and multi-outlet assemblies conform to NFPA 70, and have receptacles conforming to NEMA WD 1, Type [5-15R] [5-20R].

2.1.2 Cable Trays

Provide ladder type cable trays conforming to NEMA VE 1.

2.1.3 Wire and Cable

Use copper 600-volt type [THHN] [THWN] [XHHW] for conductors installed in conduit. Ensure all conductors 3.15 millimeter diameter AWG No. 8 and larger, are stranded. All conductors smaller than 3.15 millimeter diameter AWG No. 8 are [stranded] [solid].

Ensure flexible cable is Type SO and contains a grounding conductor with green insulation.

Ensure conductors installed in plenums are marked plenum rated.

2.1.4 Switches

2.1.4.1 Safety Switches

Ensure safety switches comply with NEMA KS 1, and are the heavy-duty type with enclosure, voltage, current rating, number of poles, and fusing as indicated on the drawings. Ensure switch construction is such that, when

the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device is coinproof and so constructed that an external tool is used to open the cover. Make provisions to lock the handle in the "OFF" position. Ensure the switch is not capable of being locked in the "ON" position.

Provide switches of the quick-make, quick-break type and terminal lugs for use with copper conductors.

Ensure safety color coding for identification of safety switches conforms to ANSI Z535.1.

2.1.4.2 Toggle Switches

Ensure toggle switches comply with EIA 480, control incandescent, mercury, and fluorescent lighting fixtures and are the heavy duty, general purpose, noninterchangeable flush-type.

Provide commercial grade toggle switches, [single] [double]-pole, [three] [four]-way two-position devices rated 20 amperes at 277 volts, 60 hertz alternating current (ac) only.

Ensure all toggle switches are products of the same manufacturer.

2.1.5 Receptacles

Provide commercial grade, NEMA 5-20R receptacles, 20A, 125 VAC, 2-pole, 3-wire duplex conforming to NEMA WD 6.

2.1.6 Outlet Boxes, Pull Boxes and Junction Boxes

Ensure outlet boxes for use with conduit systems are in accordance with NEMA FB 1 and [ANSI/NEMA OS 1] [ANSI/NEMA OS 2] and are not less than 40 millimeter 1-1/2 inches deep. Furnish all pull and junction boxes with screw-fastened covers.

2.1.7 Panelboards

Provide circuit breaker type lighting and appliance branch circuit panelboards in accordance with NEMA PB 1. Bolt circuit breakers to the bus. Plug-in circuit breakers are not acceptable. Provide copper buses of the rating indicated on the drawings, with main lugs or main circuit breaker. Provide all panelboards for use on grounded ac systems with a full-capacity isolated neutral bus and a separate grounding bus bonded to the panelboard enclosure. Ensure panelboard enclosures are NEMA 250, Type 1, in accordance with NEMA PB 1. Provide enclosure fronts with latchable hinged doors.

2.1.8 Circuit Breakers

Ensure circuit breaker interrupting rating is not less than those indicated and in no event less than [10,000] [20,000] amperes root-mean-square (rms) symmetrical at [208] [240] volts, respectively. Provide multipole circuit breakers of the common-trip type with a single handle. Molded case circuit breakers are bolt-on type conforming to UL 489.

2.1.9 Lamps and Lighting Fixtures

Manufacturers and catalog numbers shown on the drawings are indicative of

the general type desired and are not intended to restrict the selection to fixtures of any particular manufacturer. Fixtures with the same salient features and equivalent light distribution and brightness characteristics, of equal finish and quality, are acceptable. Provide lamps of the proper type and wattage for each fixture.

Ensure ballasts have a high power factor and are energy efficient. Provide ballasts with a Class P terminal protective device for [120] [277]-volt operation as indicated and are rapid-start fluorescent. Use ballasts that are "A" sound rated. Provide standard reduced wattage type fluorescent lamps.

Provide high intensity discharge (HID) lighting fixtures that have prewired integral ballasts and cast aluminum housings complete with tempered glass lenses suitable for installation in damp or wet locations. Provide fixtures and lamps.

