Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SWITCHGEAR HOUSE

11/21

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SWITCHGEAR HOUSE
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NOTE: This guide specification covers the requirements for environmentally controlled, exterior prefabricated, pre-engineered structures to house a coordinated grouping of electrical switchgear and associated power and control equipment.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

1.1 REFERENCES

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

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

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

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual
AA ASD1	(2017; Errata 2017) Aluminum Standards and Data

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 341	(2016) Seismic Provisions for Structural Steel Buildings
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISC/AISI 121	(2007) Standard Definitions for Use in the Design of Steel Structures
AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

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

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet

Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A463/A463M	(2022) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand
ASTM A500/A500M	(2021a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501/A501M	(2021) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A529/A529M	(2019) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts

ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A606/A606M	(2023) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A755/A755M	(2018) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C273/C273M	(2020) Standard Test Method for Shear Properties of Sandwich Core Materials
ASTM C518	(2021) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C553	(2013; R 2019) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM C665	(2023) Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C991	(2023) Flexible Glass Fiber Insulation for Metal Buildings
ASTM C1289	(2023) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM C1363	(2019) Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D822	(2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling

	Abrasive
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1308	(2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622/D1622M	(2014) Apparent Density of Rigid Cellular Plastics
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2247	(2015; R 2020) Standard Practice for Testing Water Resistance of Coatings in 100?Percent Relative Humidity
ASTM D2794	(1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3363	(2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test
ASTM D4060	(2019) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D6226	(2021) Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM DEFONLINE	(2008) ASTM Online Dictionary of Engineering Science and Technology
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2022) Standard Test Methods for Fire

	Tests of Building Construction and Materials
ASTM E136	(2022) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM E1646	(1995; R 2018) Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Air Pressure Difference
ASTM E1680	(2016) Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems
ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F1852	(2014) Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code

IEEE C37.20.2A	(2020) Metal-Clad Switchgear Amendment 1: Control and Secondary Circuits and Devices, and All Wiring
IEEE C57.12.29	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA MBSM	(2018) Metal Building Systems Manual

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 80	(2022) Standard for Fire Doors and Other Opening Protectives
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 15	(1999; E 2004) Steel Joist Shop Primer/Metal Building Primer
SSPC Painting Manual	(2002) Good Painting Practice, Steel Structures Painting Manual, Volume 1
SSPC SP 2	(2018) Hand Tool Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

UL 580	(2006; Reprint Mar 2019) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies
UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 GENERAL REQUIREMENTS

1.2.1 Scope

Provide a prefabricated walk-in skid-mounted switchgear house and foundation system including an insulated metal enclosure, structural steel skid, switchgear, interior power, control equipment, interior and exterior lighting, heating, cooling, [lightning protection] and related equipment. The switchgear house manufacturer must provide the equipment and materials as specified within this and related specifications. All equipment within the switchgear house must be totally complete, fully integrated and tested as an assembly prior to the shipment and arrival to the construction site providing a turn-key operational package. The structural grid base and floor system must be designed for applicable floor loading allowing the switchgear house to be lifted and transported with the interior equipment installed.

The switchgear house must be a completely self-contained pre-engineered package custom designed to specific power requirements and environmental conditions. The enclosure must be designed to house specified electrical equipment and any associated relay and control panels. The minimum aisle space and clearance around the equipment must be [as shown on drawings][designed per Article 110 of the latest National Electric Code (NFPA 70).] Provide provisions for future removal and replacement of all electrical equipment.

There must be a minimum clear space of 24 inches610 mm above the top of the tallest interior electrical equipment cabinet to the interior ceiling structure. Access doors must be provided in the exterior walls where required for each rear accessible equipment cabinets. Each access door must attach to a frame which matches the width of the respective interior equipment cabinet.

The switchgear house supplier must furnish, install, interconnect and test the equipment and materials specified herein, as well as any equipment specified in any related documents.

The specific site conditions must be considered when sizing and designing the equipment and structures.

1.2.2 Structural Performance

Provide prefabricated building capable of withstanding the effects of gravity loads and the following loads and stresses within the limits and conditions indicated.

1.2.2.1 Engineering

Design prefabricated building systems conforming to procedures described in MBMA MBSM.

1.2.2.2 Design Loads

Conform to the requirements of MBMA MBSM, ASCE 7, and the building code applicable to the project geographical location.

1.2.2.3 Live Loads

Include all vertical loads induced by the building occupancy indicated on the drawings, as well as loads induced by maintenance workers, materials and equipment for roof live loads.

1.2.2.4 Roof Snow Loads

****
NOTE: Delete this paragraph if the project is not subject to snow loads. Insert the ground snow load as determined by ASCE 7.
****

Include vertical loads induced by the ground snow load at the project site of [_____]. Allow for unbalanced and drift loads.

1.2.2.5 Wind Loads

****
NOTE: Insert the basic wind speed as determined by ASCE 7. Verify that design wind loads are in accordance with the referenced ASCE 7. It may be necessary to revise the date of the referenced ASCE 7 in 1.1 Reference paragraph to be compatible with the required design wind loads.
****

Include horizontal loads induced by a basic wind speed Project site of [_____].

1.2.2.6 Collateral Loads

Include additional dead loads other than the weight of metal building system for permanent items such as sprinklers, mechanical systems, electrical systems, and ceilings.

1.2.2.7 Auxiliary Loads

Include dynamic live loads, such as those generated by cranes and materials-handling equipment indicated on detail drawings.

1.2.2.8 Load Combinations

Design switchgear house to withstand the most critical effects of load factors and load combinations as required by MBMA MBSM, ASCE 7, and the building code applicable to the project location.

1.2.2.9 Deflection Limits

Engineer assemblies to withstand design loads with deflections no greater than the following:

a. Purlins and Rafters; vertical deflection of [1/180] [1/240] [_____] of the span.

b. Girts; horizontal deflection of [1/180] [1/240] [_____] of the span.

c. Metal Roof Panels; vertical deflection of [1/180] [1/240] [_____] of

the span.

d. Metal Wall Panels; horizontal deflection of [1/180] [1/240] [_____] of the span.

Design secondary framing system to accommodate deflection of primary building structure and construction tolerances, and to maintain clearances at openings. Provide metal panel assemblies capable of withstanding the effects of loads and stresses indicated, based on testing according to ASTM E1592.

1.2.3 Seismic Performance

Design and engineer the switchgear house capable of withstanding the effects of earthquake motions determined according to ASCE 7, AISC 341, and the applicable portions of the building code in the geographic area where the construction will take place.

1.2.4 Thermal Movements

Provide metal panel systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss as follows:

Temperature Change (Range); [67 degrees C] [120 degrees F] [_____], ambient; 100 degrees C 180 degrees F [_____], material surfaces.

