

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM

02/14

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Contractor may substitute compatible Japan Industrial Standard (JIS), Ministry of Land, Infrastructure and Transport (MLIT), Japan Electrical Safety Inspection Associations, Japanese Electrotechnical Committee (JEC) or Japan Wire Industry Association (JCS) standards for non-Japanese standards, as approved by the Contracting Officer's representative.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1 (2022) Electric Meters - Code for  
Electricity Metering

JAPANESE ELECTROTECHNICAL COMMITTEE (JEC)

JEC 2200 (2015) Transformer

JAPANESE STANDARDS ASSOCIATION (JSA)

JIS C 0365 (2007) Protection Against Electric Shock -  
Common Aspects for Installation and  
Equipment

JIS C 0920 (2003) Degrees Of Protection Provided By  
Enclosures (IP Code)

JIS C 1210 (1979) General Rules for Electricity Meters

JIS C 2336 (2012) Pressure-sensitive polyvinyl  
chloride tapes for electrical purposes

JIS C 2338 (2012) Polyester adhesive tape for  
electrical insulation

JIS C 2805 (2010) Crimp terminal for copper wire

JIS C 2806 (2003; R 2018) Bare crimping sleeve for  
copper wire

JIS C 2810 (1995; R 2021) General rules on  
non-separable type wire connectors for  
interior wiring

JIS C 3101 (1994; R 2021) Hard-drawn copper wires for  
electrical purposes

JIS C 3105 (1994; R 2021) Hard-drawn copper stranded  
conductors

JIS C 3341	(2000; R 2021) Polyvinyl chloride insulated drop service wires
JIS C 3401	(2002; R 2022) Control Cables
JIS C 3605	(2022) 600 V Polyethylene Insulated Cables, Type CV
JIS C 3606	(2022) High-Voltage Cross-Linked Polyethylene Insulated Cables, Type CV or CE
JIS C 3612	(2002; R 2022) 600V Flame Retardant Polyethylene Insulated Wires
JIS C 4212	(2010; R 2022) Low-Voltage Three-Phase Squirrel-Cage High-Efficiency Induction Motors (Amendment 1)
JIS C 5381-11	(2014; R 2019) Low-voltage surge protective devices -- Part 11: Surge protective devices connected to low-voltage power systems -- Requirements and test methods
JIS C 5381-12	(2021) Low-voltage surge protective devices -- Part 12: Surge protective devices connected to low-voltage power distribution systems -- Selection and application principles
JIS C 6436	(1995; R 2019) Power transformer for electronic equipment
JIS C 8201-2-1	(2021) Low-Voltage Switchgear and Control Gear - Part 2-1: Circuit-Breakers
JIS C 8201-2-2	(2021) Low-Voltage Switchgear And Control Gear - Part 2-2: Circuit-Breakers Incorporating Residual Current Protection
JIS C 8201-3	(2009; R 2018) Low-voltage switchgear and control units-Part 3: Switches,Disconnector, disconnecting switch and fuse assembly unit
JIS C 8201-5-1	(2022) Low-Voltage Switchgear And Control Gear - Part 5-1: Control Circuit Devices And Switching Elements - Electromechanical Control Circuit Devices
JIS C 8201-4-1	(2023) Low-voltage switchgear and controlgear -- Part 4-1: Contactors and motor-starters: Electromechanical contactors and motor-starters
JIS C 8201-4-2	(2010; 2020) Low-voltage switchgear and controlgear -- Part 4-2: Contactors and

	motor-starters -- AC semiconductor motor controllers and starters
JIS C 8201-7-1	(2016) Low-Voltage Switchgear And Control Gear -- Part 7-1: Ancillary Equipment -- Terminal Blocks For Copper Conductors
JIS C 8222	(2021) Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)
JIS C 8269-1	(2016) Low-Voltage Fuses -- Part 1: General Requirements
JIS C 8269-2	(2016) Low voltage fuse-Part 2: Additional requirements for expert fuses(Mainly industrial fuses)
JIS C 8281-1	(2019) Plugs and socket-outlets for household and similar purposes -- Part 1: General requirements
JIS C 8286	(2021) Electrical accessories -- Cord sets and interconnection cord sets
JIS C 8303	(2007; R 2022) Plugs And Receptacles For Domestic And Similar General Use
JIS C 8304	(2009; R 2019) Small switches for indoor use
JIS C 8305	(2019) Rigid Steel Conduits
JIS C 8309	(2019) Pliable metal conduits
JIS C 8330	(1999; R 2019) Fittings for rigid metal conduits
JIS C 8340	(1999; R 2019) Boxes And Box Covers For Rigid Metal Conduits
JIS C 8350	(1999; R 2014) Fittings for pliable metal conduits
JIS C 8364	(2008; R 2018) Busways
JIS C 8380	(2009; R 2019) Plastic coated steel pipes for cable-ways
JIS C 8425	(1984) Plastic surface raceways for interior wiring
JIS C 8430	(2019) Unplasticized polyvinyl chloride (PVC-U) conduits
JIS C 8432	(2019) Fittings of unplasticized polyvinyl chloride (PVC-U) conduits

JIS C 8435	(2022) Boxes And Box Covers Of Plastic Conduits
JIS C 8462-1	(2021) Boxes and enclosures for electrical accessories for household and similar fixed electrical installations -- Part 1: General requirements
JIS C 8480	(R2020) Box-Type Switchgear Assemblies for Low-Voltage Distribution Purpose
JIS C 60079-0	(2010; R 2020) Explosive atmospheres -- Part 0: Equipment -- General requirements
JIS C 60079-14	(2008; R 2014) Electrical and mechanical equipment used in explosive atmosphere- Part 14: Electrical Equipment in Hazardous Areas (Other Than Mines)
JIS C 60364-5-54	(2006; R 2015) Building Electrical Equipment-Part 5-54: Selection Of Electrical Equipment and Contruction-Grounding Equipment, Protective Conductor and Protective Bonding Conductor
JIS C 60364-6	(2010; R 2019) Low-voltage electrical installations -- Part 6: Verification
JIS C 61000-4-7	(2007; R 2017) Electromagnetic compatibility (EMC) -- Part 4-7: Testing and measurement techniques -- General guide on harmonics and interharmonics measurements and instrumentation
JIS C 61558-1	(2019) Safety of transformers, reactors, power supply units and combinations thereof -- Part 1: General requirements and tests
JIS K 6743	(2016) Unplasticized Poly (Vinyl Chloride) (PVC-U) Pipe Fittings for Water Supply
JIS K 6911	(2006; R 2021) Thermosetting plastic general test method
JIS K 6741	(2016; R 2021) Unplasticized Poly (Vinyl Chloride) (PVC-U) Pipes
JIS T 1021	(2019) Hospital grade outlet-sockets and plugs
JIS X 5150	(R2016) Information Technology-Generic Cabling for Customer Premises
JIS Z 9101	(2018) Graphical symbols -- Safety colours and safety signs -- Part 1: Design principles for safety signs and safety markings

JIS Z 9290-1 (2014; R 2019) Protection Against  
Lightning - Part 1: General Principles

THE JAPANESE ELECTRIC WIRE & CABLE MAKERS' ASSOCIATION (JCMA)

JCS 1226 (2003) Soft Stranded Wire

ELECTRICAL SAFETY INSPECTION ASSOCIATIONS

Denki Hoan Kyoukai Japan Standard for Acceptance Testing and  
Inspections

MINISTRY OF LAND, INFRASTRUCTURE, TRANSPORT AND TOURISM (MLIT)

MLIT DSKKS Denki Setsubi Kouji Kanri Shishin (DSKKS)  
Electrical Construction Supervision  
Guidelines

MLIT ESS (2019) MLIT Electrical Standard  
Specification (ESS)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70E (2024) Standard for Electrical Safety in  
the Workplace

UNDERWRITERS LABORATORIES (UL)

UL 2043 (2013) Fire Test for Heat and Visible  
Smoke Release for Discrete Products and  
Their Accessories Installed in  
Air-Handling Spaces

## 1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined.

## 1.3 SUBMITTALS

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.

SD-02 Shop Drawings

Panelboards; G[, [\_\_\_\_\_]]

Transformers; G[, [\_\_\_\_\_]]

Busway; G[, [\_\_\_\_\_]]

Cable trays; G[, [\_\_\_\_\_]]

Motor control centers; G[, [\_\_\_\_]]

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices.

Wireways; G[, [\_\_\_\_]]

[Load centers for housing units; G[, [\_\_\_\_]]]

Marking strips drawings; G[, [\_\_\_\_]]

#### SD-03 Product Data

Receptacles;

Circuit breakers; G[, [\_\_\_\_]]

Switches; G[, [\_\_\_\_]]

Transformers; G[, [\_\_\_\_]]

Enclosed circuit breakers; G[, [\_\_\_\_]]

Motor controllers; G[, [\_\_\_\_]]

[Combination motor controllers; G[, [\_\_\_\_]]]

[Load centers for housing units; G[, [\_\_\_\_]]]

Manual motor starters; G[, [\_\_\_\_]]

[Residential load centers; G[, [\_\_\_\_]]]

[Metering; G[, [\_\_\_\_]]]

[Meter base only; G[, [\_\_\_\_]]]

CATV outlets; G[, [\_\_\_\_]]

Surge protective devices; G[, [\_\_\_\_]]

Include performance and characteristic curves.

#### SD-06 Test Reports

600-volt wiring test;

Grounding system test;

Transformer tests;

Ground-fault receptacle test;

[ SD-10 Operation and Maintenance Data

Electrical Systems, Data Package 5;

Metering, Data Package 5;

Submit operation and maintenance data in accordance with Section  
01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein.

#### ]1.4 QUALITY ASSURANCE

##### 1.4.1 Fuses

Submit coordination data as specified in paragraph, FUSES of this section.

##### 1.4.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of applicable codes and standards unless more stringent requirements are specified or indicated.

##### 1.4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

- a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.
- b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
- c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

##### 1.4.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

##### 1.4.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

## 1.5 MAINTENANCE

### [1.5.1 Electrical Systems

Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:

- a. Single line diagram of the "as-built" building electrical system.
- b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).
- c. Manufacturers' operating and maintenance manuals on active electrical equipment.

### ]1.6 WARRANTY

Provide equipment items supported by service organizations that are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

### [1.7 SEISMIC REQUIREMENTS

Provide seismic details[ conforming to[ Section 13 48 00 [SEISMIC] BRACING FOR MISCELLANEOUS EQUIPMENT][ and to][ Section 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT]][ as indicated].

## ]PART 2 PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

As a minimum, meet requirements of UL or Japanese standards, where UL or applicable Japanese codes and standards are established for those items for all materials, equipment, and devices.