2.1.10 Manufacturer's Nameplate

Ensure each item of equipment has a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable.

2.1.11 Warning Signs

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

- a. Enclosure integrity to conform with [IEEE C57.12.28][IEEE C57.12.29], such as for pad-mounted transformers[and pad-mounted SF6 switches]. Provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Provide decal signs with nominal dimensions of 178 by 255 mm 7 by 10 inches. Print the legend "DANGER HIGH VOLTAGE" in two lines of nominal 50 mm 2 inch high letters. Show the word "DANGER" in white letters on a red background and the words "HIGH VOLTAGE" in black letters on a white background.[Use Panduit decal No. PPS0710D72 or approved equal.]
- [b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 355 by 255 mm 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 75 mm 3-inch high white letters on a red and black field.

]2.1.12 Dry-Type Distribution Transformers

Ensure that general purpose dry-type transformers with windings 600 volts or less are two-winding, 60 hertz, and self-cooled in accordance with UL 506. Ensure windings have a minimum of two 2-1/2-percent taps above and below nominal voltage.

PART 3 EXECUTION

3.1 PREPARATION

Submit manufacturer's instructions including special provisions required to install equipment components and system packages. Special provisions

include impedances, hazards and safety precautions.

NOTE: For all outdoor applications and all indoor applications in a harsh environment refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS. High performance coatings are specified for all outdoor applications because ultraviolet radiation will break down most standard coatings, causing a phenomena known as chalking, which is the first stage of the corrosion process. For additional information contact The Coatings Industry Alliance, specific suppliers such as Keeler and Long and PPG, and NACE International (NACE).

Clean and paint conduit, supports, fittings, cabinets, pull boxes, and racks as specified in [Section 09 90 00 PAINTS AND COATINGS][Section 09 96 00 HIGH-PERFORMANCE COATINGS].

Protect metallic materials against corrosion. Provide equipment enclosures with the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and abrasive action), and all outdoor installations, refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS. Do not use aluminum when in contact with earth or concrete and, where connected to dissimilar metal, protect by using approved fittings and treatment. Except where other equivalent protective treatment is specifically approved in writing, provide hot-dip galvanized ferrous metals for items such as, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous items not made of corrosion-resistant steel.

3.2 INSTALLATION

3.2.1 Conduits, Raceways and Fittings

Ensure that conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting does not contain more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.

Do not install crushed or deformed conduit. Avoid trapped conduit runs where possible. Take care to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clear any clogged conduit of obstructions or replace conduit.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings 1470 millimeter 5 feet or more above finished floors and not subject to mechanical damage may be electrical metallic tubing (EMT).

3.2.1.1 Rigid Steel Conduit

Make field-made bends and offsets with approved Hickey bending tool or conduit bending machine. Use long radius conduit for elbows larger than 65 millimeter 2-1/2 inches.

Provide a flush coupling for all conduit stubbed-up through concrete floors

for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, when the floor slab is of sufficient thickness. Otherwise, provide a floor box set flush with the finished floor. For conduits installed for future use, terminate with a coupling and plug; set flush with the floor.

3.2.1.2 Electrical Metallic Tubing (EMT)

Ground EMT in accordance with NFPA 70, using pressure grounding connectors especially designed for EMT.

3.2.1.3 Flexible Metallic Conduit

Use flexible metallic conduit to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.

Use bonding wires in flexible conduit as specified in NFPA 70, for all circuits. Flexible conduit is not considered a ground conductor.

Make electrical connections to vibration-isolated equipment with flexible metallic conduit.

Use liquidtight flexible metallic conduit in wet and oily locations and to complete the connection to motor-driven equipment.

3.2.1.4 Intermediate Conduit

Make all field-made bends and offsets with approved Hickey bending tool or conduit bending machine. Use intermediate metal conduit only for indoor installations.

3.2.1.5 Rigid Nonmetallic Conduit

Ensure rigid PVC conduit is direct buried.

Install a green insulated copper grounding conductor in conduit with conductors and solidly connect to ground at each end. Size grounding wires in accordance with NFPA 70.