1.2.5 Thermal Performance

Provide insulated metal panel assemblies with the following maximum U-factors and minimum R-values for opaque elements when tested according to ASTM C1363 or ASTM C518.

1.2.5.1 Metal Roof Panel Assemblies

****
NOTE: Insert the required U factors and R values.
****

a. U-Factor: [_____]

b. R-Value: [_____]

1.2.5.2 Metal Wall Panel Assemblies

a. U-Factor: [_____]

b. R-Value: [_____]

1.2.6 Air Infiltration for Metal Roof Panels

****
NOTE: Select or insert infiltration volume and negative pressure.
****

Air leakage through assembly must not exceed [0.3 L/s per sq. m] [0.06 cfm/sq.ft.] [_____] of roof area when tested according to ASTM E1680 at negative test-pressure difference of [75 Pa] [1.57 lb/sq.ft.] [_____].

1.2.7 Air Infiltration for Metal Wall Panels

****
NOTE: Select or insert infiltration volume and negative pressure.
****

Air leakage through assembly of not more than [0.3 L/s per sq. m] [0.06 cfm/sq.ft.] [_____] of wall area when tested according to ASTM E283 at static-air-pressure difference of [300 Pa] [6.24 lbf/sq.ft.] [_____].

1.2.8 Water Penetration for Metal Roof Panels

No water penetration when tested according to ASTM E1646 at test-pressure difference of [137 Pa] [2.86 lbf/sq.ft.] [_____].

1.2.9 Water Penetration for Metal Wall Panels

No water penetration when tested according to ASTM E331 at a minimum differential pressure of [20] [_____] percent of inward-acting, wind-load design pressure of not less than [300 Pa] [6.24 lbf/sq.ft.] [_____] and not more than 575 Pa 12 lbf/sq. ft.

1.2.10 Wind-Uplift Resistance

Provide metal roof panel assemblies that comply with[UL 580 for Class [30] [60] [90]][ASCE 7,][the building code in the geographic area where the construction will take place].

1.2.11 Skid base and Floor

The switchgear house must be mounted on a AWS D1.1/D1.1M all welded structural steel skid base, constructed entirely of ASTM A36/A36M steel. Structural steel skid base including design, materials, installation, workmanship, fabrication, assembly, erection inspection, quality control, and testing must be in accordance with AISC 325. The exterior perimeter and underside of the skid base must be protected with a minimum 800 micron coating of a coal tar epoxy. The entire skid must be blasted clean to SSPC SP 10/NACE No. 2 requirements prior to coating. The coating must meet the performance requirements of ASTM D4060 for abrasion, ASTM D4541 for adhesion, ASTM D2794 for impact, and ASTM B117 for salt fog. Stainless steel plates not less than 6 mm 1/4 inch must cover entire top of skid base except under incoming cable compartments. Paint coating system must comply with IEEE C57.12.29. After the unit is complete, the top side (floor) is painted with a [_____] color epoxy paint and sand mix for the non-skid finish.

1.3 DEFINITIONS

ASTM DEFONLINE applies to this definition paragraph.

a. Bay: Dimension between main frames measured normal to frame (at centerline of frame) for interior bays, and dimension from centerline of first interior main frame measured normal to end wall (outside face

of end-wall girt) for end bays.

b. Building Length: Dimension of the building measured perpendicular to main framing from end wall to end wall (outside face of girt to outside face of girt).

c. Building Width: Dimension of the building measured parallel to main framing from sidewall to sidewall (outside face of girt to outside face of girt).

d. Clear Span: Distance between supports of beams, girders, or trusses (measured from lowest level of connecting area of a column and a rafter frame or knee).

e. Eave Height: Vertical dimension from finished floor to eave (the line along the sidewall formed by intersection of the planes of the roof and wall).

f. Clear Height under Structure: Vertical dimension from finished floor to lowest point of any part of primary or secondary structure, not including crane supports, located within clear span.

g. Terminology Standard: Refer to MBMA "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

1.4 SYSTEM DESCRIPTION

General: Provide a complete, integrated set of mutually dependent components and assemblies that form a system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Include primary and secondary framing,[metal roof panels,][metal wall panels,] and accessories complying with requirements indicated.

Provide switchgear house of a size to accommodate the contained electrical equipment while maintaining the code required working clearance around all electrical equipment.

1.4.1 Primary Frame Type

****
NOTE: Select the appropriate primary frame type from the following.
****

[a. Rigid Clear Span: Solid-member, structural-framing system without interior columns.

][b. Truss-Frame Clear Span: Truss-member, structural-framing system without interior columns.

][c. Long Bay: Solid- or truss-member, structural-framing system without interior columns.

][d. Lean To: Solid- or truss-member, structural-framing system without interior columns, designed to be partially supported by another structure.

][e. As determined by the manufacturer.

][1.4.2 Fixed End-Wall Framing

****
NOTE: Select fixed or expandable end wall type and delete the other.
****

Provide manufacturer's standard fixed end wall, for buildings not required to be expandable, consisting of[primary frame, capable of supporting one-half of a bay design load, and end-wall columns][load-bearing end-wall with corner columns, and rafters].

][1.4.3 Expandable End-Wall Framing

Provide engineered end walls to be expandable. Provide primary frame, capable of supporting full-bay design loads, and end-wall columns.

]1.4.4 Secondary Frame Type

Provide manufacturer's standard purlins and joists and [flush-framed] [partially inset-framed] [exterior-framed (bypass)] girts.

1.4.5 Eave Height

Eave height must be [4.9 m] [6.1 m] [7.3 m] [8.5 m] [16 feet] [20 feet] [24 feet] [28 feet] [_____] [as determined by the manufacturer].

1.4.6 Bay Spacing

Bay Spacing must be [6.1 m] [7.6 m] [9.1 m] [20 feet] [25 feet] [30 feet] [_____] [as determined by manufacturer].

1.4.7 Roof Slope

Roof slope must be [1:48] [1:24] [1:12] [1:3] [1/4 inch per 12 inches] [1/2 inch per 12 inches] [1 inch per 12 inches] [4 inches per 12 inches] [_____] [manufacturer's standard for frame type required].

1.4.8 Roof System

Provide manufacturer's standard[vertical-rib, standing-seam][trapezoidal-rib standing-seam][lap-seam] metal roof panels[with insulation].

1.5 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item

if the submittal is sufficiently important or complex in context of the project.