### 2.2 CONDUIT AND FITTINGS

Conform to the following:

#### 2.2.1 Rigid Metallic Conduit or Type G Conduit

##### 2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit or Type G

JIS C 8305, Type G. Diameter of conduit shall be as indicated.

#### 2.2.2 Rigid Nonmetallic Conduit or Unplasticized Polyvinyl Chloride

JIS C 8430 for Type VE or HIVE conduit of diameter of less than 100mm and JIS K 6741 for Type VP or HIVP conduit diameter or 100mm and larger.

#### 2.2.3 Electrical, Zinc-Coated Steel Metallic Tubing (EMT) or Type E Metallic Conduit

JIS C 8305, Type E.



2.2.4 Plastic-Coated Rigid Steel and IMC Conduit or Type G, C or E; LL or LT

JIS C 8380.

2.2.5 Flexible Metal Conduit

JIS C 8309.

2.2.5.1 Liquid-Tight Flexible Metal Conduit, Steel

JIS C 8309.

2.2.6 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

JIS C 8330 and JIS C 8350. Ferrous fittings: cadmium- or zinc-coated in accordance with JIS C 8330 and JIS C 8350.

2.2.6.1 Fittings for Rigid Metal Conduit and IMC or Type G and Type C

Threaded-type. Split couplings unacceptable.

2.2.6.2 Fittings for EMT or Type E Conduit

[Die Cast][Steel][set screw] type.

2.2.7 Fittings for Rigid Nonmetallic Conduit or Unplasticized Polyvinyl Chloride

JIS C 8432 for diameters less than 100mm and JIS K 6743 for diameters 100mm or larger.

2.3 SURFACE RACEWAY

2.3.1 Surface Metal Raceway

Two-piece painted steel, totally enclosed, snap-cover type.[ Provide multiple outlet-type raceway with grounding-type receptacle where indicated. Provide receptacles as specified herein, spaced a minimum of one every [455] [\_\_\_\_\_] mm.][ Wire alternate receptacles on different circuits.]

2.3.2 Surface Nonmetallic Raceway

JIS C 8425, nonmetallic totally enclosed, snap-cover type.[ Provide multiple outlet-type raceway with grounding-type receptacle where indicated. Provide receptacles as specified herein, spaced a minimum of one every [455] [\_\_\_\_\_] mm.][ Wire alternate receptacles on different circuits.]

2.4 BUSWAY

JIS C 8364. Provide the following:

- a. Buses: [ copper][ or][ aluminum].
- b. Busways: rated [\_\_\_\_\_] volts, [\_\_\_\_\_] continuous current amperes, three-phase,[ three-][ four-]wire, and include integral or internal[ 50-percent] ground bus.

- c. Short circuit rating: [ [\_\_\_\_\_] root mean square (rms) symmetrical amperes minimum][ as indicated].
- [ d. Busway systems: suitable for use indoors.
- ] e. Enclosures: [ steel][ aluminum] [ metallic].
- f. Hardware: plated or otherwise protected to resist corrosion.
- g. Joints: one-bolt type with through-bolts, which can be checked for tightness without deenergizing system.
- h. Maximum hot spot temperature rise at any point in busway at continuous rated load: do not exceed 55 degrees C above maximum ambient temperature of 40 degrees C in any position.
- i. Internal barriers to prevent movement of superheated gases.
- j. Coordinate proper voltage phasing of entire bus duct system, for example where busway interfaces with transformers, switchgear, switchboards, motor control centers, and other system components.

#### 2.4.1 Feeder Busways

Provide[ ventilated, except that vertical busways within 1830 mm of floors must be unventilated,][ unventilated, totally enclosed] low-impedance busway. Provide bus bars fully covered with insulating material, except at stabs. Provide an entirely polarized busway system.

#### 2.4.2 Plug-In Busways

Unventilated type. Provide the following:

- a. Plug-in units: [ fusible, handle-operated, switch type, horsepower-rated][ circuit breaker-type][ handle-operated, switch type, equipped with high interrupting-capacity, current-limiting fuses].
- b. Bus bars: covered with insulating material throughout, except at joints and other connection points.
- [ c. A hook stick of suitable length for operating plug-in units from the floor.

#### ]2.5 CABLE TRAYS

Provide the following:

- a. Cable trays: form a wireway system, with a nominal[ [75] [100] [150] mm] depth[ as indicated].
- b. Cable trays: constructed of[ aluminum][ copper-free aluminum][ steel that has been zinc-coated after fabrication].
- c. Cable trays: include splice and end plates, dropouts, and miscellaneous hardware.
- d. Edges, fittings, and hardware: finished free from burrs and sharp

edges.

- e. Fittings: ensure not less than load-carrying ability of straight tray sections and have manufacturer's minimum standard radius.

[ f. Radius of bends: [305] [610] [915] mm.][ Radius of bends: as indicated.

#### ]2.5.1 Basket-Type Cable Trays

Provide[ size as indicated][ of nominal[ 50,][ 100,][ 150,][ 200,][ 300,][ 450,][ and][ 600] mm width and [ 25,][ 50,][ and][ 100] mm depth] with maximum wire mesh spacing of 50 by 100 mm.

#### 2.5.2 Trough-Type Cable Trays

Provide[ size as indicated][ of nominal [150] [305] [455] [610] [760] [915] mm width].

#### 2.5.3 Ladder-Type Cable Trays

Provide[ size as indicated][ of nominal [150] [305] [455] [610] [760] [915] mm width] with maximum rung spacing of [150] [225] [305] [455] mm.

#### 2.5.4 Channel-Type Cable Trays

Provide [ size as indicated][ of nominal [75] [100] [150] mm width].  
Provide trays with one-piece construction having slots spaced not more than 115 mm on centers.

#### 2.5.5 Solid Bottom-Type Cable Trays

Provide[ size as indicated][ of nominal [150] [305] [455] [610] [760] [915] mm width]. [Provide solid covers.][Do not provide solid covers.]

#### 2.5.6 [Cantilever

Cantilever-type, center-hung cable trays may be provided at the Contractor's option in lieu of other cable tray types specified.

### ]2.6 OPEN TELECOMMUNICATIONS CABLE SUPPORT

#### 2.6.1 Open Top Cable Supports

Provide open top cable supports in accordance with UL 2043. Provide [[ galvanized][ zinc-coated][ stainless] steel]open top cable supports[ as indicated].

#### 2.6.2 Closed Ring Cable Supports

Provide closed ring cable supports in accordance with UL 2043. Provide [[ galvanized][ zinc-coated][ stainless] steel]closed ring cable supports[ as indicated].

### ]2.7 OUTLET BOXES AND COVERS

JIS C 8340, cadmium- or zinc-coated, if ferrous metal. JIS C 8435, if nonmetallic. Rated [IP65 for wet locations] [IP66, 67 or 68 for dust-tight/hazardous locations].

### 2.7.1 Floor Outlet Boxes

Provide the following:

- a. Boxes: [ adjustable][ nonadjustable] and concrete tight.
- b. Each outlet: consisting of[ nonmetallic][ or][ cast-metal] body with threaded openings,[ or sheet-steel body with knockouts] for conduits,[ adjustable ][, ][ brass flange] ring, and cover plate with [19][25][31.75][53.92] mm threaded plug.
- c. Telecommunications outlets: consisting of[ surface-mounted, horizontal][ flush], aluminum or stainless steel housing with a receptacle as specified and[ 25 mm bushed side opening][ 19 mm top opening].
- d. Receptacle outlets: consisting of[ surface-mounted, horizontal][ flush] aluminum or stainless steel housing with duplex-type receptacle as specified herein.
- e. Provide gaskets where necessary to ensure watertight installation.
- [ f. Provide plugs with installation instructions to the Contracting Officer for [5] [\_\_\_\_\_] percent of outlet boxes for the capping of outlets upon removal of service fittings.

### ]2.7.2 Outlet Boxes for Telecommunications System

Provide the following:

- a. Standard type[ 100 mm square by 54 mm deep][ 120 mm square by 54 mm deep].
- [ b. Outlet boxes for wall-mounted telecommunications outlets: 100 by 54 by 54 mm deep.
- ] c. Depth of boxes: large enough to allow manufacturers' recommended conductor bend radii.
- [ d. Outlet boxes for fiber optic telecommunication outlets: include a minimum 10 mm deep single or two gang plaster ring as shown and installed using a minimum 27 mm conduit system.
- ]e. Outlet boxes for handicapped telecommunications station: 100 by 54 by 54 mm deep.

### ]2.7.3 Clock Outlet for Use in Other Than Wired Clock System

Provide the following:

- a. Outlet box with plastic cover, where required, and single receptacle with clock outlet plate.
- b. Receptacle: recessed sufficiently within box to allow complete insertion of standard cap, flush with plate.
- c. Suitable clip or support for hanging clock: secured to top plate.

- d. Material and finish of plate: as specified in paragraph DEVICE PLATES of this section.

## ]2.8 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 1640 mL, JIS C 8340, hot-dip, zinc-coated, if sheet steel. Rated [IP65 for wet locations] [IP66, 67 or 68 for dust-tight/hazardous locations].

## 2.9 WIRES AND CABLES

Provide wires and cables in accordance applicable requirements of Japanese standards for type of insulation, jacket, and conductor specified or indicated. Do not use wires and cables manufactured more than 12 months prior to date of delivery to site.

### 2.9.1 Conductors

Provide the following:

- a. Conductor sizes and capacities shown are based on copper, unless indicated otherwise.
- b. Conductors 5.5 sqmm and larger cross sectional area: stranded.
- c. Conductors 2.0 mm and smaller diameter: solid.
- d. Conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3: stranded unless specifically indicated otherwise.
- [ e. All conductors: [copper.][ Conductors indicated to be 14 sqmm or smaller diameter: copper. Conductors indicated to be 22 sqmm and larger diameter: copper , unless type of conductor material is specifically indicated, or specified, or required by equipment manufacturer.]

#### ]2.9.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to satisfy manufacturer's requirements.

#### ]2.9.1.2 Minimum Conductor Sizes

Provide minimum conductor size in accordance with the following:

- a. Branch circuits: 2.0 mm.
- b. Class 1 remote-control and signal circuits: 1.6 mm.
- c. Class 2 low-energy, remote-control and signal circuits: 1.2 mm.
- d. Class 3 low-energy, remote-control, alarm and signal circuits: 0.65 mm.

### 2.9.2 Color Coding

Provide color coding for service, feeder, branch, control, and signaling

circuit conductors.

