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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2012

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SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 05 00.00 40

COMMON WORK RESULTS FOR ELECTRICAL

11/10

PART 1    GENERAL

- 1.1    REFERENCES
- 1.2    DEFINITIONS
- 1.3    SUBMITTALS
- 1.4    PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS
- 1.5    PREVENTION OF CORROSION
- 1.6    GENERAL REQUIREMENTS
- 1.7    POSTED OPERATING INSTRUCTIONS
- 1.8    MANUFACTURER'S NAMEPLATE
- 1.9    FIELD FABRICATED NAMEPLATES
- 1.10   WARNING SIGNS

PART 2    PRODUCTS

- 2.1    MATERIALS
  - 2.1.1   Rigid Steel Conduit
  - 2.1.2   Electrical Metallic Tubing (EMT)
  - 2.1.3   Flexible Metallic Conduit
  - 2.1.4   Intermediate Metal Conduit
  - 2.1.5   Rigid Nonmetallic Conduit
  - 2.1.6   Wireways and Auxiliary Gutters
  - 2.1.7   Surface Raceways and Assemblies
  - 2.1.8   Cable Trays
- 2.2    WIRE AND CABLE
- 2.3    SPLICES AND CONNECTORS
- 2.4    SWITCHES
  - 2.4.1   Safety Switches
  - 2.4.2   Toggle Switches
- 2.5    RECEPTACLES
- 2.6    OUTLETS, OUTLET BOXES, AND PULL BOXES
- 2.7    PANELBOARDS
- 2.8    CIRCUIT BREAKERS
- 2.9    LAMPS AND LIGHTING FIXTURES
- 2.10   DRY-TYPE DISTRIBUTION TRANSFORMERS

PART 3 EXECUTION

- 3.1 CONDUITS, RACEWAYS AND FITTINGS
  - 3.1.1 Rigid Steel Conduit
  - 3.1.2 Electrical Metallic Tubing (EMT)
  - 3.1.3 Flexible Metallic Conduit
  - 3.1.4 Intermediate Conduit
  - 3.1.5 Rigid Nonmetallic Conduit
  - 3.1.6 Wireway and Auxiliary Gutter
  - 3.1.7 Surface Raceways and Assemblies
  - 3.1.8 Cable Trays
- 3.2 WIRING
- 3.3 SAFETY SWITCHES
- 3.4 WIRING DEVICES
  - 3.4.1 Wall Switches and Receptacles
  - 3.4.2 Device Plates
- 3.5 BOXES AND FITTINGS
- 3.6 LAMPS AND LIGHTING FIXTURES
- 3.7 PANELBOARDS
- 3.8 DRY-TYPE DISTRIBUTION TRANSFORMERS
- 3.9 IDENTIFICATION PLATES AND WARNINGS
- 3.10 PAINTING
- 3.11 FIELD TESTING

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEA / NASA UFGS-26 05 00.00 40 (November 2010)  
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SECTION 26 05 00.00 40

### COMMON WORK RESULTS FOR ELECTRICAL 11/10

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NOTE: This guide specification covers the  
requirements 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 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

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NOTE: This paragraph is used to list the  
publications cited in the text of the guide  
specification. The publications are referred to in  
the text by basic designation only and listed in  
this paragraph by organization, designation, date,  
and title.

Use the Reference Wizard's Check Reference feature  
when you add a RID outside of the Section's  
Reference Article to automatically place the  
reference in the Reference Article. Also use the  
Reference Wizard's Check Reference feature to update  
the issue dates.

References not used in the text will automatically

be deleted from this section of the project  
specification when you choose to reconcile  
references in the publish print process.

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The publications listed below form a part of this specification to the  
extent referenced. The publications are referred to within the text by the  
basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709 (2001; R 2007) Laminated Thermosetting  
Materials

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 480 (1981) Toggle Switches

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.28 (2005; INT 3 2011) Standard for  
Pad-Mounted Equipment - Enclosure Integrity

IEEE C57.12.29 (2005) 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 FB 1 (2007; AMD 2010) Standard for Fittings,  
Cast Metal Boxes, and Conduit Bodies for  
Conduit, Electrical Metallic Tubing, and  
Cable

ANSI/NEMA OS 1 (2008; Amd 2010) Sheet-Steel Outlet Boxes,  
Device Boxes, Covers, and Box Supports

ANSI/NEMA OS 2 (2008; AMD 2010) Nonmetallic Outlet Boxes,  
Device Boxes, Covers, and Box Supports

NEMA 250 (2008) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

NEMA KS 1	(2001; R 2006) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA PB 1	(2006; Errata 2008) Panelboards
NEMA RN 1	(2005) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2003) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2004) Standard for Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA VE 1	(2009) Standard for Metal Cable Tray Systems
NEMA WD 1	(1999; R 2005; R 2010) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2002; R 2008) Wiring Devices Dimensions Specifications

#### NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; TIA 11-1; Errata 2011; TIA 11-2; TIA 11-3; TIA 11-4) National Electrical Code
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#### UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Reprint Jul 2007) Standard for Flexible Metal Conduit
UL 1242	(2006; Reprint Jul 2007) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 489	(2009; Reprint Jun 2011) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 506	(2008; Reprint Mar 2010) Specialty Transformers
UL 6	(2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel
UL 797	(2007) Electrical Metallic Tubing -- Steel
UL 870	(2008) Standard for 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, shall be 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 135 mph** wind loading.

## ]1.3 SUBMITTALS

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

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

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

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

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section **01 33 00 SUBMITTAL PROCEDURES**:

#### SD-01 Preconstruction Submittals

Submit Material, Equipment, and Fixture Lists for the following:

Conduits, Raceway and Fittings

Wire and Cable

Splices and Connectors

Switches

Receptacles

Outlets, Outlet Boxes, and Pull Boxes

Circuit Breakers

Panelboards

Lamps and Lighting Fixtures

Dry-Type Distribution Transformers

#### SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Conduits, Raceway and Fittings

Wire and Cable

Splices and Connectors

Switches

Receptacles

Outlets, Outlet Boxes, and Pull Boxes

Circuit Breakers

Panelboards

Lamps and Lighting Fixtures

Dry-Type Distribution Transformers

Spare Parts

Certification

[ Submittal for vertical assemblies will be reviewed by a licensed Mechanical, Civil or Structural Engineer to determine that the entire assembly will withstand 217 kilometer/hour 135 mph wind loading.

] SD-06 Test Reports

Continuity Test

Phase-Rotation Tests

Insulation Resistance Test

SD-08 Manufacturer's Instructions

Submit Manufacturer's Instructions.

#### 1.4 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

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NOTE: The Predictive Testing and Inspection (PT&I) tests prescribed in section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS are MANDATORY for all [NASA] [ ] assets and systems identified as Critical, Configured, or Mission Essential. If the system is non-critical, non-configured, and not mission essential, use sound engineering discretion to assess the value of adding these additional test and acceptance requirements. See Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS for additional information regarding cost feasibility of PT&I.  
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This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

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

#### 1.5 PREVENTION OF CORROSION

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NOTE: For all outdoor applications and all indoor applications in a harsh environment refer to Section 09 96 00 HIGH-PERFORMANCE COATINGS. High performance coatings are specified for all outdoor applications because ultraviolet radiation will break down most standard coatings, causing a phenomena known as chalking, which is the first stage of the corrosion process. For additional information contact The Coatings Industry Alliance, specific suppliers such as Keeler and Long and PPG, and NACE International (NACE).  
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Protect metallic materials against corrosion. 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/or 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 approved fittings and treatment. Ferrous metals such as, but not limited to, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous spare parts not of corrosion-resistant steel shall be hot-dip galvanized except where other equivalent protective treatment is specifically approved in writing.

#### 1.6 GENERAL REQUIREMENTS

Submit material, equipment, and fixture lists for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Submit manufacturer's instructions including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

Submit certification required to install equipment components and system packages.

#### 1.7 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

- 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 of each system or item of equipment.

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. Operating instructions shall not fade when exposed to sunlight and be secured to prevent easy removal or peeling.

#### 1.8 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have 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 will not be acceptable.

#### 1.9 FIELD FABRICATED NAMEPLATES

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

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**ASTM D709.** Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 3 mm 0.125 inch thick, white with [black] [\_\_\_\_\_] center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 25 by 65 mm one by 2.5 inches. Lettering shall be a minimum of 6.35 mm 0.25 inch high normal block style.

#### 1.10 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. When the enclosure integrity of such equipment is specified to be in accordance with **IEEE C57.12.28** or **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). Sign shall be a decal and have nominal dimensions of 178 by 255 mm 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 50 mm 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. 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.

#### ] PART 2 PRODUCTS

##### 2.1 MATERIALS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products.

##### 2.1.1 Rigid Steel Conduit

Rigid steel conduit shall comply with **UL 6** and be galvanized by the hot-dip process. Rigid steel conduit shall be polyvinylchloride (PVC) coated in accordance with **NEMA RN 1**, where underground and in corrosive areas, or must be painted with bitumastic.

Fittings for rigid steel conduit shall be threaded.

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

Covers shall have captive screws and be accessible after the work has been completed.

#### 2.1.2 Electrical Metallic Tubing (EMT)

EMT shall be in accordance with [UL 797](#) and be zinc coated steel. Couplings and connectors shall be zinc-coated, raintight, gland compression with insulation throat. Crimp, spring, or setscrew type fittings are not acceptable.

