

SECTION 13 34 23 23 – FABRICATED SUBSTATION CONTROL ENCLOSURES

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section provides for the design, fabrication, delivery, and installation of prefinished, insulated, prefabricated, prewired, shop-assembled, tested, control enclosures to house relay cabinets, AC and DC power systems, and related equipment indicated and/or specified.
- B. Fabricated Substation Control Enclosures shall be environmentally controlled, and shall consist of a coordinated grouping of electrical power and control equipment as indicated on any accompanying Data Sheets and/or Drawings. Any Data Sheets, Drawings, or any other related documents accompanying this Specification shall be considered a part of this Specification.
- C. Fabricated Substation Control Enclosures shall be NEMA 3R structures with exterior walls and roof fabricated from interlocking panels.
 - 1. This specification is written for steel wall construction. However, other building materials, such as concrete wall construction, are acceptable alternatives provided they meet or exceed the requirements specified for steel wall construction in this specification.
- D. Structural grid base and floor system shall be designed for applicable floor loading, allowing Enclosures to be lifted and transported with interior equipment installed.
- E. Furnish, install, interconnect, and test the Equipment and Materials specified herein, as well as any Equipment specified in any related documents.
- F. Site conditions shall be as indicated in ARTICLE 1.08. These conditions shall be considered when sizing and designing Equipment.
- G. Provide field service representatives to offload and set the fabricated substation control enclosure. Any tools/labor required will be supplied by the Supplier.

1.02 RELATED REQUIREMENTS:

- A. Related Work Specified Elsewhere:
 - 1. Section 23 75 00 – Substation Enclosure HVAC Equipment
 - 2. Section 26 24 16 – Panelboards
 - 3. Section 26 51 23 – Substation Interior Lighting and Receptacles
 - 4. Section 26 36 00 – Power Switching and Control Devices
 - 5. Section 33 72 33 16 – Relay Switchboards
 - 6. Section 33 72 33 33 – Raceway and Boxes for Utility Substations
 - 7. Section 33 72 33 36 – Cable Tray and Wireway for Utility Substations
 - 8. Section 33 72 33 43 – Substation Battery, Battery Charger and Battery Rack
 - 9. Section 33 72 43 11 – Substation Wire, Cable and Accessories

1.03 REFERENCE STANDARDS:

- A. All Materials, Equipment, and labor supplied shall be in strict compliance with the statutes, codes, and standards listed herein. Where conflicts exist between statutes, codes, and standards, the more stringent requirement shall prevail. Applicable statutes, codes, and standards are as listed below:
 - 1. American Institute of Steel Construction (AISC):
 - a. AISC 360 – Specification for Structural Steel Buildings.
 - 2. American National Standards Institute (ANSI).
 - 3. American Society of Civil Engineer (ASCE):

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- a. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
 4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
 5. ASTM International (ASTM):
 - a. A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
 - b. A36/A36M - Standard Specification for Carbon Structural Steel.
 - c. A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - d. A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - e. A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - f. A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 - g. A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 6. American Welding Society (AWS):
 - a. D1.1/D1.1M - Structural Welding Code - Steel.
 7. International Building Code (IBC).
 8. International Safety Equipment Association (ISEA):
 - a. ISEA Z308.1 - American National Standard - Minimum Requirements for Workplace First Aid Kits and Supplies.
 9. Metal Building Manufacturers Association (MBMA).
 10. National Electric Manufacturers Association (NEMA).
 11. National Fire Protection Association (NFPA):
 - a. NFPA 1 – Fire Code.
 - b. NFPA 10 - Standard for Portable Fire Extinguishers.
 - c. NFPA 12 - Standard on Carbon Dioxide Extinguishing Systems.
 - d. NFPA 70 – National Electrical Code (NEC).
 - e. NFPA 80 – Standard for Fire Doors and Other Opening Protectives.
 - f. NFPA 101 - Life Safety Code.
 - g. NFPA 252 – Standard Methods of Fire Tests for Door Assemblies.
 12. Illuminating Engineering Society of North America:
 - a. RP-7 Recommended Practice for Lighting Industrial Facilities
 13. Occupational Safety and Health Administration (OSHA).
 14. Steel Door Institute (SDI):
 - a. A250.8 – Recommended Specifications for Standard Steel Doors and Frames.
 15. Underwriters Laboratory (UL).
 16. Applicable State Building Code and Local Ordinances.
- 1.04 SUBMITTALS:
- A. Engineer shall supply panel elevation drawings with panel Bill of materials, building power, equipment & relaying single line diagrams, nameplate schedule, and general building plan view. Supplier shall provide general drawings of equipment showing overall dimensions,