#### 2.9.2.1 Ground and Neutral Conductors

Provide color coding of ground and neutral conductors as follows:

- a. Grounding conductors: Green.
- b. Neutral conductors: White or Gray.
- c. Exception, where neutrals of more than one system are installed in same raceway or box, other neutrals color coding: white with a different colored (not green) stripe for each.

#### 2.9.2.2 Ungrounded Conductors

Provide color coding of ungrounded conductors in different voltage systems as follows:

- a. [480/277][440/254V][420/242V][208/120 volt], three-phase, four-wire
  - (1) Phase A - red
  - (2) Phase B - black
  - (3) Phase C - blue
- b. [480 volt][440 volt][420 volt][220 volt][210 volt][208 volt], three-phase, three-wire
  - (1) Phase A - red
  - (2) Phase B - black
  - (3) Phase C - blue
- c. [105/210][120/240] volt, single phase, three-wire:
  - (1) Phase A - red
  - (2) Phase B - black
- [ d. On three-phase, four-wire delta system, high leg: orange, as required.

#### 2.9.3 Insulation

Unless specified or indicated otherwise, provide power and lighting wires rated for 600-volts, [Type EM-IE conforming to JIS C 3612][ or ][Type EM-CE, EM-CET or EM-ECEQ conforming to JIS C 3605], except that grounding wire may be type TW conforming to JIS C 3612, Type EM-IE; remote-control and signal circuits: Type TW or TF, conforming to JIS C 3401, Type CEV. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

#### 2.9.4 Bonding Conductors

JIS C 3101, solid bare copper wire for sizes 8 sqmm and smaller diameter; JIS C 3105 and JCS 1226, Class B, stranded bare copper wire for sizes 14 sqmm and larger diameter, JIS C 3102 Annealed Copper Wire.

#### 2.9.4.1 Telecommunications Bonding Backbone (TBB)

Provide a copper conductor TBB in accordance with JIS C 60364-5-54 with 14 sqmm minimum size, and sized at 3.3 sqmm per linear meter of conductor length up to a maximum size of 1500 sqmm.[ Provide insulated TBB with insulation as specified in the paragraph INSULATION and meeting the fire ratings of its pathway.]

#### 2.9.4.2 Bonding Conductor for Telecommunications

Provide a copper conductor Bonding Conductor for Telecommunications between the telecommunications main grounding busbar (TMGB) and the electrical service ground in accordance with JIS C 60364-5-54. Size the bonding conductor for telecommunications the same as the TBB.

#### [2.9.5 Service Entrance Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, JIS C 3341 and JIS C 3605.

#### ] [2.9.6 EM-EEF Cable

JIS C 3605, Type EM-EEF Cable.

#### ] [2.9.7 Wire and Cable for 400 Hertz (Hz) Circuits

Insulated copper conductors.

#### ] [2.9.8 Metal-Clad Cable

Type MC cable.

#### ] [2.9.9 Armored Cable

Type AC cable.

#### ] [2.9.10 Mineral-Insulated, Metal-Sheathed Cable

UL listed; Type MI cable. Do not use sheathing containing asbestos fibers.

#### ] [2.9.11 Flat Conductor Cable

UL listed; Type FCC.

#### ] [2.9.12 Cable Tray Cable or Power Limited Tray Cable

UL listed; type TC or PLTC.

#### ] [2.9.13 Cord Sets and Power-Supply Cords

JIS C 8286.

#### ] [2.9.14 Polyethylene or Cross-Linked Polyethylene Cable

[Type [CV][CE] conforming to JIS C 3605 for 600V.][Type [CV][CE], conforming to JIS C 3606 for 6.6kV]

]2.10 SPLICES AND TERMINATION COMPONENTS

JIS C 2805, JIS C 2806 and JIS C 2810 for wire connectors and JIS C 2336, JIS C 2338 for insulating tapes. Connectors for 5.5 sqmm and smaller diameter wires: insulated, pressure-type in accordance with JIS C 2805, JIS C 2806 and JIS C 2810 or JIS C 2806 (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors. Resin splices, where made, must be made of a rigid tube used to inject polyurethane insulating and sealing resin during a splice installation. Splices shall be performed in accordance with the manufacturer's instructions. The installation must not require heat or any additional materials such as covering.

2.11 DEVICE PLATES

Provide the following:

- a. UL listed, one-piece device plates for outlets to suit the devices installed.
- b. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.
- c. For nonmetallic boxes and fittings, other suitable plates may be provided.
- [ d. Plates on finished walls: nylon or lexan, minimum 0.792 mm wall thickness and same color as receptacle or toggle switch with which they are mounted.
- ] [e. Plates on finished walls: satin finish stainless steel or brushed-finish aluminum, minimum 0.792 mm thick.
- ] f. Screws: machine-type with countersunk heads in color to match finish of plate.
- g. Sectional type device plates are not be permitted.
- h. Plates installed in wet locations: gasketed and UL listed or JIS listed for "wet locations."
- [ i. Device plates in areas normally accessible to prisoners: brown or ivory finish nylon-device plates rated for high abuse. Test device plates for compliance with JIS C 8340 and JIS C 8435 for physical strength. Attach device plates with spanner head bolts.

]2.12 SWITCHES

2.12.1 Toggle Switches

JIS C 8304, [ single pole][, double pole][, three-way][, and four-way], totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:

- a. Handles: [ white][ ivory][ brown] thermoplastic.
- b. Wiring terminals: screw-type, side-wired[ or of the solderless pressure type having suitable conductor-release arrangement].



- c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.
- d. Switches: rated quiet-type ac only, [105][120][210][240][120/277] volts, with current rating and number of poles indicated.

#### 2.12.2 Switch with Red Pilot Handle

Provide the following:

- a. Pilot lights that are integrally constructed as a part of the switch's handle.
- b. Pilot light color: red and illuminate whenever the switch is closed or "on".
- c. Pilot lighted switch: rated 20 amps and [105][120] volts or [210][240][277] volts as indicated.
- d. The circuit's neutral conductor to each switch with a pilot light.

#### 2.12.3 Breakers Used as Switches

For [100][120]- and [200][277]-Volt fluorescent fixtures, mark breakers "SWD" in accordance with JIS C 8201-2-1. Provide label adjacent to circuit breaker indicating Breaker used as switch.

#### 2.12.4 Disconnect Switches

JIS C 8201-3. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Utilize Class R fuseholders and fuses for fused switches, unless indicated otherwise. Provide horsepower rated for switches serving as the motor-disconnect means. Provide switches in IP rated enclosure[ as indicated] per JIS C 8462-1.

### 2.13 FUSES

JIS C 8269-1, JIS C 8269-2. Provide complete set of fuses for each fusible[ switch][ panel][ and control center]. Coordinate time-current characteristics curves of fuses serving motors or connected in series with circuit breakers[ or other circuit protective devices] for proper operation. Submit coordination data for approval. Provide fuses with a voltage rating not less than circuit voltage.

#### 2.13.1 Fuseholders

Provide in accordance with JIS C 8269-1 or JIS C 8269-2.

#### 2.13.2 Cartridge Fuses, Current Limiting Type (Class R)

JIS C 8269-1 or JIS C 8269-2, [Class[ RK-1][ RK-5][ time-delay type]][Fuse System [A][B][C][D][E][F][G][H][I][J][L]]. Provide only Class R associated fuseholders in accordance with JIS C 8269-1 or JIS C 8269-2.

### 2.14 RECEPTACLES

Provide the following:

- a. [JIS C 8303, JIS C 8281-1, general purpose specification grade (also designated heavy-duty),][ JIS C 8303, JIS C 8281-1 and JIS T 1021, hospital grade,] grounding-type.
- b. Ratings and configurations: as indicated.
- c. Bodies: [ white][ ivory][ brown].
- d. Face and body: thermoplastic supported on a metal mounting strap.
- e. Dimensional requirements: per JIS C 8462-1.
- f. Screw-type, side-wired wiring terminals or of the solderless pressure type having suitable conductor-release arrangement.
- g. Grounding pole connected to mounting strap.
- h. The receptacle: containing triple-wire power contacts and double or triple-wire ground contacts.

#### 2.14.1 Switched Duplex Receptacles

Provide separate terminals for each ungrounded pole. Top receptacle: switched when installed.

#### 2.14.2 Weatherproof Receptacles

Provide receptacles, UL listed for use in "wet locations" or weather resistant per JIS C 8303. Include cast metal box with gasketed, hinged, lockable and weatherproof while-in-use, [polycarbonate, UV resistant/stabilized][die-cast metal/aluminum] cover plate. The cover shall have notches or other openings that allow cords and plugs to be inserted into the receptacle while the cover is closed. (reason: this is an NEC requirement, but some JIS listed products do not have this feature)

#### 2.14.3 Ground-Fault Circuit Interrupter Receptacles

Duplex type for mounting in standard outlet box. Provide device capable of detecting current leak of 6 milliamperes or greater and tripping for Class A ground-fault circuit interrupter devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

#### 2.14.4 Special Purpose Receptacles

Receptacles serving [\_\_\_\_\_] are special purpose.[ Provide in ratings indicated.][ [\_\_\_\_\_] configuration, rated [\_\_\_\_\_] amperes, [\_\_\_\_\_] volts.][ Furnish one matching plug with each receptacle.]

#### 2.14.5 [Plugs

Provide heavy-duty, rubber-covered[ three-,][ four-,][ or][ five-]wire cord of required size, install plugs thereon, and attach to equipment. Provide UL listed plugs with receptacles, complete with grounding blades. Where equipment is not available, turn over plugs and cord assemblies to the Government.

]2.14.6 Range Receptacles

[ ] ampere receptacle configuration [as indicated],[ flush mounted for housing units,] rated 50 amperes, [105/210][125/250] volts.[ Furnish one matching plug with each receptacle.]

2.14.7 Dryer Receptacles

Provide NEMA 14-30R receptacles.

2.14.8 Tamper-Resistant Receptacles

Provide duplex receptacle with mechanical sliding shutters that prevent the insertion of small objects into its contact slots.