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

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

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

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

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G[, [_____]]

SD-02 Shop Drawings

Switchgear House Drawings; G[, [_____]]

SD-03 Product Data

Manufacturer's data indicating percentage of recycle material of the following to verify sustainable acquisition compliance; G[, [_____]]

SD-04 Samples

Coil Stock, 304.8 mm 12 inches long by the actual panel width; G[, [_____]]

Roof Panels, 304.8 mm 12 inches long by actual panel width; G[, [_____]]

Wall Panels, 304.8 mm 12 inches long by actual panel width; G[, [_____]]

Fasteners; G[, [_____]]

Metal Closure Strips 250 mm 10 inches long of each type; G[, [_____]]

Insulation, approximately 200 by 280 mm 8 by 11 inches; G[, [_____]]

Vapor Barrier; G[, [_____]]

Manufacturer's Color Charts and Chips, 101.6 mm by 101.6 mm 4 by 4 inches; G[, [_____]]

SD-05 Design Data

Manufacturer's Descriptive and Technical Literature; G[, [_____]]

Manufacturer's Building Design Analysis; G[, [_____]]

SD-06 Test Reports

Test Reports; G[, [_____]]

Coatings; G[, [_____]]

Finishes; G[, [_____]]

Submit test reports in accordance with specification Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

SD-07 Certificates

Coil Stock Certification; G[, [_____]]

Aluminized Steel Repair Paint; G[, [_____]]

Galvanizing Repair Paint; G[, [_____]]

Enamel Repair Paint; G[, [_____]]

Manufacturer's Qualifications; G[, [_____]]

Qualification of Erection Contractor; G[, [_____]]

SD-08 Manufacturer's Instructions

Installation of Roof and Wall Panels; G[, [_____]]

Shipping, Handling, and Storage; G[, [_____]]

SD-11 Closeout Submittals

Manufacturer's Warranty; G[, [_____]]

Contractor's Warranty for Installation; G[, [_____]]

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawing Requirements

Switchgear house drawings must include, but are not limited to the

following:

a. Dimensioned architectural floor plan drawings at 6 mm = 304 mm 1/4 inch = 12 inch scale.

b. Building elevations, section views and skid foundation details. Section views must include electrical and mechanical equipment.

c. Electrical and mechanical equipment floor plan drawings at 6 mm = 304 mm 1/4 inch = 12 inch scale. Drawings must show all electrical and HVAC equipment including all required working clearances and access to the electrical equipment. Indicate removal path for large equipment such as switchgear.

d. Electrical floor plan drawing at 6 mm = 304 mm 1/4 inch = 12 inch scale showing electrical receptacle, lighting and lighting control layout and circuiting.

e. Provide drawings showing conduit and cable entry areas for switchgear field connections.

f. Provide rigging plan showing lifting points and shipping splits.

1.6.2 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products, erection of structural framing and installation of roof and wall panels in the geographical area where construction will take place.

1.6.3 Manufacturer's Qualifications

Switchgear House manufacturer must have a minimum of five years experience as a qualified manufacturer[and a member of MBMA] of metal building systems and accessory products.

Provide engineering services by an authorized currently licensed engineer in the geographical area where construction will take place, having a minimum of five years of experience as an engineer knowledgeable in building design analysis, protocols and procedures for the "Metal Building Systems Manual" (MBMA MBSM); ASCE 7,[the building code in the geographic area where the construction will take place] and ASTM E1592.

Provide certified engineering calculations using the products submitted for:

a. Roof and Wall Wind Loads with basic wind speed, exposure category, co-efficient, importance factor, designate type of facility, negative pressures for each zone, methods and requirements of attachment.

b. Roof Dead and Live Loads

c. Collateral Loads

d. Foundation Loads

e. Roof Snow Load

f. Seismic Loads

1.6.4 Qualification of Erection Contractor

An experienced erector who has specialized in erecting and installing work similar in material, design, and extent to that indicated for this Project and must be approved and certified by the switchgear house manufacturer.

1.6.5 Single Source

Obtain primary and secondary components and structural framing members, each type of metal roof, wall and liner panel assemblies, clips, closures and other accessories from the standard products of the single source from a single manufacturer to operate as a complete system for the intended use.

1.6.6 Welding

Qualify procedures and personnel according to AWS A5.1/A5.1M, AWS D1.1/D1.1M, and AWS D1.3/D1.3M.

1.6.7 Structural Steel

Comply with AISC 325,[AISC 341 for seismic impacted designs,] AISC 360, for design requirements and allowable stresses.

1.6.8 Cold-Formed Steel

Comply with AISC/AISI 121 and AISI SG03-3 for design requirements and allowable stresses.

1.6.9 Fire-Resistance Ratings

Where indicated, provide metal panels identical to those of assemblies tested for fire resistance per ASTM E119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Indicate design designations from UL Bld Mat Dir or from the listings of another qualified testing agency. Combustion Characteristics must conform to ASTM E136.

1.6.10 Surface-Burning Characteristics

Provide metal panels having[field-insulation][insulation core][insulation and vapor barrier] material with the following surface-burning characteristics as determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency showing:

a. Flame-Spread Index: [25] [_____] or less.

b. Smoke-Developed Index: [450] [_____] or less.

1.6.11 Fabrication

Fabricate and finish the switchgear house at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles with dimensional and structural requirements.

Provide metal panel profile, including major ribs and intermediate

stiffening ribs, if any, for full length of panel. Aluminum and aluminum-alloy sheet and plate must conform to ASTM B209.

Fabricate metal panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather-tight and minimize noise from movements within panel assembly.

Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated:

a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

c. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA or by metal building system manufacturer for application, but not less than thickness of metal being secured.

1.6.12 Certifications

The switchgear house must be Third Party certified by UL as NEC (National Electric Code) compliant and / or UL 3R RAIN TEST and / or IEEE C37.20.2A RAIN TEST compliant and must bear a UL Label.

[The switchgear house design must be accomplished by a Professional Engineer and drawings and supporting calculations will bear the Professional Engineer's seal.

]1.6.13 Finishes

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.6.14 Pre-Erection Conference

After submittals are received and approved but before metal building system work, including associated work, is performed, the Contracting Officer will hold a pre-erection conference to review the following:

a. The detail drawings, specifications, and manufacturer's descriptive and technical literature.

b. Finalize construction schedule and verify availability of materials, erector's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Methods and procedures related to metal building system erection, including, but not limited to: qualification of manufacturer, qualification of erector, manufacturer's catalog data, manufacturer's building design analysis, lateral force calculations, written instructions and test reports. Lateral force calculations must include all analysis and confirmation of system components required to transfer lateral forces to the foundation.

d. Support conditions for compliance with requirements, including alignment between and erection of structural members.

e. Flashing, special roofing and siding details, roof and wall penetrations, openings, and condition of other construction that will affect the metal building system, including coatings and base metals, factory color finish performance requirements, system components, and coil stock certification.

f. Governing regulations and requirements for, certificates, insurance, tests and inspections if applicable.

g. Temporary protection requirements for metal panel assembly during and after installation.

h. Samples of roof panels, wall panels, aluminized steel repair paint, galvanizing repair paint, and enamel repair paint.