#### 2.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall comply with [UL 1](#) and be galvanized steel.

Fittings for flexible metallic conduit shall be 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.

Specifically design fittings for liquidtight flexible metallic conduit for such conduit.

#### 2.1.4 Intermediate Metal Conduit

Intermediate metal conduit shall comply with [UL 1242](#) and be galvanized.

#### 2.1.5 Rigid Nonmetallic Conduit

Rigid nonmetallic conduit shall comply with [NEMA TC 2](#) and [NEMA TC 3](#) with wall thickness not less than Schedule 40.

#### 2.1.6 Wireways and Auxiliary Gutters

Wireway and auxiliary gutters shall be a minimum 100 by 100 millimeter 4-by 4 inch trade size conforming to [UL 870](#).

#### 2.1.7 Surface Raceways and Assemblies

Surface metal raceways and multi-outlet assemblies shall conform to [NFPA 70](#). Receptacles shall conform to [NEMA WD 1](#), Type [5-15R] [5-20R].

#### 2.1.8 Cable Trays

Provide ladder type cable trays conforming to [NEMA VE 1](#).

### 2.2 WIRE AND CABLE

Conductors installed in conduit shall be copper 600-volt type [THHN] [THWN] [XHHW]. All conductors 3.15 millimeter diameter AWG No. 8 and larger, shall be stranded. All conductors smaller than 3.15 millimeter diameter AWG No. 8 shall be [stranded] [solid].

Flexible cable shall be Type SO and contain a grounding conductor with green insulation.

Conductors installed in plenums shall be marked plenum rated.

### 2.3 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]. Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

### 2.4 SWITCHES

#### 2.4.1 Safety Switches

Safety switches shall comply with NEMA KS 1, and be the heavy-duty type with enclosure, voltage, current rating, number of poles, and fusing as indicated. Switch construction shall be such that, when the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device shall be coinproof and be so constructed that an external tool shall be used to open the cover. Make provisions to lock the handle in the "OFF" position, but the switch shall not be capable of being locked in the "ON" position.

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

Safety color coding for identification of safety switches shall conform to ANSI Z535.1.

#### 2.4.2 Toggle Switches

Toggle switches shall comply with EIA 480, control incandescent, mercury, and fluorescent lighting fixtures and be of the heavy duty, general purpose, noninterchangeable flush-type.

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

All toggle switches shall be products of the same manufacturer.

### 2.5 RECEPTACLES

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

### 2.6 OUTLETS, OUTLET BOXES, AND PULL BOXES

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

### 2.7 PANELBOARDS

Lighting and appliance branch circuit panelboards shall be the circuit-breaker type in accordance with NEMA PB 1. Bolt circuit breakers to the bus. Plug-in circuit breakers are not acceptable. Buses shall be

copper of the rating indicated, with main lugs or main circuit breaker as indicated. 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. Panelboard enclosures shall be NEMA 250, Type 1, in accordance with NEMA PB 1. Provide enclosure fronts with latchable hinged doors.

## 2.8 CIRCUIT BREAKERS

Circuit-breaker interrupting rating shall be 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. Multipole circuit breakers shall be the common-trip type with a single handle. Molded case circuit breakers shall be bolt-on type conforming to UL 489.

## 2.9 LAMPS AND LIGHTING FIXTURES

Manufacturers and catalog numbers shown 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.

Ballasts shall be high power factor and be energy efficient. Ballasts shall have a Class P terminal protective device for [120] [277]-volt operation as indicated and be rapid-start fluorescent. Ballasts shall be "A" sound rated. Fluorescent lamps shall be standard reduced wattage type.

High intensity discharge (HID) lighting fixtures shall 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.

## 2.10 DRY-TYPE DISTRIBUTION TRANSFORMERS

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

# PART 3 EXECUTION

## 3.1 CONDUITS, RACEWAYS AND FITTINGS

Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting shall 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 be replaced.

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).

#### 3.1.1 Rigid Steel Conduit

Make field-made bends and offsets with approved hickey or conduit bending machine. Conduit elbows larger than 65 millimeter 2-1/2 inches shall be long radius.

Provide 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, with a flush coupling when the floor slab is of sufficient thickness. Otherwise, provide a floor box set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

#### 3.1.2 Electrical Metallic Tubing (EMT)

EMT shall be grounded in accordance with NFPA 70, using pressure grounding connectors especially designed for EMT.

#### 3.1.3 Flexible Metallic Conduit

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

Bonding wires shall be used in flexible conduit as specified in NFPA 70, for all circuits. Flexible conduit shall not be considered a ground conductor.