2.15 PANELBOARDS

Provide panelboards in accordance with the following:

- [ a. JIS C 8480 and JIS C 8480, JIS C 0920 having a short-circuit current rating[ as indicated][ of 10,000 amperes symmetrical minimum].
- b. Panelboards for use as service disconnecting means: additionally conform to manufacturer's recommendations.
- c. Panelboards: circuit breaker-equipped.
- d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.
- e. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings.
- f. Use of "Subfeed Breakers" is not acceptable unless specifically indicated otherwise.
- g. Main breaker: "separately" mounted[ "above"][ or][ "below"] branch breakers.
- h. Where "space only" is indicated, make provisions for future installation of breakers.
- i. Directories: indicate load served by each circuit in panelboard.
- j. Directories: indicate source of service to panelboard (e.g., Panel PA served from Panel MDP).
- [ k. Provide new directories for existing panels modified by this project as indicated.
- ] l. Type directories and mount in holder behind transparent protective covering.
- [ m. Panelboards: listed and labeled for their intended use.
- ] n. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

- ]a. JIS C 8480 and JIS C 8480, JIS C 0920.
- b. Panelboards for use as service disconnecting: additionally conform to manufacturer's recommendations..
  - c. Panelboards: circuit breaker-equipped.
  - d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.
  - e. Where "space only" is indicated, make provisions for future installation of breaker sized as indicated.
  - f. Directories: indicate load served by each circuit of panelboard.
  - g. Directories: indicate source of service (upstream panel, switchboard, motor control center, etc.) to panelboard.
  - h. Type directories and mount in holder behind transparent protective covering.
  - i. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

]2.15.1 Enclosure

Provide panelboard enclosure in accordance with the following:

- a. JIS C 0920.
- b. Cabinets mounted outdoors or flush-mounted: hot-dipped galvanized after fabrication.
- c. Cabinets: painted in accordance with paragraph PAINTING.
- d. Outdoor cabinets: Weatherproof rated IP code with[ conduit hubs welded to the cabinet][ a removable steel plate 7 mm thick in the bottom for field drilling for conduit connections].
- e. Front edges of cabinets: form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front.
- f. All cabinets: fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 3 mm.
- g. Holes: provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 15 mm clear space between the back of the cabinet and the wall surface.
- h. Flush doors: mounted on hinges that expose only the hinge roll to view when the door is closed.
- i. Each door: fitted with a combined catch and lock, except that doors over 600 mm long provided with a three-point latch having a knob with

a T-handle, and a cylinder lock.

- j. Keys: two provided with each lock, with all locks keyed alike.
- k. Finished-head cap screws: provided for mounting the panelboard fronts on the cabinets.

#### 2.15.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per JIS C 8480 for connecting grounding conductors; bond to steel cabinet.[ In addition to equipment grounding bus, provide second "isolated" ground bus, where indicated.]

##### [2.15.2.1 Panelboard Neutrals for Non-Linear Loads

Provide in accordance with the following:.

- a. UL listed, with panelboard type specifically UL heat rise tested for use on non-linear loads.
- b. Panelboard: heat rise tested in accordance with JIS C 8480, except with the neutral assembly installed and carrying 200 percent of the phase bus current during testing.
- c. Verification of the testing procedure: provided upon request.
- d. Two neutral assemblies paralleled together with cable is not acceptable.
- e. Nameplates for panelboard rated for use on non-linear loads: marked "SUITABLE FOR NON-LINEAR LOADS" and in accordance with paragraph FIELD FABRICATED NAMEPLATES.
- f. Provide a neutral label with instructions for wiring the neutral of panelboards rated for use on non-linear loads.

##### ]2.15.3 Circuit Breakers

JIS C 8201-2-1,[ thermal magnetic-type][ solid state-type] having an interrupting rating as shown on the drawings. Breaker terminals: UL listed as suitable for type of conductor provided.[ Where indicated on the drawings, provide circuit breakers with shunt trip devices.] Series rated circuit breakers and plug-in circuit breakers are unacceptable.

#### 2.15.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

#### 2.15.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter or Type RCBO

JIS C 8222 or JIS C 8201-2-2. [Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect and trip on

current imbalance of 6 milliamperes or greater per requirements of JIS C 8222 or JIS C 8201-2-2 for Class A ground-fault circuit interrupter.][Provide Residual Current Device (RCBO) circuit breaker with a leakage current detection of 15 milliamperes.]

#### 2.15.3.3 Arc-Fault Circuit Interrupters

JIS C 8201-2-1. Molded case circuit breakers: rated as indicated.[ Two pole arc-fault circuit-interrupters: rated 120/240 volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable.] Provide with "push-to-test" button.

#### [2.15.4 Fusible Switches for Panelboards

JIS C 8201-3, hinged door-type. Provide switches serving as motor disconnect means rated for kilowatt.

#### ] [2.15.5 400 Hz Panelboard and Breakers

Provide panelboards and breakers for use on 400 Hz systems rated and labeled "400 Hz."

#### [2.15.6 Branch Circuit Monitoring Panelboards

Provide a microprocessor-based panelboard monitoring system having the following features:

- a. ANSI C12.1 and IEC 62053-21 Class 1 energy revenue metering accuracy.
- b. Direct reading metered or calculated values for up to forty-two branch circuits.
- c. Monitored values at the branch circuit level for current (A), power (kW), and energy (kWh).
- d. Four user-configurable alarm thresholds.
- e. Communications with building automation system using Modbus RTU protocol via RS-485 cable connection.

#### ] [2.15.7 Lighting Control Panelboards

Provided a lighting control panelboard having the following features:

- a. Minimum sixteen schedules including a 7-day repeating schedule with sixteen daily on/off periods.
- b. Minimum sixteen lighting zones grouping branch breakers that are controlled by schedules, manual inputs, or override commands.
- c. Electronic clock including real-time, astronomical clock, and leap year and daylight savings time adjustments.
- d. Burn-hour tracking.
- e. Remote circuit breaker operation.
- [ f. Master Lighting Control Panelboard with controller to control up to

[8] [\_\_\_\_\_] control bussed located [individually][in slave panelboard] up to [400] [\_\_\_\_\_] feet away from the master panelboard.

- ] g. Communications with building automation system using Modbus RTU protocol via RS-485 cable connection.

][2.16 RESIDENTIAL LOAD CENTERS

Provide residential load centers (RLCs) in accordance with the following:

- a. JIS C 8480 and JIS C 8480, JIS C 0920.
- b. RLCs for use as service disconnecting means: additionally conform to manufacturer's recommendations.
- c. Circuit breaker equipped.
- d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.
- e. Where "space only" is indicated, make provisions for future installation of breakers sized as indicated.
- [ f. Provide load centers with keyed locks.
- ] g. Provide printed directories.

2.16.1 RLC Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated groundable neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per JIS C 8480 for connecting grounding conductors; bond to steel cabinet.

2.16.2 Circuit Breakers

JIS C 8201-2-1, thermal magnetic-type with interrupting capacity[ as indicated]. Breaker terminals: UL listed as suitable for the type of conductor provided.

2.16.2.1 Multipole Breakers

Provide common trip-type with single operating handle. Provide a breaker design such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any two adjacent breaker poles are connected to alternate phases in sequence.

[2.16.2.2 Circuit Breaker With Ground-Fault Circuit Interrupter or Type RCBO

JIS C 8222. [Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater per requirements of JIS C 8222 for Class A ground-fault circuit interrupter devices.][Provide Residual Current Device (RCBO) circuit breaker with a leakage current detection of 15 milliamperes

or 30 milliamperes to provide ground fault protection.]

#### ]2.16.2.3 Arc-Fault Circuit-Interrupters

JIS C 8201-2-1. Molded case circuit breakers: rated as indicated.[ Two pole arc-fault circuit-interrupters: rated [105/210][120/240] volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable.] Provide with "push-to-test" button.

#### ]2.17 LOAD CENTERS FOR HOUSING UNITS

Provide single-phase panelboards for housing units on this project in accordance with the following:

- a. Load center type, circuit breaker equipped, conforming to JIS C 8480 and JIS C 8480 or JIS C 0920.
- b. Panelboards series short-circuit current rating: 22,000 amperes symmetrical minimum for the main breaker and the branch breakers.
- c. Panelboards for use as service disconnecting means: additionally conform to manufacturer's recommendations.
- d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.
- e. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings.
- f. Where "space only" is indicated, make provisions for future installation of breakers.
- g. Provide cover with latching door.
- h. Directories: indicate load served by each circuit in panelboard.
- i. Directories: indicate source of service to panelboard (e.g., Panel PA served from panel MDP).
- j. Type directories and mount behind in holder with transparent protective covering on inside of panel door.

#### 2.17.1 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide copper or aluminum bus bars, either tin plated or silver plated. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per JIS C 8480 for connecting grounding conductors; bond to steel cabinet.

#### 2.17.2 Circuit Breakers

JIS C 8201-2-1 thermal magnetic type having a minimum short-circuit



current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals: UL listed as suitable for type of conductor provided. Half-size and tandem breakers are not acceptable. Provide switch duty rated 15 and 20 ampere breakers. Breakers must not require use of panel trim to secure them to the bus.

#### 2.17.2.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any two adjacent breaker poles are connected to Phases A and B respectively.

#### 2.17.2.2 Arc-Fault Circuit-Interrupters

JIS C 8201-2-1. Molded case circuit breakers: rated as indicated.[ Two pole arc-fault circuit-interrupters: rated [1050/210][120/240] volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable.] Provide with "push-to-test" button.

### ]2.18 ENCLOSED CIRCUIT BREAKERS

JIS C 8201-2-1. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated.[ Provide solid neutral.]

### [2.19 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors, also called motor circuit protectors (MCPs): JIS C 8201-5-1 and JIS C 8201-2-1, and provided as shown. Provide MSCPs that consist of an adjustable instantaneous trip circuit breaker used only in conjunction with a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection. Rate MSCPs in accordance with MLIT ESS.

### ]2.20 TRANSFORMERS

Provide transformers in accordance with the following:

- a. JEC 2200 and JIS C 61558-1, general purpose, dry-type, self-cooled,[ ventilated][ unventilated][ sealed].
- b. Provide transformers in indoor rated or weatherproof IP rated enclosure.
- c. Taps for transformers 15 kVA and larger: [ Two 2.5 percent taps Full Capacity Above Nominal (FCAN) and four 2.5 percent taps Full Capacity Below Nominal (FCBN)] [Two 2.5 percent taps Full Capacity Above Nominal (FCAN) and two 2.5 percent taps Full Capacity Below Nominal (FCBN)] [\_\_\_\_\_].
- d. Transformer insulation system:
  - (1) 220 degrees C insulation system for transformers 15 kVA and greater, with temperature rise not exceeding[ 150][ 115][ 80]

degrees C under full-rated load in maximum ambient of 40 degrees C.

(2) 180 degrees C insulation for transformers rated 10 kVA and less,  
with temperature rise not exceeding[ 150][ 115][ 80] degrees C  
under full-rated load in maximum ambient of 40 degrees C.