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- location of major components, weights, and locations of conduit entrance plates including, but not limited to, the following:
1. Complete elevation, arrangement, fabrication, erection, layout, and detail drawings with anchorage requirements and all door and penetration locations. These include:
 - a. Control enclosure plan view and wall elevations
 - b. Control enclosure structural base and wall frame details
 - c. Control panel fabrication drawings
 2. Locations, magnitudes, and directions of resultant structural loads of the enclosures, including installed equipment loads and all design loads.
 3. Wiring diagrams of complete electrical systems.
 - a. Supplier shall provide schematics and wiring diagrams for all enclosure electrical systems.
 - b. Supplier shall provide wiring diagrams for control panels based on schematics provided by the Engineer post award.
- B. The Supplier shall prepare and deliver these and other drawings in AutoCAD 2025 format.
- C. The Supplier shall prepare HVAC design calculations including heat loss of all equipment to be installed in the enclosure and sealed by a Professional Engineer (PE) registered in the State where the Project Site is located.
- D. Structural calculations with center of gravity, lifting instructions, and load diagrams signed and sealed by a Professional Engineer (PE) registered in the State where the Project Site is located. Calculations shall indicate the load capabilities of enclosure walls, roof, and floor.
1. Calculations shall include, but shall not be limited to, the following:
 - a. Project Name and Enclosure Description
 - b. Governing State Building Code
 - c. Dead Load
 - d. Collateral Loads and Locations
 - e. Live Load and Locations
 - f. Wind Load Value
 - g. Snow Load Value
 - h. Seismic Load Value
 - i. Importance Factors applied to appropriate load groups
 - j. Load Combinations Analyzed
 2. Provide structural loading diagrams indicating the load on building components and foundations during the various load cases specified.
- E. Complete specifications including thermal insulating values of enclosure.
- F. Paint and touch-up specifications.
- G. Certificate: Submit certificate with bid stating all design load criteria and structural design will conform to the specified standards and design requirements.
- H. Bill of materials, nameplate lists, spare parts list, and list of parts shipped loose.
- I. Reports of factory tests.
- J. Written inspection and test report for on-site acceptance testing.
- K. Complete Operations and Maintenance (O&M) manuals for all furnished equipment in the enclosure. The O&M manual shall include manufacturer's instruction books and documents for maintenance and operation of the equipment, and complete information for ordering spare parts and dismantling of equipment. The information shall be submitted as a complete package of

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“as-built” information and data shall be logically grouped. O&M manual shall include the following:

1. Final versions of general arrangement drawings, guaranteed performance data, design and performance data, and test results for all equipment.
2. Operator instructions for start-up and operations of the equipment.
3. Complete operation, troubleshooting, and maintenance instructions for each piece of equipment.
4. Complete part lists with parts identified by the original manufacturer’s complete part number as well as by Manufacturer’s identification number.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver enclosure, pre-assembled to the extent possible, complete with factory installation of all equipment specified, f.o.b. jobsite unless noted otherwise, freight prepaid and allowed.
- B. Enclosures and all components mounted thereon shall be designed for and anchored sufficiently for transportation to the jobsite. Protect all components from damage during shipment, unloading and installation.
- C. Delivery truck shall be positioned adjacent to the foundation on the Project Site to facilitate lifting and setting on the foundation by Supplier.
- D. Enclosure shall be designed to rest on concrete drilled pier foundations or slab foundation by others. Attachment locations and mounting details shall be provided as Submittals by this Contract.

1.06 QUALITY ASSURANCE:

- A. Fabricated Substation Control Enclosures shall be manufactured under an established quality assurance program.
 1. Supplier shall submit for approval any and/or all quality plans, forms, and procedures applicable to manufacture of enclosures, if requested.
- B. Supplier shall be engaged in the production of such equipment for a minimum of five (5) years and able to supply proof, if requested, of manufacturing at least twelve (12) fabricated substation control enclosures of a similar type in that time frame.