3.2.1.6 Wireway and Auxiliary Gutter

Bolt together straight sections and fittings to provide a rigid, mechanical connection and electrical continuity. Close dead ends of wireways and auxiliary gutters. Plug all unused conduit openings.

Support wireways for overhead distribution and control circuits at maximum [_____] [1500] millimeter [5]-foot intervals.

Ensure auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure contains no switches, overcurrent devices, appliances, or apparatus and is not more than [_____] [9000] millimeter [30] feet long.

3.2.1.7 Surface Raceways and Assemblies

Mount surface raceways plumb and level, with the base and cover secured. Minimum circuit run is three-wire, with one wire designated as ground.

3.2.1.8 Cable Trays

Support cable trays from ceiling hangers, equipment bays, or floor or wall supports. Cable trays may be mounted on equipment racks. Provide support when the free end extends beyond [_____] [900] millimeter [3] feet. Maximum support spacing is [_____] [1800] millimeter [6] feet. Support trays 250 millimeter 10-inches wide or less by [one] [_____] hanger. Support trays greater than 250 millimeter 10 inches wide by [two] [_____] hangers. Bond cable trays at splices.

3.2.1.9 Splices and Connectors

Make all splices in 3.15 millimeter diameter AWG No. 8 and smaller with approved [insulated electrical type] [indentor crimp-type connectors and compression tools].

Make all splices in 4.1 millimeter diameter AWG No. 6 and larger with [indentor crimp-type connectors and compression tools] [bolted clamp-type connectors]. Wrap joints with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

3.2.2 Wiring

Color code feeder and branch circuit conductors as follows:

CONDUCTOR	COLOR AC
Phase A	[_____]
Phase B	[_____]
Phase C	[_____]
Neutral	[White] [Natural Gray]
Equipment Grounds	[Green] [Green with Yellow Stripe] [Bare]

Use conductors up to and including 6.5 millimeter diameter AWG No. 2 that are manufactured with colored insulating materials. For conductors larger than 6.5 millimeter diameter AWG No. 2, have ends identified with color plastic tape in outlet, pull, or junction boxes.

Splice in accordance with the NFPA 70. Provide conductor identification within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Match terminal and conductor identification as indicated.

Where several feeders pass through a common pullbox, tag the feeders to clearly indicate the electrical characteristics, circuit number, and panel designation.

3.2.3 Safety Switches

Securely fasten switches to the supporting structure or wall, utilizing a minimum of [four] [_____] 6 millimeter 1/4 inch bolts. Do not use sheet metal screws and small machine screws for mounting. Do not mount switches

in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height [_____] [1500] millimeter [5] feet above floor level, when possible.

3.2.4 Wiring Devices

3.2.4.1 Wall Switches and Receptacles

Install wall switches and receptacles so that when device plates are applied, the plates are aligned vertically to within [_____] [2] millimeter [1/16] inch.

Bond ground terminal of each flush-mounted receptacle to the outlet box with an approved green bonding jumper when used with dry wall type construction.

3.2.4.2 Device Plates

Ensure device plates for switches are suitably engraved with a description of the loads when not within sight of the loads controlled.

Mark device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets. Show the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Use self-adhesive labels having [_____] [6] millimeter [1/4] inch embossed letters.

Similarly mark device plates for convenience outlets indicating the supply panel and circuit number.

3.2.5 Boxes and Fittings

Provide pullboxes where necessary in the conduit system to facilitate conductor installation. For conduit runs longer than [_____] [30] meter [100] feet or with more than three right-angle bends, install a pullbox at a convenient intermediate location.

Securely mount boxes and enclosures to the building structure using supports that are independent of the conduit entering or leaving the boxes.