- [ e. Transformer of 150 degrees C temperature rise: capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.
- ][f. Transformer of 115 degrees C temperature rise: capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.
- ][g. Transformer of 80 degrees C temperature rise: capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating.
- ][h. Transformers: quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

#### ]2.20.1 Specified Transformer Efficiency

Transformers, indicated and specified with: [420][440V][480V] primary, 80 degrees C or 115 degrees C temperature rise, kVA ratings of 37.5 to 100 for single phase or 30 to 500 for three phase, energy efficient type. Minimum efficiency, based on factory test results.

#### 2.20.2 [Transformers With Non-Linear Loads

Provide transformers for non-linear loads in accordance JIS C 61000-4-7.

#### ]2.21 MOTORS

Provide motors in accordance with the following:

- a. JIS C 4212[ except provide fire pump motors as specified in Section 21 30 00] FIRE PUMPS.
- b. Provide the size in terms of kW, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified.
- c. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters.
- d. Rate motors for operation on [200-volt, 3-phase circuits with a terminal voltage rating of 200 volts, and those for operation on [400][440] volt, 3 phase circuits with a terminal voltage rating of [400][440] volts.][208-volt, 3-phase circuits with a terminal voltage rating of 200 volts, and those for operation on 480-volt, 3-phase circuits with a terminal voltage rating of 460 volts.]
- e. Use motors designed to operate at full capacity with voltage variation of plus or minus 10 percent of motor voltage rating.
- f. Unless otherwise indicated, use continuous duty type motors if rated 745 Watts and above.

- h. Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.
- i. Use [Inverter-Rated] [Inverter-Duty] motors designed to operate with adjustable speed drive (ASD).

#### 2.21.1 High Efficiency Single-Phase Motors

Single-phase fractional-horsepower alternating-current motors: high efficiency types corresponding to the applications listed in JIS C 4212. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

#### 2.21.2 Premium Efficiency Polyphase Motors

Select polyphase motors based on high efficiency characteristics relative to typical characteristics and applications as listed in JIS C 4212. In addition, continuous rated, polyphase squirrel-cage medium induction motors must meet the requirements for premium efficiency electric motors in accordance with JIS C 4212, including the full load efficiency ratings. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

#### 2.21.3 Motor Sizes

Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided. Provide controllers for motors rated 1-hp (746 watts) and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

#### 2.21.4 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment[, and motor control equipment forming part of motor control centers or switchgear assemblies, the conduit and wiring connecting such centers, assemblies, or other power sources to equipment] as specified herein. Power wiring and conduit: conform to the requirements specified herein. Control wiring: provided under, and conform to, the requirements of the section specifying the associated equipment.

### 2.22 MOTOR CONTROLLERS

Provide motor controllers in accordance with the following:

- a. JIS C 8201-5-1, JIS C 8201-4-1 and JIS C 8201-4-2,[ except fire pump controllers as specified in Section 21 30 00 FIRE PUMPS].
- b. Provide controllers with thermal overload protection in each phase,

and one spare normally open auxiliary contact, and one spare normally closed auxiliary contact.

- c. Provide controllers for motors rated 1-hp (746 kilowatt) and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage.
- d. Provide protection for motors from immediate restart by a time adjustable restart relay.
- e. When used with pressure, float, or similar automatic-type or maintained-contact switch, provide a hand/off/automatic selector switch with the controller.
- f. Connections to selector switch: wired such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position.
- g. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices: connected in motor control circuit in "hand" and "automatic" positions.
- h. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device: made in accordance with indicated or manufacturer's approved wiring diagram.
- [ i. Provide selector switch with the means for locking in any position.
- ] j. Provide a disconnecting means, capable of being locked in the open position, for the motor that is located in sight from the motor location and the driven machinery location. As an alternative, provide a motor controller disconnect, capable of being locked in the open position, to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.
- l. Overload protective devices: provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case.
- m. Cover of combination motor controller and manual switch or circuit breaker: interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position.
- [ n. Minimum short circuit withstand rating of combination motor controller: [\_\_\_\_\_] rms symmetrical amperes.
- ]o. Provide controllers in hazardous locations with classifications as indicated.

#### ]2.22.1 Control Wiring

Provide control wiring in accordance with the following:

- a. All control wire: stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type CCE/F meeting JIS C 3401, or Type CEE/F meeting JIS C 3401, and passing the flame tests included in those standards.

- b. Current transformer secondary leads: not smaller than 5.5 sqmm
- c. Control wire minimum size: 1.6mm
- d. Power wiring for [400][440][480]-volt circuits and below: the same type as control wiring with 2.0mm minimum size.
- e. Provide wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

#### 2.22.2 Control Circuit Terminal Blocks

Provide control circuit terminal blocks in accordance with the following:

- a. JIS C 8201-7-1.
- b. Control circuit terminal blocks for control wiring: molded or fabricated type with barriers, rated not less than 600 volts.
- c. Provide terminals with removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts.
- d. Terminals: not less than 5.5 sqmm in size with sufficient length and space for connecting at least two indented terminals for 5.5 sqmm conductors to each terminal.
- e. Terminal arrangement: subject to the approval of the Contracting Officer with not less than four (4) spare terminals or 10 percent, whichever is greater, provided on each block or group of blocks.
- f. Modular, pull apart, terminal blocks are acceptable provided they are of the channel or rail-mounted type.
- g. Submit data showing that any proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

##### 2.22.2.1 Types of Terminal Blocks

- a. Short-Circuiting Type: Short-circuiting type terminal blocks: furnished for all current transformer secondary leads with provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks: comply with the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.
- b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity: provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. Provide terminals of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, provide screws with hexagonal heads. Conducting parts between connected terminals must have adequate contact surface and cross-section to operate without overheating. Provide each connected terminal with the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

### 2.22.3 Control Circuits

[Control circuits: maximum voltage of [105][120] volts derived from control transformer in same enclosure. Transformers: conform to JIS C 6436, as applicable. Transformers, other than transformers in bridge circuits: provide primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of rated capacity equals connected load. Provide disconnect switch on primary side.[ Provide fuses in each ungrounded primary feeder]. Provide one fused secondary lead with the other lead grounded.[ For designated systems, as indicated, provide backup power supply, including transformers connected to[ emergency power source][\_\_\_\_]. Provide for automatic switchover and alarm upon failure of primary control circuit.]]

[Control circuits: maximum voltage of [105][120] volts derived from a separate control source. Provide terminals and terminal boards. Provide separate control disconnect switch within controller. Provide one fused secondary lead with the other lead grounded.[ For designated systems, as indicated, provide backup power supply, including connection to[ emergency power source][\_\_\_\_]. Provide for automatic switchover and alarm upon failure of primary control circuit.]]

### 2.22.4 Enclosures for Motor Controllers

JIS C 8462-1.

### 2.22.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers

Across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers: include compelling relays and multiple-button, station-type with pilot lights for each speed.

### 2.22.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations: heavy duty, oil-tight design.

### 2.22.7 Pilot and Indicating Lights

[Provide LED cluster lamps.][Provide transformer, resistor, or diode type.]

### 2.22.8 Reduced-Voltage Controllers

Provide for polyphase motors [\_\_\_\_] kilowatt and larger. Reduced-voltage starters: single-step, closed transition[ autotransformer,][ reactor,][ primary resistor-type,][ solid state-type,] or as indicated, with an adjustable time interval between application of reduced and full voltages to motors.[ Wye-delta reduced voltage starter or part winding increment starter having adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced-voltage starters for starting of[ motor-generator sets,][ centrifugally operated equipment,][ or][ reciprocating compressors provided with automatic unloaders].]

]2.23 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

[Single][Double][Three] pole designed for[ flush][ surface] mounting with overload protection[ and pilot lights].

2.23.1 Pilot Lights

[ Provide yoke-mounted, seven element LED cluster light module. Color:[ green][ red][ amber][ in accordance with JIS C 8201-4-1 and JIS C 8201-4-2 ].][Provide yoke-mounted, candelabra-base sockets rated 125 volts and fitted with glass or plastic jewels. Provide clear, 6 watt lamp in each pilot switch. Jewels for use with switches controlling motors: green; jewels for other purposes:[ white][ red][ amber].

]2.24 MOTOR CONTROL CENTERS

Provide motor control centers in accordance with the following:

- a. JIS C 8201-4-1, JIS C 8201-4-1 and JIS C 8201-4-2.
- b. Wiring: in [indoor][weatherproof][ ] IP rated enclosure per JIS C 0920.
- c. Provide control centers suitable for operation on [\_\_\_\_]-volt, [\_\_\_\_]-phase, [\_\_\_\_]-wire, [\_\_\_\_] Hz system with minimum short-circuit withstand and interrupting rating of[ 100,000][ 65,000][ 42,000][ 25,000][\_\_\_\_] amperes rms symmetrical.
- d. Incoming power feeder: [ bus duct][ cable] entering at the[ top][ bottom] of enclosure and terminating on[ terminal lugs][ main protective device].
- [ e. Main protective device: [ molded case circuit breaker][ low-voltage power circuit breaker][ fusible switch] rated at [\_\_\_\_] amperes rms symmetrical interrupting capacity.
- ]f. Arrange busing so that control center can be expanded from both ends.
- ] g. Interconnecting wires: copper.
- h. Terminal blocks: plug-in-type so that controllers may be removed without disconnecting individual control wiring.

2.24.1 Bus Systems

Provide the following bus systems. Power bus: be braced to withstand fault current of[ 100,000][ 65,000][ 42,000][ 25,000][\_\_\_\_] amperes rms symmetrical. Wiring troughs: isolated from horizontal and vertical bus bars.

2.24.1.1 Horizontal and Main Buses

Horizontal bus: continuous current rating of[ 600][ 800][ 1000][ 1200][\_\_\_\_] amperes. Main bus: [ aluminum, tin-plated][ copper, silver-plated] enclosed in isolated compartment at top of each vertical section. Main bus: isolated from wire troughs, starters, and other areas.

#### 2.24.1.2 Vertical Bus

Vertical bus: continuous current rating of [ 300][ 450][ 600][\_\_\_\_\_] amperes, and [ aluminum, tin-plated][ copper, tin-plated][ copper, silver-plated]. Vertical bus: enclosed in flame-retardant, polyester glass "sandwich."

#### 2.24.1.3 Ground Bus

Copper ground bus: provided full width of motor control center and equipped with necessary lugs.

#### [2.24.1.4 Neutral Bus

Insulated neutral bus: provided continuous through the motor control center; neutral full rated. Provide lugs of appropriate capacity, as required.

#### ]2.24.2 Combination Motor Controllers

JIS C 8201-5-1 and other requirements in paragraph, MOTOR CONTROLLERS. Provide in controller a [ molded case circuit breaker][ fusible switch with clips for [\_\_\_\_\_] -type fuses for branch circuit protection]. [ Minimum short circuit withstand rating of combination motor controller: [\_\_\_\_\_] rms symmetrical amperes.][ Circuit breakers for combination controllers: [ thermal magnetic][ magnetic only].]