1.07 WARRANTY:

- A. The Fabricated Substation Control Enclosure and associated equipment shall be warranted for a period of not less than two (2) years from the date of commissioning against defects in materials and workmanship.
- B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

1.08 PROJECT SITE CONDITIONS:

- A. Site Elevation: 2039 ft
- B. The Project Site has the following Site Conditions:
 1. Design Temperatures (Outdoor Installation):
 - a. Maximum Dry Bulb: 101.1 °F
 - b. Minimum Dry Bulb: 2.8 °F

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- c. 1% Design Wet Bulb: 71.8 °F
- 2. Design Temperatures (Outdoor Extremes):
 - a. Maximum Dry Bulb: 112.8 °F
 - b. Minimum Dry Bulb: -16.2 °F
 - c. 1% Design Wet Bulb: 81.7 °F
- C. IBC:
 - 1. Seismic loads (IBC):
 - a. Design Spectral Response Accelerations:
 - (1) Short Period, Ss: 0.15
 - (2) 1 Second, S1: 0.05
 - (3) Max. considered short period, SMS: 0.18
 - (4) Max. considered 1-second, SM1: 0.11
 - (5) 5% damped design short period, SDS: 0.12
 - (6) 5% damped design 1-second, SD1: 0.07
 - b. Risk Category: III
 - c. Site Class: D
 - d. Importance Factor, IE: 1.25
 - e. Seismic Design Category: B
 - f. Long-Period Transition Period, TL: 12 seconds
 - 2. Snow loads (IBC):
 - a. Ground snow load, pg: 33 psf
 - b. Exposure Category: C
 - a. Exposure Factor, Ce: Per ASCE 7-22 Table 7.3-1
 - b. Thermal Factor, Ct: Per ASCE 7-22 Table 7.3-2
 - c. Drift Load shall be considered when applicable

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- 3. Wind Loads (IBC):
 - a. Basic Wind Speed: V3s 119 mph
 - b. Exposure Category: C
- 4. Ice Loads (ASCE 7):
 - a. Factored (Cat. III) Ice Thickness, t: 1.58 in.
 - b. Concurrent Wind Speed, VC: 49 mph

PART 2 - PRODUCTS

2.01 GENERAL:

- A. General Performance Requirements: The enclosure and penetrations shall be designed and constructed to be wind resistant and shall be sealed to prevent infiltration of water, rain, snow, and dust when the doors are closed. The roof surface may be single-slope or gable, but designed for positive drainage. Provide a stainless-steel drip flashing over entrance doors.
 - 1. The body, shell, and floor shall be so constructed to accept the application of screws, anchors, and toggle bolts without the extensive addition of other materials or blocking.
 - 2. All fittings, hardware and ferrous-metal trim shall be stainless steel or corrosion resistant. The gel coat color coating shall be chalk-resistant, ultraviolet-resistant, fade-resistant and shall retain its gloss and color for a minimum 20-year period without appreciable degradation.
 - 3. Provide necessary mountings or shims to assure that all equipment can be mounted level and plumb.
- B. The basic design and construction of the enclosure shall be as described in the following paragraphs. The enclosure dimensions and arrangement shall be as shown on the Contract Drawings.
- C. Build America, Buy American Requirements: Supplier to provide a Certification of Compliance that the enclosure complies with the Build America, Buy America Act (BABAA) requirements set forth in Pub. L. No. 117-58, §§ 70901-52
 - 1. Reference Section II-K of the following document:
<https://www.energy.gov/node/4857326>

2.02 SERVICE CONDITIONS:

- A. The enclosure shall perform satisfactorily when installed outdoors. The enclosure shall be suitable for installation in ambient minimum and maximum specified temperatures at an elevation as indicated in ARTICLE 1.08.

2.03 DESIGN REQUIREMENTS:

- A. Fabricated Substation Control Enclosures shall be designed and constructed for outdoor use under the ambient temperature and load conditions indicated in ARTICLE 1.08.
- B. Wind Loads:
 - 1. Velocity pressure proportioned and applied as horizontal and uplift forces as recommended by the MBMA Design Practices Manual.