Select the mounting height of wall-mounted outlet and switch boxes, as measured between the bottom of the box and the finished floor, in accordance with ICC/ANSI A117.1 and as follows:

LOCATION	MOUNTING HEIGHT
Receptacles in offices	450 millimeter
Receptacles in corridors	450 millimeter
Receptacles in shops and laboratories	1200 millimeter
Receptacles in rest rooms	1200 millimeter
Switches for light control	1200 millimeter

LOCATION	MOUNTING HEIGHT (inches)
Receptacles in offices	18
Receptacles in corridors	18
Receptacles in shops and laboratories	48
Receptacles in rest rooms	48
Switches for light control	48

3.2.6 Lamps and Lighting Fixtures

Install new lamps of the proper type and wattage in each fixture. Securely fasten fixtures and supports to structural members and install parallel and perpendicular to major axes of structures.

3.2.7 Panelboards

NOTE: Ability to remove access covers is required for maintenance activities. In addition, access may be required to inspect this device while circuits are energized (for example, using infrared imaging). Minimum distances to energized circuits is specified in OSHA Standards Part 1910.333 (Electrical - Safety-Related work practices). OSHA Standards are available on the internet.

Securely mount panelboards so that the top operating handle does not exceed [____][1800] millimeter [72]-inches above the finished floor. Do not mount equipment within 914 millimeter 36-inches of the front of the panel. Ensure directory card information is complete and legible.

3.2.8 Dry-Type Distribution Transformers

Connect dry-type transformers with flexible metallic conduit.

[Mount all dry-type transformers on vibration isolators in accordance with Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT.

3.2.9 Field Fabricated Nameplates

NOTE: Use the following paragraph where nameplates are fabricated to identify specific equipment designated on the drawings.

Ensure nameplates conform to ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device, as specified or as indicated on the drawings. Each nameplate inscription identifies the function and, when applicable, the position. Provide nameplates that are melamine plastic, 3 mm 0.125-inch thick, white with [black] [____] center core and a matte finish surface [with square

corners]. Accurately align lettering and engrave into the core. Minimum size of nameplates is 25 by 65 mm 1 by 2.5 inches. Lettering is a minimum of 6.35 mm 0.25-inch high normal block style.

3.2.10 Identification Plates and Warnings

Provide identification plates for lighting and power panelboards, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, door bells, pilot lights, disconnect switches, manual starting switches, and magnetic starters. Attach identification plates to process control devices and pilot lights.

Install identification plates for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source. For circuits 480 volts and above, install conspicuously located warning signs in accordance with OSHA requirements.

3.2.11 Posted Operating Instructions

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Ensure operating instructions do not fade when exposed to sunlight. Secure instructions to prevent easy removal or peeling.

Ensure each system and principal item of equipment is as specified in the technical sections for use by operation and maintenance personnel. Include the following information with the operating instructions:

- a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
- b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
- c. Safety precautions.
- d. The procedure in the event of equipment failure.
- e. Other items of instruction as recommended by the manufacturer.

3.3 FIELD QUALITY CONTROL

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.

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

After completion of the installation and splicing, and prior to energizing the conductors, perform wire and cable continuity and insulation tests as herein specified before the conductors are energized.

Provide all necessary test equipment, labor, and personnel to perform the tests, as herein specified.

Isolate completely all wire and cable from all extraneous electrical connections at cable terminations and joints. Use substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices to isolate the circuits under test.

Perform insulation-resistance test on each field-installed conductor with respect to ground and adjacent conductors. Applied potential is 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Take readings after 1 minute and until the reading is constant for 15 seconds. Minimum insulation-resistance values is not less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes 3.15 millimeter diameter AWG No. 8 and smaller insulation resistance testing is not required.

Perform continuity test to insure correct cable connection end-to-end (i.e correct phase conductor, grounded conductor, and grounding conductor wiring). Repair and verify any damages to existing or new electrical equipment resulting from mis-wiring. Receive approval for all repairs from the Contracting Officer prior to commencement of the repair.

Conduct phase-rotation tests on all three-phase circuits using a phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment in a clockwise direction, facing the source.

Submit test reports in accordance with referenced standards in this section.

Final acceptance requires the successful performance of wire and cable under test. Do not energize any conductor until the final test reports are reviewed and approved by the Contracting Officer.

-- End of Section --