1.6.14.1 Pre-Roofing and Siding Installation Conference

After structural framing system erection and approval but before roofing, siding[, insulation and vapor barrier] work, including associated work, is performed; the Contracting Officer will hold a pre-roofing and siding conference to review the following:

a. Examine purlins, sub-girts and formed shapes conditions for compliance with requirements, including flatness and attachment to structural members.

b. Review structural limitations of purlins, sub-girts and formed shapes during construction and after roofing and siding.

c. Review flashings, special roof and wall details, roof drainage, roof and wall penetrations, roof equipment curbs, and condition of other construction that will affect the metal building system.

d. Review temporary protection requirements for metal roof and wall panels' assembly during and after installation.

e. Review roof and wall observation and repair procedures after metal building system erection.

1.7 SHIPPING, HANDLING AND STORAGE

1.7.1 Delivery

Package and deliver the assembly and other manufactured items so as not to

be damaged or deformed and protected during transportation and handling.

For a building that must be shipped in multiple shipping sections, junction boxes must be provided at the shipping splits for easy breakdown of the building wiring for shipment and reconnection at the job site. Prior to shipment the open end/sides of each shipping section will be crated (weatherproofed) for transit to the job site.

Each shipping piece must be designed for lifting by lugs located along the base perimeter members at 4.5 m 15 feet approximate intervals. All lifting lugs must be removable.

1.8 PROJECT CONDITIONS

1.8.1 Weather Limitations

Proceed with installation preparation only when existing and forecasted weather conditions permit Work to proceed without water entering into the switchgear house.

1.8.2 Field Measurements

1.8.2.1 Established Dimensions for Foundations

Comply with established dimensions on approved anchor-bolt plans, established foundation dimensions, and proceed with fabricating structural framing. Do not proceed without verifying field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.

1.8.2.2 Verification Record

Verify locations of all framing and opening dimensions by field measurements before metal panel fabrication and indicate measurements on Shop Drawings.

1.9 COORDINATION

Coordinate size and location of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in section on 03 30 00 CAST-IN-PLACE CONCRETE.

[Coordinate installation of [fire suppression system] [equipment supports] [piping and supports][and][accessories], which are specified in Division 21 - FIRE SUPPRESSION.

][Coordinate installation of [plumbing system] [equipment supports] [piping and supports][and][accessories], which are specified in Division 22 - PLUMBING.

] Coordinate installation of [HVAC system] [equipment supports] [ductwork and supports] [piping and supports][and][accessories], which are specified in Division 23 - HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

Coordinate installation of [equipment supports][and][roof penetrations], which are specified in Division 07 - THERMAL AND MOISTURE PROTECTION.

Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leak-proof, secure, and non-corrosive installation.

1.10 WARRANTY

1.10.1 Building System Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal building system. The warranty period is to be no less than [10] [15] [20] years from the date of acceptance of the work and be issued directly to the Government. The warranty must provide that if within the warranty period, the switchgear house shows evidence of deterioration resulting from defective materials and/or workmanship, correcting of any defects is the responsibility of the metal building system manufacturer. Repairs that become necessary because of defective materials and workmanship while metal building system is under warranty are to be performed within [32] [_____] hours after notification, unless additional time is approved by the Contracting Officer.

1.10.2 Roof System Weather-Tightness Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal panel system. The warranty period is to be no less than [10] [20] [_____] years from the date of acceptance of the work and be issued directly to the Government.

The warranty is to provide that if within the warranty period the roof panel system shows evidence of corrosion, perforation, rupture, lost of weather-tightness or excess weathering due to deterioration of the panel system resulting from defective materials and correction of the defective workmanship is to be the responsibility of the metal building system manufacturer.

Repairs that become necessary because of defective materials and workmanship while roof panel system is under warranty are to be performed within [24] [_____] hours after notification, unless additional time is approved by the Contracting Officer. Immediate follow-up and completion of permanent repairs must be performed within [_____] days from date of notification.

1.10.3 Roof and Wall Panel Finish Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal panel system. The warranty period is to be no less than [10] [20] [_____] years from the date of acceptance of the work and be issued directly to the Government.

The warranty is to provide that if within the warranty period the metal panel system shows evidence of checking, delaminating cracking, peeling, chalk in excess of a numerical rating of eight, as determined by ASTM D4214 test procedures; or change colors in excess of five CIE or Hunter units in accordance with ASTM D2244 or excess weathering due to deterioration of the panel system resulting from defective materials and finish or correction of the defective workmanship is to be the responsibility of the metal building system manufacturer.

Liability under this warranty is exclusively limited to replacing the defective coated materials.

Repairs that become necessary because of defective materials and workmanship while roof and wall panel system is under warranty are to be performed within [32] [_____] hours after notification, unless additional time is approved by the Contracting Officer.

PART 2 PRODUCTS

2.1 STRUCTURAL FRAMING MATERIALS

2.1.1 W-Shapes

ASTM A992/A992M; ASTM A572/A572M or ASTM A529/A529M.

2.1.2 Channel, Angles, M-Shapes and S-Shapes

ASTM A36/A36M; ASTM A572/A572M or ASTM A529/A529M.

2.1.3 Plate and Bar

ASTM A36/A36M, ASTM A572/A572M or ASTM A529/A529M.

2.1.4 Steel Pipe

ASTM A36/A36M, ASTM A53/A53M, ASTM A572/A572M or ASTM A529/A529M.

2.1.5 Cold-Formed and Hot Formed Hollow Structural Sections

Cold formed: ASTM A500/A500M or ASTM B221, ASTM B221M. Hot-formed: ASTM A501/A501M.

2.1.6 Structural-Steel Sheet

Hot-rolled, ASTM A1011/A1011M or cold-rolled, ASTM A1008/A1008M.

2.1.7 Metallic-Coated Steel Sheet

ASTM A653/A653M, ASTM A606/A606M.

2.1.8 Metallic-Coated Steel Sheet Pre-painted with Coil Stock Coating

Steel sheet metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A755/A755M.

[a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, and ASTM A123/A123M.

][b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, and ASTM A463/A463M.

][2.1.9 Joist Girders

Refer to Section 05 21 00 STEEL JOIST FRAMING.

][2.1.10 Steel Joists

Refer to the following sections subject to project design requirements:

Section 05 21 00 STEEL JOIST FRAMING.