#### ]2.24.3 Space Heaters

Provide space heaters where indicated on the drawings, controlled using an adjustable 10 to 35 degrees C thermostat, magnetic contactor, and a molded-case circuit breaker [ and a [480][400]-[120][100] volt single-phase transformer]. Provide space heaters equipped with 250-watt, [210][240] volt strip elements operated at [105][120] volts and [ supplied from the motor control center bus][ wired to terminal blocks for connection to [105][120]-volt single-phase power sources located external to the control centers]. Contactors: open type, electrically-held, rated 30 amperes, 2-pole, with 120-volt ac coils.

#### ]2.25 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with MLIT ESS. Comply with requirements of Division 23, "Mechanical" for mechanical isolation of machines and other equipment.

#### 2.26 TELECOMMUNICATIONS SYSTEM

Provide system of telecommunications wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires [ wireways,][ cable trays,] and other accessories for telecommunications outlets and pathway in accordance with the drawings and as specified herein. [ Additional telecommunications requirements are specified in Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEM.]

#### [2.27 COMMUNITY ANTENNA TELEVISION (CATV) SYSTEM

[Additional CATV requirements are specified in [ Section 27 54 00.00 20, COMMUNITY ANTENNA TELEVISION (CATV) SYSTEMS.][ Section 27 05 14.00 10,



CABLE TELEVISION PREMISES DISTRIBUTION SYSTEM.]]

[2.27.1 CATV Outlets

Provide flush mounted, 75-ohm, F-type connector outlet rated from 5 to 1000 MHz in standard electrical outlet boxes[ with isolation barrier] with mounting frame.

][2.27.2 CATV Faceplates

Provide modular faceplates for mounting of CATV Outlets.[ Faceplate: include designation labels and label covers for circuit identification.] Faceplate color: match outlet and switch coverplates.

][2.27.3 Backboards

[Provide void-free, fire rated interior grade plywood, 19 mm thick,[ 1200 by 2400 mm][ as indicated]. Do not cover the fire stamp on the backboard.][ Coordinate CATV backboard requirements with telecommunications backboard requirements as specified in Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING.]

]]2.28 GROUNDING AND BONDING EQUIPMENT

2.28.1 Ground Rods

JIS C 60364-5-54. Ground rods: [ copper-clad steel][ solid copper][ stainless steel], with minimum diameter of 14mm and minimum length 1500mm. Sectional ground rods are permitted.

[2.28.2 Ground Bus

Copper ground bus: provided in the electrical equipment rooms as indicated.

]2.28.3 Telecommunications [and CATV]Grounding Busbar

Provide corrosion-resistant grounding busbar suitable for[ indoor][ outdoor] installation in accordance with JIS C 60364-5-54. Busbars: plated for reduced contact resistance. If not plated, clean the busbar prior to fastening the conductors to the busbar and apply an anti-oxidant to the contact area to control corrosion and reduce contact resistance. Provide a telecommunications main grounding busbar (TMGB) in the telecommunications entrance facility[ and a (TGB) in all other telecommunications rooms and equipment rooms]. The telecommunications main grounding busbar (TMGB)[ and the telecommunications grounding busbar (TGB)]: sized in accordance with the immediate application requirements and with consideration of future growth. Provide telecommunications grounding busbars with the following:

- a. Predrilled copper busbar provided with holes for use with standard sized lugs,
- b. Minimum dimensions of 6 mm thick by 100 mm wide for the TMGB[ and 50 mm wide for TGBs] with length as indicated;
- c. Listed by a nationally recognized testing laboratory.

[2.29 HAZARDOUS LOCATIONS

Electrical materials, equipment, and devices for installation in hazardous locations, as defined by JIS: specifically approved by Underwriters' Laboratories, Inc., or Factory Mutual for particular "Class," "Division," and "Group" of hazardous locations involved. Boundaries and classifications of hazardous locations: as indicated. Equipment in hazardous locations: comply with JIS C 60079-0 and JIS C 60079-14 for electrical equipment and industrial controls and JIS C 60079-0 and JIS C 60079-14 for motors.

]2.30 MANUFACTURER'S NAMEPLATE

Provide on each item of equipment 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.

2.31 FIELD FABRICATED NAMEPLATES

Provide field fabricated nameplates in accordance with the following:

- a. JIS K 6911.
- b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.
- c. Each nameplate inscription: identify the function and, when applicable, the position.
- d. Nameplates: melamine plastic, 3 mm thick, white with [black] [\_\_\_\_\_] center core.
- [ e. Provide red laminated plastic label with white center core where indicated.
- ] f. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.
- g. Minimum size of nameplates: 25 by 65 mm.
- h. Lettering size and style: a minimum of 6.35 mm high normal block style.

2.32 WARNING SIGNS

Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer in accordance with NFPA 70E and JIS Z 9101 for switchboards, panelboards, industrial control panels, and motor control centers. Provide marking that is clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.33 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00, FIRESTOPPING.

## 2.34 WIREWAYS

Material: steel[ epoxy painted][ galvanized] 16 gauge for heights and depths up to 150 by 150 mm, and 14 gauge for heights and depths up to 305 by 305 mm. Provide in length[ indicated][ required for the application] with[ hinged-][ screw-] cover enclosure per [indoor][weatherproof][hazardous] IP rated enclosure per JIS C 8462-1.

## [2.35 METERING

JIS C 1210. Provide a self-contained, socket-mounted, electronic programmable outdoor watthour meter. Meter: either programmed at the factory or programmed in the field. Turn field programming device over to the Contracting Officer at completion of project. Coordinate meter to system requirements. [Metering shall be compliant with the current Advanced Meter Reading System (AMRS) specification.]

- a. Design: Provide watthour meter designed for use on a single-phase, three-wire, [210/105][ 240/120][440/254][420/242][480/240] volt system. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS).
- b. Class: 200; Form: [ 2S][\_\_\_\_], accuracy: plus or minus 1.0 percent; Finish: Class II.
- c. Cover: Polycarbonate and lockable to prevent tampering and unauthorized removal.
- d. Kilowatt-hour Register: five digit electronic programmable type.
- e. Demand Register:
  - (1) Provide solid state.
  - (2) Meter reading multiplier: Indicate multiplier on the meter face.
  - (3) Demand interval length: programmed for[ 15][ 30][ 60] minutes with rolling demand up to six subintervals per interval.
- f. Socket: JIS C 1210. Provide [weatherproof][ ] IP rated, box-mounted socket, ringless, having[ manual circuit-closing bypass and having] jaws compatible with requirements of the meter. Provide manufacturers standard enclosure color unless otherwise indicated.

## ]2.36 METER BASE ONLY

JIS C 1210. Provide [weatherproof][ ] IP rated, box-mounted socket, ringless, having jaws compatible with requirements of a class: 200 and Form: [ 2S][\_\_\_\_] self contained watthour meter. Provide gray plastic closing cover and bypass links. Provide manufacturers standard enclosure color unless otherwise indicated.

## ]2.37 SURGE PROTECTIVE DEVICES

Provide surge protective devices (SPD) which comply with JIS C 5381-11 and JIS C 5381-12 at the service entrance[, load centers] [, panelboards] [, MCC] [and] [\_\_\_\_]. Provide surge protectors in a [indoor][weatherproof] IP rated enclosure per JIS C 8462-1. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker.

[ Provide SPDs per JIS Z 9290-1 for the lightning protection system.

]2.38 FACTORY APPLIED FINISH

Provide factory-applied finish on electrical equipment in accordance with the following:

- a. JIS C 0920 corrosion-resistance test and the additional requirements as specified herein.
- b. Interior and exterior steel surfaces of equipment enclosures: thoroughly cleaned followed by a rust-inhibitive phosphatizing or equivalent treatment prior to painting.
- c. Exterior surfaces: free from holes, seams, dents, weld marks, loose scale or other imperfections.
- d. Interior surfaces: receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.
- e. Exterior surfaces: primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish.
- f. Equipment located indoors: Light Gray,[ and equipment located outdoors: [ Light Gray][ Dark Gray]].
- g. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.39 SOURCE QUALITY CONTROL

2.39.1 Transformer Factory Tests

Submittal: include routine JEC 2200 and JIS C 61558-1 transformer test results on each transformer and also provide the results of Japanese standard "design" and "prototype" tests that were made on transformers electrically and mechanically equal to those specified.

[2.40 COORDINATED POWER SYSTEM PROTECTION

Prepare analyses as specified in Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION.

]PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces: conform to requirements of MLIT ESS, JIS C 0365 and to requirements specified herein.

[3.1.1 Underground Service

Underground service conductors and associated conduit: continuous from service entrance equipment to outdoor power system connection.

]3.1.2 Overhead Service

Overhead service conductors into buildings: terminate at service entrance fittings or weatherhead outside building. Overhead service conductors and support bracket for overhead conductors are included in[ Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.]

]3.1.3 Hazardous Locations

Perform work in hazardous locations, as defined by applicable codes and standards, for particular "Class," "Division," and "Group" of hazardous locations involved. Provide conduit and cable seals where required. Provide conduit with tapered threads.

]3.1.4 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures: labeled and identified as such.

3.1.4.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum: indicate number of service disconnect devices housed by enclosure and indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 6.35 mm in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure: provided only as permitted.

3.1.5 Wiring Methods

Provide insulated conductors installed in rigid steel conduit or type G, IMC or type C, rigid nonmetallic conduit or Unplasticized Polyvinyl Chloride, or EMT or Type E, except where specifically indicated or specified otherwise or required to be installed otherwise. Grounding conductor: separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways.[ Shared neutral, or multi-wire branch circuits, are not permitted with arc-fault circuit interrupters.] Minimum conduit size: 16 mm in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings: made with metal conduit in fire-rated shafts, with metal conduit extending through shafts for minimum distance of 150 mm. Firestop conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors in accordance with Section 07 84 00, FIRESTOPPING.

3.1.5.1 Pull Wire

Install pull wires in empty conduits. Pull wire: plastic having minimum 890-N force tensile strength. Leave minimum 915 mm of slack at each end of pull wire.

[3.1.5.2 Metal Clad Cable

Install in accordance with manufacturer's requirements, Type MC cable.

]3.1.5.3 Armored Cable

Install in accordance with manufacturer's requirements, Type AC cable.

]3.1.5.4 Flat Conductor Cable

Install in accordance with manufacturer's requirements, Type FCC cable.

]3.1.6 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 150 mm away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.[ Run conduits[ in crawl space][ under floor slab] as if exposed.]