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- C. Seismic Loads:
 - 1. As developed per the requirements of ASCE 7-22.
- D. Floor Loads:
 - 1. Minimum 250 psf or a concentrated load of 1000 lbs. applied at any point on a 3” diameter surface.
- E. Collateral Loads: The enclosure shall be designed for the following collateral loads in addition to the loads indicated in ARTICLE 1.08.
 - 1. Roof
 - a. Primary roof framing members shall be designed for a resultant governing purlin loading. Each purlin shall be designed for the worst case of either:
 - (1) A point load of 500 lbs (for every 25 sq. ft.)
 - (2) 20 psf load on the purlin tributary area
 - (3) 250 lb./Lin Ft run of cable tray run the entire length of the enclosure on each side of the peak at mid span in combination with a 5 psf load over the purlin tributary area.
 - b. The load that produces the maximum moment, shear and deflection shall be the governing load. These loading criteria are to provide for the support of any cable tray design.
 - 2. Walls
 - a. 250 lb. point load at mid span of the panel, 12 inches out from the face of the wall at a spacing of 6 feet along the entire length of the wall.
 - 3. Ceiling
 - a. Interior ceiling structures that do not allow adequate access for attachment of miscellaneous equipment/cable tray to the roof purlins shall be designed for the same load as the roof purlins.
 - 4. All collateral loads are to be included in the seismic analysis of the enclosure. Cable trays hung from the ceiling must be laterally supported for the code required horizontal seismic loadings.
- F. Static Loads
 - 1. Battery rack, batteries and charger.
 - 2. Electrical equipment and raceways.
 - 3. Heating, ventilating, and air conditioning equipment.
 - 4. Substation Control Panels (including future).
 - 5. Communications cabinets.
 - 6. Lighting, Furniture, and other miscellaneous items as indicated
- G. Combination of Loads: The combining of normal and auxiliary loads for design shall be as prescribed and recommended by the MBMA Design Practices Manual.
- H. Deflection Criteria
 - 1. Vertical and horizontal deflection of steel members including roof panels shall be limited to 1/240 times the span under full design loads.
 - 2. Lateral drift shall be limited to 1/120 of the eve height for required lateral loads.
- I. Falling Ice: Exterior of enclosure shall be designed to resist damage by hail and falling ice from adjacent structures and overhangs.

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2.04 ENCLOSURE CONSTRUCTION:

- A. For Enclosures that must be shipped in multiple shipping sections, provide miscellaneous NEMA 1 junction boxes at the shipping splits for easy breakdown of the enclosures' wiring for shipment and reconnecting at jobsite. Prior to shipment, open end/sides of each shipping section shall be crated (weatherproofed) for transit to jobsite.
- B. Where wall bulkhead penetrations are required, cutouts shall be completely framed with 1/4" aluminum cover plates with neoprene gasket. All wall penetrations shall be made in walls prior to bending with appropriate machinery. No manual cutting of wall penetrations via jigsaw, plasma torch, or similar means will be permitted.
- C. All fastening hardware shall be zinc plated. Welding of galvanized steel and rivets shall not be an acceptable method of exterior fastening.
- D. BASE:
 - 1. Structural base shall be of all welded, seamless construction using ASTM A36/A36M / ASTM A572/A572M Grade 50 structural steel members, sized and arranged for proper strength, and able to withstand the stress and loads which will result when lifting the complete factory-fabricated and equipped assemblies and other loads as indicated.
 - 2. Provide a minimum of four removable lifting eyes or connections and galvanized or stainless-steel anchorage hardware for loading, unloading, transportation and permanent anchorage to ground supports.
 - 3. Welding shall be in accordance with requirements of AWS D1.1/D1.1M. Welders certified through the 4G position shall perform all welding. Provide welders' certificates if requested.
 - 4. Deflection shall not exceed 0.34 inches per ten (10) feet of length in any direction when the equipped enclosure is lifted by crane for shipping or installation.
 - 5. Base shall be designed for installation on drilled pier foundations located at critical support points (as determined by the Supplier). Base support locations shall be no closer than 12'-0" on center unless approved by the Engineer.
 - 6. Base structural members shall not interfere with or obstruct the areas designated for routing of power cables or control wiring.
 - 7. Equip structural base with copper ground pads located at each corner.
 - 8. Equip structural base with means to bond adjacent units of multiple enclosures.
 - 9. Supplier shall furnish anchor bolts for securing Enclosure to the foundation.
 - 10. Supplier shall furnish hold down clips to fit anchor bolts.
 - 11. Base frame shall be coated with Sherwin-Williams Industrial Marcropoxy 646 Fast Cure Epoxy with a dry film thickness of 5 to 7 mils.
- E. FLOOR:
 - 1. Floor shall be a minimum of 1/4" hot-rolled ASTM A36/A36M smooth steel plate welded to perimeter and longitudinal and/or transverse structural members of base, and coated with a non-skid finish. Floor loading shall be not less than 250 psf.
 - 2. Capable of supporting a uniform live load of 250 psf or a concentrated load of 1000 lbs. applied to any point on a 3" diameter surface.
 - 3. Maximum deflection shall be: 0.04 in. for the uniform live load and 0.08 in. for the concentrated load.
 - 4. Minimum safety factor shall be 2 ½ times the given loads.
 - 5. The finished floor shall be:
 - a. Level within 1/16 inch over the entire area.