]2.1.11 High-Strength Bolts, Nuts, and Washers

ASTM A325M ASTM A325 heavy hex steel structural bolts; ASTM A563M ASTM A563 heavy hex carbon-steel nuts; and ASTM F436M ASTM F436 hardened carbon-steel washers.

Finish: [Hot-dip zinc coating, ASTM A153/A153M] [Mechanically deposited zinc coating, ASTM B695] [Stainless steel].

Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F1852, heavy-hex-head steel structural bolts with spline.

Finish: [Mechanically deposited zinc coating, ASTM B695] [Mechanically deposited zinc coating, ASTM B695 baked epoxy coated] [Stainless steel].

2.1.12 Anchor Rods

[ASTM F1554] [ASTM A572/A572M] [ASTM A36/A36M] [ASTM A307].

a. Configuration: Straight.

b. Nuts: Heavy duty stainless steel.

c. Plate Washers: Stainless steel.

d. Washers: Stainless steel.

e. Finish: [Hot-dip zinc coating, ASTM A153/A153M] [Mechanically deposited zinc coating, ASTM B695].

2.1.13 Threaded Rods

[ASTM A193/A193M] [ASTM A572/A572M] [ASTM A36/A36M] [ASTM A307].

a. Nuts: Heavy duty stainless steel.

b. Washers: Stainless steel.

c. Finish: [Hot-dip zinc coating, ASTM A153/A153M] [Mechanically deposited zinc coating, ASTM B695].

2.1.14 Floors

Floor must be 6 mm 1/4 inch minimum thickness flat ASTM A36/A36M steel plate, welded to all longitudinal and transverse base members. Floor plate seams must be continuously welded at all joints, and ground smooth to minimize visibility of seams. Welding of floor plate must be staggered to produce a flat and ripple free surface.

2.1.15 Primer

SSPC Paint 15, Type I, red oxide.

2.2 FABRICATION

2.2.1 General

All facets of construction through coating and weatherproofing must be

performed indoors, protected from outdoor weather conditions. Construction prior to this stage out-of-doors is not acceptable.

All permanent coatings and finishes must be applied inside a dedicated paint booth with ventilation and filtration provisions in compliance with the coating manufacturer's requirements. Coatings applied in outside, ambient air conditions must not be acceptable.

2.3 STRUCTURAL FRAMING

2.3.1 General

Clean all framing members to remove loose rust and mill scale. Provide one shop coat of primer to an average dry film thickness of 1 mil according to SSPC SP 2. Balance of painting and coating procedures must conform to SSPC Paint 15 and SSPC Painting Manual.

2.3.2 Primary Framing

Manufacturer's standard structural primary framing system includes transverse and lean-to frames; rafter, rakes, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing designed to withstand required loads and specified requirements. Provide frames with attachment plates, bearing plates, and splice members.

Shop fabricate framing components by welding or by using high-strength bolts to the indicated size and section with base-plates, bearing plates, stiffeners, and other items required.

[a. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.

][b. Rigid Modular Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from [steel round pipe] [steel tube] [shop-welded, built-up steel plates].

] c. Frame Configuration: [Single gable] [One-directional sloped] [Lean to, with high side connected to, and supported by, another structure] [Multiple gables] [Load-bearing-wall type] [Multistory].

d. Exterior Column Type: [Uniform depth] [Tapered].

e. Rafter Type: [Uniform depth] [Tapered].

2.3.3 Secondary Framing

Manufacturer's standard secondary framing members, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Fabricate framing from cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet pre-painted with coil coating, unless otherwise indicated.

Shop fabricate framing components by roll-forming or break-forming to the indicated size and section with base-plates, bearing plates, stiffeners, and other plates required for erection. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

a. Purlins: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; minimum depth [as indicated] [as required to comply with system performance requirements] [_____].

b. Girts: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees to flange minimum depth [as indicated] [as required to comply with system performance requirements] [_____].

c. Eave Struts: Unequal-flange, C-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; to provide adequate backup for metal panels.

d. Flange Bracing: Structural-steel angles or cold-formed structural tubing to stiffen primary frame flanges.

e. Sag Bracing: Structural-steel angles.

f. Base or Sill Angles: Zinc-coated (galvanized) steel sheet.

g. Purlin and Girt Clips: Steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.

h. Secondary End-Wall Framing: Manufacturer's standard sections fabricated from [zinc-coated (galvanized) steel sheet] [structural-steel sheet].

i. Framing for Openings: Channel shapes; fabricated cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings, and head, jamb, and sill of other openings.

j. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

2.3.4 Bracing

Provide adjustable wind bracing as follows:

a. Rods: ASTM A36/A36M; ASTM A572/A572M; or ASTM A529/A529M [threaded full length] [threaded a minimum of [_____]] at each end.

b. Cable: ASTM A475, [_____] diameter, extra-high-strength grade, zinc-coated, [_____]-strand steel; with threaded end anchors.

c. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.

d. Rigid Portal Frames: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

e. Fixed-Base Columns: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

f. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

g. Bracing: Provide wind bracing using any method specified above, at manufacturer's option.

2.4 PANEL MATERIALS

2.4.1 Aluminum Sheet

Roll-form aluminum [roof] [wall] [liner] panels to the specified profile, with fy = [30] [40] [50] [80] ksi [.032] [.040] [.050] inch thickness and depth as indicated. Material must be plumb and true, and within the tolerances listed:

a. Aluminum Sheet conforming to ASTM B209M ASTM B209, AA ADM and AA ASD1.

b. Individual panels to have continuous length to cover the entire length of any [roof slope] [wall area] with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

c. Provide panels with thermal expansion and contraction consistent with the type of system specified.

****

NOTE: Select the desired profile from below and delete remaining items.

****

(1) Profile and coverage to be a minimum height and width from manufacturer's standard for the indicated [roof slope] [wall area].

[(2)Profile to be a 38 mm 1-1/2 inch high rib at 304.8 mm 12 inches o.c. with small stiffening ribs, 965.2 mm 38 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][(3) Profile to be a 38 mm 1-1/2 inch high rib at 182.9 mm 7.2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][(4) Profile to be a 25.4 mm 1 inch high rib at 101.6 mm 4 inches o.c., 1260.5 mm 49-5/8 inch overall width with [1219.2] [1117.6] mm [48] [44] inch coverage and exposed fasteners.

][(5) Profile to be a 25.4 mm 1 inch high rib at 203.2 mm 8 inches o.c., 1057.3 mm 41-5/8 inch overall width with 1016 mm 40 inch coverage and exposed fasteners.

][(6) Profile to be a 44.5 mm 1-3/4 inch high V-beam rib at 127 mm 5 inches o.c., 1139.9 mm 44-7/8 inch overall width with 1066.8 mm 42 inch coverage and exposed fasteners.