3.1.6.1 Restrictions Applicable to EMT or Type E

- a. Do not install underground.
- b. Do not encase in concrete, mortar, grout, or other cementitious materials.
- c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT or Type E conduit.
- d. Do not use in hazardous areas.
- e. Do not use outdoors.
- f. Do not use in fire pump rooms.
- g. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

[3.1.6.2 Restrictions Applicable to Nonmetallic Conduit or Type VE, HIVE, VP, HIVP

- a. PVC Schedule 40 and PVC Schedule 80 or Type VE, HIVE, VP, HIVP
  - (1) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, hospitals, power plants, missile magazines, and other such areas.
  - (2) Do not use in hazardous (classified) areas.
  - (3) Do not use in fire pump rooms.
  - (4) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.
  - (5) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.
  - (6) Do not use when the enclosed conductors must be shielded from the

effects of High-altitude Electromagnetic Pulse (HEMP).

]3.1.6.3 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.6.4 Underground Conduit

Plastic-coated rigid steel; plastic-coated steel IMC or type C, LL or LT; PVC, Type EPC-40 or Type VE, HIVE, VP, HIVP. Convert nonmetallic conduit, other than PVC Schedule 40 or 80 or Type VE, HIVE, VP, HIVP, to plastic-coated rigid, or IMC, steel conduit before rising through floor slab. Plastic coating: extend minimum 150 mm above floor.

[3.1.6.5 Conduit Interior to Buildings for 400 Hz Circuits

Aluminum or nonmetallic. Where 400-Hz circuit runs underground or through concrete, provide PVC Schedule[ 40][ 80] or Type VE, HIVE, VP, HIVP conduit.

]3.1.6.6 Conduit for Circuits Rated Greater Than 600 Volts

Rigid metal conduit or Type G only.

3.1.6.7 Conduit Installed Under Floor Slabs

Conduit run under floor slab: located a minimum of [305] [\_\_\_\_\_] mm below the vapor barrier. Seal around conduits at penetrations thru vapor barrier.

3.1.6.8 Conduit Through Floor Slabs

Where conduits rise through floor slabs, do not allow curved portion of bends to be visible above finished slab.

[3.1.6.9 Conduit Installed in Concrete Floor Slabs

[Rigid steel or Type G; steel IMC or Type C; fiberglass, or PVC, Type EPC-40.][PVC, Type EPC-40, unless indicated otherwise.] Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab.[ Do not stack conduits.][ Do not stack conduits more than two diameters high with minimum vertical separation of [\_\_\_\_\_] mm.] Space conduits horizontally not closer than three diameters, except at cabinet locations. Curved portions of bends must not be visible above finish slab. Increase slab thickness as necessary to provide minimum 25 mm cover over conduit. Where embedded conduits cross building and/or expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings must allow horizontal and vertical movement of raceway. Conduit larger than 27 mm trade size: installed parallel with or at right angles to main reinforcement; when at right angles to reinforcement, install conduit close to one of supports of slab.[ Where nonmetallic conduit is used, convert raceway to plastic coated rigid steel or Type G or plastic coated steel IMC or Type C; LL or LT before rising above floor, unless specifically indicated.]

13.1.6.10 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 150 mm above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.6.11 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Do not exceed one-fourth proof test load for load applied to fasteners. Provide vibration resistant and shock-resistant fasteners attached to concrete ceiling. Do not cut main reinforcing bars for any holes cut to depth of more than 40 mm in reinforced concrete beams or to depth of more than 20 mm in concrete joints. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems: supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Do not share supporting means between electrical raceways and mechanical piping or ducts. Coordinate installation with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations.[ Support exposed risers in wire shafts of multistory buildings by U-clamp hangers at each floor level and at 3050 mm maximum intervals.] Where conduit crosses building expansion joints, provide suitable[ watertight] expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 63 mm inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction. Type E conduit shall be secured and supported at least 1 meter from terminations.

3.1.6.12 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.6.13 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Provide locknuts with sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required.



#### 3.1.6.14 Flexible Connections

Provide flexible steel conduit between 915 and 1830 mm in length for recessed and semirecessed lighting fixtures[; for equipment subject to vibration, noise transmission, or movement; and for motors]. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: 16 mm diameter. Provide liquidtight flexible[ nonmetallic] conduit in wet and damp locations[ and in fire pump rooms] for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

#### 3.1.6.15 Telecommunications and Signal System Pathway

Install telecommunications pathway in accordance with JIS X 5150.

- a. Horizontal Pathway: Telecommunications pathways from the work area to the telecommunications room: installed and cabling length requirements in accordance with JIS X 5150. Size conduits[, wireways][, and cable trays] in accordance with JIS X 5150[ and][ as indicated].
- b. Backbone Pathway: Telecommunication pathways from the telecommunications entrance facility to telecommunications rooms, and, telecommunications equipment rooms (backbone cabling): installed in accordance with JIS X 5150. Size conduits[, wireways][, and cable trays] for telecommunications risers in accordance with JIS X 5150[ and][ as indicated].

#### [3.1.6.16 Community Antenna Television (CATV) System Conduits

Install a system of CATV wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires[ wireways,][ cable trays,] and other accessories for CATV outlets and pathway in accordance with JIS X 5150. [Provide distribution system with star topology with empty conduit and pullwire from each outlet box to the telecommunications room and empty conduit and pullwire from each telecommunications room to the headend equipment location][Provide distribution system with star topology with empty conduit and pullwire from each outlet to the headend equipment location].

#### ]3.1.7 Busway Installation

Install busways parallel with or at right angles to ceilings, walls, and structural members. Support busways at 1525 mm maximum intervals, and brace to prevent lateral movement. Provide fixed type hinges on risers; spring-type are unacceptable. Provide flanges where busway makes penetrations through walls and floors, and seal to maintain smoke and fire ratings. Provide waterproof curb where busway riser passes through floor. Seal gaps with fire-rated foam and caulk. Provide expansion joints, but only where bus duct crosses building expansion joints. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

#### 3.1.8 Cable Tray Installation

[ Install and ground in accordance with manufacturer's instructions.[ In addition, install and ground telecommunications cable tray in accordance with JIS X 5150, and JIS C 60364-5-54]. Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Support[

in accordance with manufacturer recommendations but at not more than [1830] [\_\_\_\_\_] mm intervals][ as indicated].[ Coat contact surfaces of aluminum connections with an antioxidant compound prior to assembly.] Adjacent cable tray sections: bonded together by connector plates of an identical type as the cable tray sections. For grounding of cable tray system provide 38 sqmm bare copper wire throughout cable tray system, and bond to each section, except use 60 sqmm aluminum wire if cable tray is aluminum. Terminate cable trays 255 mm from both sides of smoke and fire partitions. Install conductors run through smoke and fire partitions in 103 mm rigid steel conduits with grounding bushings, extending 305 mm beyond each side of partitions. Seal conduit on both ends to maintain smoke and fire ratings of partitions. Firestop penetrations in accordance with Section 07 84 00, FIRESTOPPING. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

][Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Support[ as indicated][ at maximum [1830] [\_\_\_\_\_] mm] intervals.[ In addition, install and ground telecommunications cable tray in accordance with JIS X 5150, and JIS C 60364-5-54][ Coat contact surfaces of aluminum connections with an antioxidant compound prior to assembly.] Ensure edges, fittings, and hardware are finished free from burrs and sharp edges. Provide 38 sqmm AWG bare copper wire throughout cable tray system, and bond to each section. Use 60 sqmm aluminum wire if cable tray is aluminum. Install conductors that run though smoke and fire partitions in 103 mm rigid steel conduits with grounding bushing, extending 305 mm beyond each side of partitions. Seal conduit on both ends to maintain smoke and fire ratings of partitions. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

#### ][3.1.9 Telecommunications Cable Support Installation

Install open top and closed ring cable supports on 1.2 m to 1.5 m centers to adequately support and distribute the cable's weight. Use these types of supports to support a maximum of 50 6.4 mm diameter cables. Install suspended cables with at least 75 mm of clear vertical space above the ceiling tiles and support channels (T-bars). Open top and closed ring cable supports: suspended from or attached to the structural ceiling or walls with hardware or other installation aids specifically designed to support their weight.

#### ][3.1.10 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways: cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces,[ when surface mounted on interior walls exposed up to 2135 mm above floors and walkways,][ or when installed in hazardous areas] and when specifically indicated. Boxes in other locations: sheet steel, except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic[ sheathed cable] conduit system. Provide each box with volume required for number of conductors enclosed in box. Boxes for mounting lighting fixtures: minimum 100 mm square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls: square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet

locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; provide readily removable fixtures for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. [ Threaded studs driven in by powder charge and provided with lockwashers and nuts [ or nail-type nylon anchors ] may be used in lieu of wood screws, expansion shields, or machine screws. ] In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 610 mm from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

#### 3.1.10.1 Boxes

Boxes for use with raceway systems: minimum 40 mm deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets: minimum 100 mm square, except that 100 by 50 mm boxes may be used where only one raceway enters outlet. Telecommunications outlets: a minimum of [ 100 mm square by 54 mm deep ] [ 120 mm square by 54 mm deep ] [ , except for [ wall mounted telephones ] [ and ] [ outlet boxes for handicap telephone stations ] ]. Mount outlet boxes flush in finished walls.

#### 3.1.10.2 Pull Boxes

Construct of at least minimum size required [ of code-gauge aluminum or galvanized sheet steel, ] [ and ] [ compatible with nonmetallic raceway systems, ] except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

#### [3.1.10.3 Extension Rings

Extension rings are not permitted for new construction. Use only on existing boxes in concealed conduit systems where wall is furred out for new finish.

#### ]3.1.11 Mounting Heights

Mount panelboards, [ enclosed ] circuit breakers, [ motor controller ] and disconnecting switches so height of operating handle at its highest position is maximum 1980 mm above floor. Mount lighting switches [ and handicapped telecommunications stations ] [ 1220 mm above finished floor ]. Mount receptacles [ and telecommunications outlets ] 460 mm above finished floor [ , unless otherwise indicated ]. [ Wall-mounted telecommunications outlets: mounted at height [ 1525 mm above finished floor ] [ indicated ]. ] [ Mount other devices as indicated. ] [ Measure mounting heights of wiring devices and outlets [ in non-hazardous areas ] to center of device or outlet. ] [ Measure mounting heights of receptacle outlet boxes in the [ hazardous area ] [ \_\_\_\_\_ ] to the bottom of the outlet box. ]

[3.1.12 Nonmetallic Sheathed Cable Installation

Where possible, install cables concealed behind ceiling or wall finish. Thread cables through holes bored on approximate centerline of wood members; notching of end surfaces is not permitted. Provide sleeves through concrete or masonry for threading cables. Install exposed cables parallel to or at right angles to walls or structural members. Protect exposed nonmetallic sheathed cables less than 1220 mm above floors from mechanical injury by installation in conduit or tubing. When cable is used in metal stud construction, insert plastic stud grommets in studs at each point through which cable passes, prior to installation of cable.