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- b. Provided with a non-slip surface.
- c. Free of metal bindings, cracks or open joints.
- d. All joints shall be flush and tight.
- e. The maximum variation in elevation in 10 ft. shall be 0.062 inches.
- 6. The floor shall be insulated to an R35 value with a combination of blown-in cellulose over a 1 inch Dow Blue Board. Rodent barrier shall be 26 gauge galvanized steel coated with Marcopoxy undercoating.
- 7. Floor cutouts with gasketed cover plates shall be provided as required for cable entry and exit into the bottom of the equipment.
 - a. Floor cutouts under the equipment shall have surface-mounted plates and shall be manufactured from 1/4" aluminum.
 - b. All cover plates for cable entry/exit within the walk ways of the enclosure shall be recessed and manufactured from 1/4" aluminum. All screw heads shall be countersunk so as not to cause a trip hazard.
 - c. Floor cutouts shall be designed to prevent external ingress from pests.
- F. FRAME:
 - 1. The entire enclosure shall be framed with an equivalent of three (3) inch square tubular steel, to provide moment resisting welded connections of base to walls, side walls to end walls, and walls to roof. All frame connections shall be welded.
 - 2. All openings, such as doors, windows, etc., shall be similarly framed with three-inch square tubular steel or structural equivalent.
 - 3. No structural supports of any kind (center posts) shall be installed inside the enclosure.
- G. WALLS:
 - 1. The height from equipment floor to ceiling shall be ten (10) feet. Walls shall be constructed using a 4-inch channel framework system. Paint finish shall be baked on Kynar 500 PVDF resin based coating over Galvalume sheet.
 - 2. Exterior walls shall be a minimum of 18-gage thickness, but rated to withstand loading requirements of jobsite. Galvannealed steel sheets shall create a self-framing structure. Joints in roof and wall panels shall align with the sections of the metalclad assembly. Wall panels shall be formed to interlock and shall be bolted together.
 - 3. Interior walls, supporting panels and structurals, shall be designed so that interior loads of 400 pounds per linear foot of wall length may be attached to the wall without compromising the design wind loads. If additional reinforcement is required to mount equipment, the manufacturer may use Unistrut or equivalent.
 - 4. Interior wall panels shall be a minimum of 24-gage thickness steel panels with Galvalume substrate, roll-formed and painted white with Kynar 500 paint. Wall panels shall be formed to interlock and be bolted together.
 - 5. Fabricate Enclosure walls, roof, and ceiling from Class G90 galvanized steel. Exterior walls, exterior roof, and interior ceiling shall be of self-framing, interlocking design, with maximum panel width of 16". Enclosures of framed construction are not acceptable.
 - 6. Should damaged exterior wall panels need to be replaced, the frame design will facilitate replacement without disrupting the integrity of the roof and adjoining wall panels or adjacent walls.