][(7) Profile to be a 22.2 mm 7/8 inch high corrugated rib at 50 mm 2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][(8) Profile to be a 76 mm 3 inch high standing seam, 609.6 mm 24 inch coverage, factory-caulked and mechanical crimping or snap-together seams with concealed clips and fasteners.

][(9) Profile to be a [25.4] [44.5] [50.8] [63.5] mm [1] [1-3/4] [2] [2-1/2] inch high standing seam, [304.8] [406.4] [457.2] mm [12] [16] [18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

][(10) [Smooth, flat] [Embossed] Surface Texture.

][(11) Custom profile to be [_____] [as shown on drawings].

]2.4.2 Steel Sheet

Roll-form steel [roof] [wall] [liner] panels to the specified profile, with fy = [30] [40] [50] [80] ksi [26] [24] [22] [20] [18] gauge and depth as indicated. Material must be plumb and true, and within the tolerances listed:

[a. Galvanized Steel Sheet conforming to ASTM A653/A653M and AISI SG03-3.

][b. Aluminum-Zinc Alloy-coated Steel Sheet conforming to ASTM A792/A792M and AISI SG03-3.

][c. Individual panels to have continuous length to cover the entire length of any unbroken [roof slope] [wall area] with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

] d. Provide panels with thermal expansion and contraction consistent with the type of system specified;

[profile and coverage to be a minimum height and width from manufacturer's standard for the indicated [roof slope] [wall area].

][profile to be a 38 mm 1-1/2 inch high rib at 304.8 mm 12 inches o.c. with small stiffening ribs, 965.2 mm 38 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][profile to be a 38 mm1-1/2 inch high rib at 182.9 mm 7.2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][profile to be a 25.4 mm1 inch high rib at 101.6 mm 4 inches o.c., 1260.5 mm 49-5/8 inch overall width with [1219.2] [1117.6] mm [48] [44] inch coverage and exposed fasteners.

][profile to be a 25.4 mm1 inch high rib at 203.2 mm 8 inches o.c., 1057.3 mm 41-5/8 inch overall width with 1016 mm 40 inch coverage and exposed fasteners.

][profile to be a 22.2 mm 7/8 inch high corrugated rib at 50 mm 2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][profile to be a 76 mm 3 inch high standing seam, 609.6 mm 24 inch coverage, factory-caulked and mechanical crimping or snap-together seams with concealed clips and fasteners.

][profile to be a [25.4] [44.5] [50.8] [63.5] mm [1] [1-3/4] [2] [2-1/2] inch high standing seam, [304.8] [406.4] [457.2] mm [12] [16] [18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

][[Smooth, flat] [Embossed] Surface Texture.

][profile to be custom as shown on drawings.

]2.4.3 Foam-Insulation Core Wall Panel

Provide factory-formed [aluminum] [steel] [roof] [wall] panel assembly fabricated from two sheets of metal with modified polyisocyanurate or polyurethane foam insulation core [foamed-in-place] [board] during fabrication with joints between panels designed to form weather-tight seals. Include accessories required for weather-tight installation.

a. Closed-Cell Content: 90 percent when tested according to ASTM D6226, ASTM C1289.

b. Density: 32 to 42 kg/cu. m 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D1622/D1622M.

c. Compressive Strength: Minimum 140 kPa 20 psi when tested according to ASTM D1621.

d. Shear Strength: 179 kPa 26 psi when tested according to ASTM C273/C273M.

2.4.4 Insulated Panel Construction

Shop fabricate or field assemble insulated panel construction with specified exterior and interior [aluminum] [steel] sheet in accordance with manufacturer's printed instructions.

Insulation to be [glass-fiber-ASTM C991] [slag-wool-fiber] [rock-wool-fiber] conforming to ASTM C553 and ASTM C612 of thickness and density as required for the geographical area where construction will take place. Glass-Fiber and Mineral-Wool-Fiber are materials listed in the EPA's Comprehensive Procurement Guidelines (CPG), and are a component of sustainable acquisition compliance.

Insulation fasteners to be adhesively attached, plate welded to projecting spindle anchors; capable of holding insulation of thickness indicated, secured in position with self-locking washer and complying with the following requirements:

a. Plate: Perforated galvanized carbon-steel sheet, 0.762 mm 0.030 inch thick by 50 mm 2 inches square.

b. Spindle: Copper-coated, low carbon steel; fully annealed; 2.67 mm 0.105 inch in diameter; length to suit depth of insulation indicated.

c. Insulation-Retaining Washers: Self-locking washers formed from 0.41-mm- 0.016-inch-thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 38 mm 1-1/2 inches square or in diameter.

d. Anchor adhesive to be a product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

2.4.5 Finishes

All panels are to receive a factory-applied [polyvinylidene fluoride] [Kynar 500/Hylar 5000] [_____] finish consisting of a baked-on top-coat with a manufacturer's recommended prime coat conforming to the following:

a. Metal Preparation: All metal is to have the surfaces carefully prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with acid rinse, and thorough drying.

b. Prime Coating: A base coat of epoxy paint, specifically formulated to interact with the top-coat, is to be applied to the prepared surfaces by roll coating to a dry film thickness of 0.20 plus 0.05 mils. This prime coat must be oven cured prior to application of finish coat.

c. Exterior Finish Coating: Apply the finish coating over the primer by roll coating to dry film thickness of 0.80 plus 5 mils (3.80 plus 0.50 mils for Vinyl Plastisol) for a total dry film thickness of 1.00 plus 0.10 mils (4.00 plus 0.10 mils for Vinyl Plastisol). This finish coat must be oven-cured.

d. Interior Finish Coating: Apply a wash-coat on the reverse side over the primer by roll coating to a dry film thickness of 0.30 plus 0.05 mils for a total dry film thickness of 0.50 plus 0.10 mils. The wash-coat must be oven-cured.

e. [Color: The exterior finish chosen from the manufacturer's color charts and chips.] [_____]

f. Physical Properties: Coating must conform to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:

Chalking: ASTM DEFONLINE

Color Change and Conformity: ASTM D2244

Weatherometer: ASTM G152, ASTM G153 and ASTM D822

Humidity: ASTM D2247 and ASTM D714

Salt Spray: ASTM B117

Chemical Pollution: ASTM D1308

Gloss at 60 degrees: ASTM D523

Pencil Hardness: ASTM D3363

Reverse Impact: ASTM D2794

Flexibility: ASTM D522/D522M

Abrasion: ASTM D968

Flame Spread: ASTM E84

2.4.6 Repair Of Finish Protection

Repair paint for color finish enameled metal panel must be compatible paint of the same formula and color as the specified finish furnished by the metal panel manufacturer, conforming to ASTM A780/A780M.