Electrical connections to vibration-isolated equipment shall be made with flexible metallic conduit.

Liquidtight flexible metallic conduit shall be used in wet and oily locations and to complete the connection to motor-driven equipment.

#### 3.1.4 Intermediate Conduit

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

#### 3.1.5 Rigid Nonmetallic Conduit

Rigid PVC conduit shall be direct buried.

A green insulated copper grounding conductor shall be in conduit with conductors and be solidly connected to ground at each end. Grounding wires shall be sized in accordance with NFPA 70.

#### 3.1.6 Wireway and Auxiliary Gutter

Straight sections and fittings shall be bolted together to provide a rigid, mechanical connection and electrical continuity. Dead ends of wireways and auxiliary gutters shall be closed. Plug all unused conduit openings.

Wireways for overhead distribution and control circuits shall be supported at maximum [\_\_\_\_\_] [1500] millimeter [5]-foot intervals.

Auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure shall contain no switches, overcurrent

devices, appliances, or apparatus and be not more than [\_\_\_\_\_] [9000] millimeter [30] feet long.

### 3.1.7 Surface Raceways and Assemblies

Surface raceways shall be mounted plumb and level, with the base and cover secured. Minimum circuit run shall be three-wire with one wire designated as ground.

### 3.1.8 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 shall be [\_\_\_\_\_] [1800] millimeter [6] feet. Trays 250 millimeter 10-inches wide or less shall be supported by [one] [\_\_\_\_\_] hanger. Trays greater than 250 millimeter 10-inches wide shall be supported by [two] [\_\_\_\_\_] hangers. Bond cable trays at splices.

## 3.2 WIRING

Feeder and branch circuit conductors shall be color coded as follows:

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

Conductors up to and including 6.5 millimeter diameter AWG No. 2 shall be manufactured with colored insulating materials. Conductors larger than 6.5 millimeter diameter AWG No. 2 shall 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. Terminal and conductor identification shall match as indicated.

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

## 3.3 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 shall be [\_\_\_\_\_] [1500] millimeter [5] feet above floor level, when possible.

### 3.4 WIRING DEVICES

#### 3.4.1 Wall Switches and Receptacles

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

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

#### 3.4.2 Device Plates

Device plates for switches that are not within sight of the loads controlled shall be suitably engraved with a description of the loads.

Device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets shall be suitably marked, showing the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Required marking shall consist of a self-adhesive label having [\_\_\_\_\_] [6] millimeter [1/4] inch embossed letters.

Device plates for convenience outlets shall be similarly marked indicating the supply panel and circuit number.

### 3.5 BOXES AND FITTINGS

Furnish and install pullboxes where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than [\_\_\_\_\_] [30] meter [100] feet or with more than three right-angle bends shall have a pullbox installed at a convenient intermediate location.

Securely mount boxes and enclosures to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

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

<u>LOCATION</u>	<u>MOUNTING HEIGHT</u>
Receptacles in offices	450 millimeter
Receptacles in corridors	450 millimeter
Receptacles in shops & laboratories	1200 millimeter
Receptacles in rest rooms	1200 millimeter
Switches for light control	1200 millimeter
<u>LOCATION</u>	<u>MOUNTING HEIGHT</u>
Receptacles in offices	18 inches
Receptacles in corridors	18 inches



<u>LOCATION</u>	<u>MOUNTING HEIGHT</u>
Receptacles in shops and laboratories	48 inches
Receptacles in rest rooms	48 inches
Switches for light control	48 inches

### 3.6 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.

### 3.7 PANELBOARDS

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**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. Directory card information shall be complete and legible.

### 3.8 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.

### ] 3.9 IDENTIFICATION PLATES AND WARNINGS

Furnish and install 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. Process control devices and pilot lights shall have identification plates.

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

### 3.10 PAINTING

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks shall be thoroughly cleaned and painted as specified in Section 09 90 00 PAINTS

AND COATINGS or Section 09 96 00 HIGH-PERFORMANCE COATINGS.

### 3.11 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.

Submit Test Reports in accordance with referenced standards in this section.

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.

Contractor shall 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. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices shall be used to isolate the circuits under test.

Perform [insulation-resistance test](#) on each field-installed conductor with respect to ground and adjacent conductors. Applied potential shall be 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 shall not be less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes 8AWG and smaller insulation resistance testing is not required.

Perform [continuity test](#) to insure correct cable connection (i.e correct phase conductor, grounded conductor, and grounding conductor wiring) end-to-end. Any damages to existing or new electrical equipment resulting from contractor mis-wiring will be repaired and re-verified at contractor's expense. All repairs shall be approved by the CO prior to acceptance 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 clockwise, facing the source.

Final acceptance will depend upon 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 CO.

-- End of Section --