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7. Walls shall be insulated to meet or exceed the minimum value as required by the State Building Code applicable to the specific Project Site and to ensure proper functioning of installed equipment.
 8. Wall panels shall be sealed at base and flashed to prevent water intrusion under the sill into the building.
 9. Wall insulation shall be 3 ½ “ fiberglass battery with a 1” fiberglass wall blanket serving as a thermal break, and have a UL flame-spread classification of 25 or less where exposed. The minimum “R” value shall be 13.
 10. Walls shall contain a Visqueen vapor barrier (4 mils) on the inside of the building framework.
 11. Wall openings to be fully framed, sleeved, trimmed and provided with a drip cap.
 12. Attic space to be ventilated to prevent condensation.
- H. ROOF AND CEILING:
1. Exterior roof shall be a minimum of 22-gage thickness, but rated to withstand loading requirements indicated in Paragraph 1.07.C finished with baked on Kynar 500 PVDF resin based coating. Roof shall be sloped a minimum of 1/4" per linear foot. Joints in roof and wall panels shall align with the sections of the metalclad assembly. Roof caps of formed 22-gage galvanized steel shall cover each roof panel joint to create a permanent weather seal.
 2. The roof shall be designed to support the greater between interior loads of 100 pounds per linear foot of truss length or a 200 lb. point load at mid span of the panel without compromising the roof design load.
 3. Interior ceiling shall be a minimum of 24-gage thickness, but rated to withstand loading requirements of jobsite. Minimum indoor ceiling height shall be 10'-0".
 4. Walls, floor, and roof shall be fully insulated. Minimum R-value shall be R-19 for roof. Provide walls and roof with fiberglass battery type insulation. Provide floor with polyurethane spray foam insulation. Enclosures shall be of fire resistant construction.
 5. Steel sheets shall conform to ASTM A653/A653M, Grade A, having a galvanized coating conforming to ASTM A653/A653M, Class G90.
 6. Roof shall be warranted against leaks for ten (10) years.
 7. Roof panels shall be of one continuous length from the eave to the ridge lines.
 8. Metal closures shall be provided along building ridge line and end-wall junctures of roof and gable. Closures shall be of minimum 26 gauge galvanized steel and shall be designed to provide a weather and light tight seal.
 9. Roof overhang shall be 4 inches.
 10. Purlins shall be exposed to provide adequate access to mount cable trays as required.
 11. Two (2) screened, louvered ventilation openings shall be provided, one at each end, to prevent condensation in attic space.
 12. The ceiling shall be flat and consist of formed 22 gauge paint quality galvanized steel panels reinforced with 16 gauge channel 24 inches on center. It shall be designed to retain the insulation and to provide a smooth ceiling surface. Ceiling shall be insulated to a minimum value of R30.
 13. Design for additional load as required to support cable tray, lighting, conduits and other items provided by this Contract.
 14. Gutters and downspouts shall be fabricated from the same material and finish as the wall panels.

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15. Louvers shall be rectangular, galvanized steel or aluminum, fixed, mesh screen, self-framing, general purpose type with an inside closure panel for winter closing.

2.05 DOORS:

1. Provide Enclosures with a minimum of two entrance doors. Doors shall be insulated, double-wall construction, with brushed aluminum panic bar with cylinder lock and thumb latch, brushed aluminum automatic closure with built-in hold open device, prime coat hinges, threshold built into the door frame, neoprene gasket, drip shields/water flashing, and a 12" removable transom above the equipment door only. Personnel doors shall be 36" x 84".
 2. Large equipment access
 - a. Overall dimension is 4'-0" wide by 8'-2" high.
 - (1) The door area shall consist of:
 - (a) One leaf 4'-0" by 8'-2", secured with 6" steel cadmium plated surface bolts at the top and bottom.
 - (2) The doors shall be:
 - (a) 18-gauge steel with 16-gauge steel door frame.
 - (b) Swinging out and have a minimum swing of 105 degrees.
 - (c) Flush design
 - (d) Filled with mineral fiber fire resistant insulation.
 - (e) Minimum insulation to meet State Building Code.
 - (3) Each door leaf shall be equipped with three (3) 4 ½" by 4 ½" hinges. Hinge pins shall be irremovable by means of a set screw in barrel non-removable when door is closed.
 - (4) A removable access transom 6'-0" wide by 1'-2" high secured with four (4) 6" steel cadmium plated surface bolts mounted approximately 4" from the top and bottom on the narrow ends.
 - (5) Astragal shall be steel overlapping type by door manufacturer mounted on the secured door leaf fastened to door at 12" o.c., with strike mounting preparation.
 - (6) Thresholds: 3-¾" by ½" high-extruded aluminum, fluted type.
 - (7) A drip shield shall be provided above all exterior doors.
 - (8) Provide watertight and infiltration-proof perimeter, door, and threshold seals.
 - (9) Key and master key all hardware cylinders as directed by the Owner.
 - (10) Each set of exterior door hinges shall include one entry alarm hinge comprised of an integral SPST electric switch rated 125 volt dc.
 3. Walk-in Door(s):
 - a. The enclosure shall include the quantity of single walk-in doors as shown on the drawings.
 - b. Doors shall be 36 by 84 inch, 16 gauge heavy-duty steel doors.
 - c. The doors shall open outward and have minimum swing of 105 degrees.
 - d. Shall have all the other features as specified for the large equipment access doors.
- B. WEATHERPROOFING:
1. All enclosure joints and door openings shall be designed and fabricated to minimize or prevent loss of conditioned or pressurized air and to prevent entry of dust, rain, sleet, snow or moisture.