2.5 MISCELLANEOUS METAL FRAMING

2.5.1 General

Cold-formed metallic-coated steel sheet conforming to ASTM A653/A653M and specified in Section 05 40 00 COLD-FORMED METAL FRAMING unless otherwise indicated.

2.5.2 Fasteners for Miscellaneous Metal Framing

Refer to the following paragraph FASTENERS.

2.6 FASTENERS

2.6.1 General

Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 25.4 mm 1 inch with other properties required to fasten miscellaneous metal framing members to substrates in accordance with the metal panel manufacturer's and ASCE 7 requirements.

2.6.2 Exposed Fasteners

Fasteners for metal panels to be corrosion resistant coated steel, aluminum, stainless steel, or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads. Fasteners for accessories to be the manufacturer's standard. Provide an integral metal washer matching the color of attached material with compressible sealing EPDM gasket approximately .09 mm 3/32 inch thick.

2.6.3 Screws

Screws to be corrosion resistant coated steel, aluminum and/or stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

2.6.4 Rivets

Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.

2.6.5 Attachment Clips

Fabricate clips from steel hot-dipped galvanized in accordance with ASTM A653/A653M or Series 300 stainless steel. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.7 FRAMES AND MATERIALS FOR OPENINGS

2.7.1 Doors

The switchgear house must be provided with a minimum of [two] [_____] entrance doors. The doors must be double wall construction, with brushed aluminum panic hardware with cylinder lock and thumb latch, brushed aluminum automatic closure with built-in hold open device, stainless steel hinges, threshold, weather-stripping, drip shields/water flashing, "DANGER, HIGH VOLTAGE, KEEP OUT" sign.[Provide a [304 mm] [12-inch] [_____] removable transom above the equipment door to allow for future equipment removal.] The personnel door must be [914 mm by 2438 mm] [36-inch by 96-inch] [_____]. The equipment door must be [1219 mm by 2438 mm] [48-inch by 96-inch] [_____].

Fire-Rated and Non-Fire-Rated Door Assemblies conforming with NFPA 80 and based on testing according to NFPA 252 as specified in Division 08 - OPENINGS unless otherwise indicated. Doors must open in the direction of egress from the electrical space and be equipped with listed panic hardware and wind safety chain.

Entrance and egress from the electrical equipment working space must be in accordance with NFPA 70, Article 110.

[For equipment requiring rear access, provide rear access doors in exterior walls. Doors must be equipped as follows:

a. Posts (mullions) must be easily removable (allowing total door and post removal) providing full open access, of (at least) any four continuous doors without temporary structural reinforcement, for potential equipment replacement or the addition of future equipment.

b. Stainless steel continuous piano type hinge.

c. Stainless steel pad lockable vault handle.

d. Three-point latching system.

e. Full gasketing and drip shield.

f. Signage as appropriate for internal equipment.

g. Hold open device.

h. Metal inner skin over insulation welded to door.

i. "Danger High Voltage / Keep Out" signs.

]2.8 ACCESSORIES

2.8.1 General

All accessories to be compatible with the metal panels; sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the metal panels. Exposed metal accessories/finishes to match the panels furnished, except as otherwise indicated. Molded foam rib, ridge and other closure strips to be non-absorbent closed-cell or solid-cell synthetic rubber or

pre-molded neoprene to match configuration of the panels.

2.8.2 Roof and Wall Accessories and Specialties

[Aluminum][Steel]roof curbs, equipment supports, roof hatches, dropout-type heat and smoke vents, hatch-type heat and smoke vents, gravity and roof ridge ventilators, wall louvers and other miscellaneous roof and wall equipment or penetrations conforming to AAMA, ASTM, and UL as specified in Division 07 unless otherwise indicated.

2.8.3 Insulation

Faced, Glass-Fiber Blanket Insulation: ASTM C665, Type [I, blankets without membrane coverings][and][II, blankets with non-reflecting coverings][and][III, blankets with reflective coverings]; Class [A, membrane-faced surface with a flame spread of 25 or less] [B, membrane-faced surface with a flame propagation resistance; critical radiant flux of 0.12 W/m2 0.11 Btu/ft2 or greater], except a flame spread rating of [25] [75] [100] or less[and a smoke developed rating of 150 or less] when tested in accordance with ASTM E84.

2.8.3.1 Polyethylene Vapor Retarder

Install polyethylene vapor retarder membrane over entire [wall][and roof] surface. Use fully compatible polyethylene tape to seal the edges of the sheets to provide a vapor tight membrane. Lap sheets not less than 150 mm 6 inch. Provide sufficient material to avoid inducing stresses in sheets due to stretching or binding. All tears or punctures visible in the finished surface, at anytime during the construction process, must be sealed with polyethylene tape.

2.8.3.2 Wall Liner

Securely fasten wall liner into place in accordance with the manufacturer's recommendation and in a neatly presented appearance.

2.8.4 Rubber Closure Strips

Closed-cell, expanded cellular rubber conforming to ASTM D1056 and ASTM D1667; extruded or molded to the configuration of the specified metal panel and in lengths supplied by the metal panel manufacturer.

2.8.5 Metal Closure Strips

Factory fabricated [aluminum] [steel] closure strips to be the same [gauge] [thickness], color, finish and profile of the specified [roof] [wall] panel.

2.8.6 Joint Sealants

2.8.6.1 Sealants

Sealants are to be an approved gun type for use in hand or air-pressure caulking guns at temperatures above 4 degrees C 40 degrees F (or frost-free application at temperatures above minus 12 degrees C 10 degrees F with minimum solid content of 85 percent of the total volume. Sealant is to dry with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone,

glass, vinyl, or wood.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the metal panel manufacturer.

2.8.6.2 Shop-Applied

Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

2.8.6.3 Field-Applied

Sealant for field-applied caulking must be an approved gun grade, non-sag one component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and conforming to ASTM C920, Type II. Color to match panel colors.

2.8.6.4 Tape Sealant

Pressure sensitive, 100 percent solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the metal panel manufacturer.

2.8.6.5 Floor Cutouts

Floor Cutouts: Under equipment for cable entry and exit from below floor with gasketed 1.214 mm 12 ga galvanized top cover plates attached to the floor by screws.

[2.8.6.6 Stairs and Landings

Where required for access, provide landings and stairs for the building. The stairs must be hot-dipped galvanized after fabrication.