] [3.1.13 Mineral Insulated, Metal Sheathed (Type MI) Cable Installation

Mineral-insulated, metal-sheathed cable system, Type MI, may be used in lieu of exposed conduit and wiring. Conductor sizes: not less than those indicated for the conduit installation. Fasten cables within 305 mm of each turn or offset and at 830 mm maximum intervals. Make cable terminations in accordance with cable manufacturer's recommendations. Terminate single-conductor cables of a circuit, having capacities of more than 50 amperes, in a single box or cabinet opening. Color code individual conductors in all outlets and cabinets.

] 3.1.14 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors 14 sqmm and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors 22 sqmm and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations in accordance with [ Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS. ] [ Section [\_\_\_\_], [\_\_\_\_] ] [ Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC ] [ manufacturer's recommendations ]. [ Provide telecommunications system conductor identification as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS. ]

3.1.14.1 Marking Strips

Provide marking strips in accordance with the following:

- a. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.
- b. Use permanent ink for the wire numbers
- c. Provide reversible marking strips to permit marking both sides, or provide two marking strips with each block.
- d. Size marking strips to accommodate the two sets of wire numbers.
- e. Assign a device designation in accordance with JIS C 8201-4-1 and JIS C 8201-4-2 to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.
- f. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according

to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations.

- g. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

#### 3.1.15 Splices

Make splices in accessible locations. Make splices in conductors 5.5 sqmm and smaller diameter with insulated, pressure-type connector. Make splices in conductors 8 sqmm and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

#### 3.1.16 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 0.58 mm. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

#### 3.1.17 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

#### 3.1.18 Grounding and Bonding

[Provide in accordance with JIS Z 9290-1]. Ground exposed, non-current-carrying metallic parts of electrical equipment, [access flooring support system,] metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, [grounding conductor of nonmetallic sheathed cables, ]and neutral conductor of wiring systems.[ Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode.][ Make ground connection to driven ground rods on exterior of building.][ Interconnect all grounding media in or on the structure to provide a common ground potential. This includes lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Make interconnection to the gas line on the customer's side of the meter. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system.] In addition to the requirements specified herein, provide telecommunications grounding in accordance with JIS C 60364-5-54. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection. If a splice is made inside a metal box, then the box shall be bonded to the equipment grounding conductor.

#### 3.1.18.1 Ground Rods

Provide cone pointed ground rods. Measure the resistance to ground using the fall-of-potential method described in JIS C 60364-6. Do not exceed 25 ohms under normally dry conditions for the maximum resistance of a driven ground. If this resistance cannot be obtained with a single rod, [ ] additional rods, spaced on center, not less than twice the distance of the length of the rod, [ ] or if sectional type rods are used, [ ] additional sections may be coupled and driven with the first rod. [ In high-ground-resistance, UL listed chemically charged ground rods may be used. ] If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

#### 3.1.18.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, [ excepting specifically those connections for which access for periodic testing is required, ] by exothermic weld or compression connector.

- a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.
- b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Provide tools and dies as recommended by the manufacturer. Use an embossing die code or other standard method to provide visible indication that a connector has been adequately compressed on the ground wire.

#### 3.1.18.3 Ground Bus

Provide a copper ground bus in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of [ transformer neutrals and other electrical ] [ electrical ] equipment: effectively grounded by bonding to the ground bus. Bond the ground bus to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 100 mm above the floor. Make connections and splices of the brazed, welded, bolted, or pressure-connector type, except use pressure connectors or bolted connections for connections to removable equipment. [ For raised floor equipment rooms in computer and data processing centers, provide a minimum of 4, one at each corner, ground buses connected to the building grounding system. Use bolted connections in lieu of thermoweld, so they can be changed as required by additions and/or alterations. ]

#### 3.1.18.4 Resistance

Maximum resistance-to-ground of grounding system: do not exceed [ 5 ] [ ] ohms under dry conditions. Where resistance obtained exceeds [ 5 ] [ ] ohms, contact Contracting Officer for further instructions.

#### 3.1.18.5 Telecommunications System

Provide telecommunications grounding in accordance with the following:

- a. Telecommunications Grounding Busbars: Provide a telecommunications main grounding busbar (TMGB) in the telecommunications entrance facility. Install the TMGB as close to the electrical service entrance grounding connection as practicable.[ Provide a telecommunications grounding busbar (TGB) in all other telecommunications rooms and telecommunications equipment rooms. Install the TGB as close to the telecommunications room panelboard as practicable, when equipped. Where a panelboard for telecommunications equipment is not installed in the telecommunications room, locate the TGB near the backbone cabling and associated terminations. In addition, locate the TGB to provide for the shortest and straightest routing of the grounding conductors. Where a panelboard for telecommunications equipment is located within the same room or space as a TGB, bond that panelboard's alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure to the TGB.] Install telecommunications grounding busbars to maintain clearances as required and insulated from its support. A minimum of 50 mm separation from the wall is recommended to allow access to the rear of the busbar and adjust the mounting height to accommodate overhead or underfloor cable routing.
- b. Telecommunications Bonding Conductors: Provide main telecommunications service equipment ground consisting of separate bonding conductor for telecommunications, between the TMGB and readily accessible grounding connection of the electrical service. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 1 m in length, bond the conductors to each end of the conduit using a grounding bushing or a 14 sqmm conductor, minimum.[ Provide a telecommunications bonding backbone (TBB) that originates at the TMGB extends throughout the building using the telecommunications backbone pathways, and connects to the TGBs in all telecommunications rooms and equipment rooms. Install the TBB conductors such that they are protected from physical and mechanical damage. The TBB conductors should be installed without splices and routed in the shortest possible straight-line path. Make the bonding conductor between a TBB and a TGB continuous. Where splices are necessary, the number of splices should be a minimum. Make the splices accessible and located in telecommunications spaces. Connect joined segments of a TBB using exothermic welding, irreversible compression-type connectors, or equivalent. Install all joints to be adequately supported and protected from damage. Whenever two or more TBBs are used within a multistory building, bond the TBBs together with a grounding equalizer (GE) at the top floor and at a minimum of every third floor in between. Do not connect the TBB and GE to the pathway ground, except at the TMGB or the TGB.]
- c. Telecommunications Grounding Connections: Telecommunications grounding connections to the TMGB[ or TGB]: utilize listed compression two-hole lugs, exothermic welding, suitable and equivalent one hole non-twisting lugs, or other irreversible compression type connections. Bond all metallic pathways, cabinets, and racks for telecommunications cabling and interconnecting hardware located within the same room or space as the TMGB[ or TGB] to the TMGB[ or TGB] respectively]. In a metal frame (structural steel) building, where the steel framework is readily accessible within the room; bond each TMGB[ and TGB] to the vertical steel metal frame using a minimum 14 sqmm conductor. Where the metal frame is external to the room and readily accessible, bond the metal frame to the TGB or TMGB with a

minimum 14 sqmm conductor. When practicable because of shorter distances and, where horizontal steel members are permanently electrically bonded to vertical column members, the TGB may be bonded to these horizontal members in lieu of the vertical column members. All connectors used for bonding to the metal frame of a building must be listed for the intended purpose.

### 3.1.19 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications and are provided under the section specifying the associated equipment.

### 3.1.20 Elevator

Provide circuit to line terminals of elevator controller, and disconnect switch on line side of controller, outlet for control power, outlet receptacle and work light at midheight of elevator shaft, and work light and outlet receptacle in elevator pit.

### [3.1.21 Government-Furnished Equipment

Contractor[ rough-in for Government-furnished equipment][ make connections to Government-furnished equipment] to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

### ]3.1.22 Repair of Existing Work

Perform repair of existing work[, demolition, and modification of existing electrical distribution systems] as follows:

#### 3.1.22.1 Workmanship

Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.

#### 3.1.22.2 Existing Concealed Wiring to be Removed

Disconnect existing concealed wiring to be removed from its source. Remove conductors; cut conduit flush with floor, underside of floor, and through walls; and seal openings.

#### [3.1.22.3 Removal of Existing Electrical Distribution System

Removal of existing electrical distribution system equipment includes equipment's associated wiring, including conductors, cables, exposed conduit, surface metal raceways, boxes, and fittings,[ back to equipment's power source] as indicated.

#### ]3.1.22.4 Continuation of Service

Maintain continuity of existing circuits of equipment to remain. Maintain



existing circuits of equipment energized. Restore circuits wiring and power which are to remain but were disturbed during demolition back to original condition.

][3.1.23 Watthour Meters

JIS C 1210.

]3.1.24 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible. Maximum allowed lead length is 900 mm.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. [Painting: as specified in Section 09 90 00 PAINTS AND COATINGS.][Where field painting of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.]

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer[ 5][\_\_\_\_\_] working days notice prior to[ each][\_\_\_\_\_] test[s].

3.5.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring 14 sqmm and larger diameter using instrument which applies voltage of 1,000 volts DC for 600 volt rated wiring and 500 volts DC for 300 volt rated wiring to provide direct reading of resistance. All existing wiring to be reused shall also be tested.

3.5.3 Transformer Tests

Perform the standard, not optional, tests in accordance with the

Inspection and Test Procedures for transformers, dry type, air-cooled, 600 volt and below; as specified in Denki Hoan Kyoukai and MLIT DSKKS. Measure primary and secondary voltages for proper tap settings. Tests need not be performed by a recognized independent testing firm or independent electrical consulting firm.

#### 3.5.4 Ground-Fault Receptacle Test

[Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed.][Test RCBO circuit breakers in accordance with JIS C 8222, Annex G.]

#### 3.5.5 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

#### [3.5.6 Watthour Meter

##### a. Visual and mechanical inspection

- (1) Examine for broken parts, shipping damage, and tightness of connections.
- (2) Verify that meter type, scales, and connections are in accordance with approved shop drawings.

##### b. Electrical tests

- (1) Determine accuracy of meter.
- (2) Calibrate watthour meters to one-half percent.
- (3) Verify that correct multiplier has been placed on face of meter, where applicable.

#### ]3.5.7 Phase Rotation Test

Perform phase rotation test to ensure proper rotation of service power prior to operation of new or reinstalled equipment using a phase rotation meter. Follow the meter manual directions performing the test.

-- End of Section --