]2.9 SHEET METAL FLASHING AND TRIM

2.9.1 Fabrication

Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.10 FINISHES

2.10.1 General

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

2.10.2 Appearance of Finished Work

Variations in appearance of abutting or adjacent pieces are acceptable if

they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.11 HEATING VENTILATION AND AIR CONDITIONING (HVAC)

2.11.1 HVAC Performance

[a. Redundancy: NONE. One or multiple units as required to meet atmospheric and internal heating and cooling requirements.

][b. Redundancy: N+1. Multiple units as required to meet atmospheric and internal heating and cooling requirements plus one additional unit for redundancy purposes.

][c. Redundancy: 100 percent. Two independent systems consisting of multiple units as required meeting atmospheric and internal heating and cooling requirements.

] d. Exterior Design Temperatures:

(1) Summer: (Per ASHRAE 2.5 percent design temperature).

(2) Winter: (Per ASHRAE 97.5 percent design temperature).

e. Interior Design Temperatures:

(1) Summer: 27 degrees C 80 degree F.

(2) Winter: 16 degrees C 60 degree F.

f. Occupancy: Number of Persons [_____].

g. Ventilation Air (cfm): [_____].

2.11.2 General

The switchgear house must be provided with self-contained, package type HVAC system. It must consist of through-the-wall type units. The system must have a free or ducted air discharge and return. The total design load for the system must include infiltration, ventilation load and heat generated by the equipment within the house. Provide at least 0.762 (l/s)/sq m 0.15 cfm/sq feet of mechanical induced outside air for ventilation. The HVAC system must be provided with an electronic, automatic changeover thermostat.

HVAC system must maintain the maximum interior temperature required with consideration to ambient conditions and the specified internal equipment total heat load.

HVAC Unit(s): Size and quantity as required to maintain interior design temperatures and redundancy requirements. Industrial quality, vertical, self-contained, wall mounted unit(s) with aluminum fin, and copper coils:

a. Cooling capacity: [_____] tons capacity as required to meet design temperatures as specified.

b. Heating capacity: [_____] Kw as required to meet design temperatures

as specified.

c. Thermostat, Auto Change Over, Digital, F or C Display:

(1) Smart recovery (heating mode).

(2) Droopless control, 4 cycles/hr.

(3) Backlit display.

(4) Settings never lost during power failure.

(5) 5-minute compressor protection.

(6) Separate set points for heating and cooling.

(7) Battery-less operation.

(8) Electro-Mechanical relay design.

d. Low Pressure Switch.

e. High Pressure Switch.

f. Low Ambient Control.

g. Compressor anti-cycle relay.

h. Alarm Relay.

i. Barometric Damper.

j. Supply and Return Grills.

k. Pleated Filter 51 mm 2 inches MERV 8.

l. R410A Refrigerant.

2.12 ELECTRICAL

2.12.1 General

Provide conductors, conduits, fittings, panelboards, circuit breakers, receptacles, GFI receptacles, toggle switches,[dry-type transformers,][automatic transfer switches,] surge protective devices, lighting contactors, grounding and related switchgear house accessories in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. All electrical equipment and devices must be UL listed. All wiring must be installed in metallic conduit. Utilize EMT for interior locations and rigid galvanized steel for exterior locations and areas subject to physical damage. Access and working space must be maintained about all electrical equipment to permit ready and safe operation and maintenance of such equipment in accordance with NFPA 70, Article 110.

2.12.2 Interior Lighting

Provide surface mounted interior LED lighting fixtures in accordance with Section 26 51 00 INTERIOR LIGHTING. The interior lighting system must

provide a minimum light level of 300 lux with a 3:1 average to minimum ratio. Provide toggle switch type control at each entry door to the switchgear house.

2.12.3 Exit Signs

Provide LED lamp exit sign that operates in normal, AC input with emergency battery power backup in accordance with Section 26 51 00 INTERIOR LIGHTING.

2.12.4 Emergency Lighting

Provide battery backup type emergency lighting units at each entry door. The emergency lighting units must be in accordance with Section 26 51 00 INTERIOR LIGHTING.

2.12.5 Wiring

Provide normal lighting and exit-emergency combo units lighting on the same branch circuit. Wire exit-emergency combo units ahead of the local switch within the same area.

2.12.6 Exterior Lighting

Provide wall pack LED luminaires that are suitable for outdoor applications in accordance with Section 26 56 00 EXTERIOR LIGHTING. Mount wall pack LED luminaires exterior of the switchgear house and above personnel exit doors. Wall packs must utilize LED sources. Wall packs must be constructed of rugged, weather resistant, die cast aluminum housing with an integral photocell. Control for exterior lighting must be in accordance with ASHRAE 90.1 - IP.

2.12.7 Metal-Clad Switchgear

Provide in accordance with Section 26 13 13 METAL-CLAD SWITCHGEAR.

2.12.8 Grounding

Provide grounding system in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide listed grounding pads welded to the switchgear house skid base for bonding of the steel structure in two places.

[2.12.9 Lightning Protection System

Provide lightning protection system in accordance with Section 26 41 00 LIGHTNING PROTECTION SYSTEM.

]PART 3 EXECUTION

3.1 EXECUTION

3.1.1 Examination

Before the installation begins, conduct an inspection with the erector present. The inspection must ensure that the following items are in compliance with the switchgear house manufacturer's approved shop drawings.

a. Concrete foundation dimensions and layout.

b. Anchor bolt size, type and placement.

c. Survey information showing the foundation elevations.

d. Location of bearing plates and other embedment's to receive structural framing.

Examine roughing-in for electrical feeders serving the contained switchgear and equipment within the switchgear house to ensure proper placement.

Submit to the Contracting Officer a written report, endorsed by Erector, listing conditions detrimental to performance of the Work.

Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

Electrical installations must conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.3 GROUNDING

NFPA 70 and IEEE C2, except that grounds and grounding systems must have a resistance to solid earth ground not exceeding 5 ohms.

3.3.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.3.2 Connections

Connections must be installed as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Inaccessible connections or connections below finished grade must be exothermic weld type.

3.3.3 Grounding and Bonding Equipment

Grounding and bonding of equipment must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. The switchgear house steel structure must be bonded to the grounding system.

3.4 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect the switchgear house furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.5 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount the switchgear house on concrete slab as required to satisfy the required loading. The mounting design must be performed by a registered structural engineer and included in the Structural Design Report which is sealed by the structural engineer of record. Provide conduit turn-ups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water and oil-resistant caulking or

sealant.

3.6 FIELD QUALITY CONTROL

3.6.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.6.2 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.6.3 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers must be tripped by operation of each protective device. Test must require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 10 working days in advance of the dates and times for checks, settings, and tests.

3.7 WARRANTY

3.7.1 Manufacturer's Warranty

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.7.2 Contractor's Warranty for Installation

Submit warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

-- End of Section --