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2. All wall seams and areas where metal to metal contact is made shall be liberally caulked with butyl rubber caulking or equivalent. All roof panels shall be continuous-seam welded without the need for gaskets or joint caps.

2.06 HVAC:

- A. HVAC equipment shall comply with Section 23 75 00.
- B. HVAC equipment shall be sized based on maintaining an interior temperature range of 60-80°F, taking into consideration the heat load of present and future equipment and site conditions. HVAC unit shall maintain a temperature of 77°F in the battery area for optimum battery performance.
- C. HVAC units shall be controlled by an external thermostat.
- D. Provide one (1) Form C contact to activate an alarm if the interior temperature exceeds 90°F. Install and terminate wiring required between the temperature alarm and wall-mounted junction box for all miscellaneous control enclosure controls and alarms. Owner will wire from the junction box to COMM/SCADA equipment. Once alarm conditions have been cleared, all HVAC Systems will resume normal operation.
- E. The design calculations shall be submitted with the bid. Final design calculations shall be submitted for approval prior to fabrication.
- F. Final design calculations and drawings shall be prepared and sealed by a Professional Mechanical Engineer, licensed and registered in the State where the Project Site is located.
- G. The ventilation system shall provide a minimum of six (6) air changes per day. Replaceable air filters shall be provided and be accessible from the exterior of the enclosure.
- H. The HVAC control circuitry shall include a smoke detector shutdown provision. The enclosure shall be equipped with a compatible smoke detector connection to this provision of the HVAC. Additionally, the HVAC Unit(s) will be disabled if 1% hydrogen level is reached.
- I. A NEMA 3R enclosed safety disconnect switch with padlocking provisions in the “OFF” position shall be provided on or mounted adjacent to wall mounted HVAC unit(s). The source of the power for the HVAC unit(s) shall be identified on the disconnect switch.
- J. A separate exhaust fan, with timer, and louvered intake vent shall be installed near the batteries to provide ventilation in accordance with NFPA Standard 70E, Article 320. Intake and exhaust to be sized by Supplier based on the size of the area around the battery.

2.07 GROUNDING:

- A. Copper ground pads configured for NEMA 2 hole connectors shall be provided on all four corners of the enclosures on the exterior of the enclosure and be connected to the enclosure perimeter ground bus with a #4/0 bare copper conductor.
- B. Interior metal building walls shall be electrically connected to the ground bus with 4/0 AWG bare copper 19 strand cable every six (6) feet.
- C. A 4/0 bare copper ground shall extend from enclosure perimeter ground bus to all distribution panels, disconnect switches and transfer switches.

2.08 ENCLOSURE ELECTRICAL SYSTEM:

- A. Equipment arrangement shall be as indicated on Drawings. Working space, access aiseways, and means of egress shall comply with NEC and Life Safety Code. Any equipment relocations shall be coordinated with Engineer.
- B. AC & DC Panelboards:

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1. All AC and DC Panelboards utilized within the control enclosure shall conform to Section 26 24 16 – Panelboards.
2. Provide in quantities and in locations as shown on the drawings.
3. Panels shall be completely assembled as shown on the drawings.
4. Provide raceway and wiring between panels and disconnect switches where shown on the drawings.
5. Panelboards shall be as specified and shall be attached to the control enclosure walls using horizontally placed Unistrut backing rails. Rails shall provide for an approximate 1" air gap between the building wall and back of panel.
6. All panels mounted in the control enclosure shall be configured for top feed.
7. Panels shall have the following:
 - a. Phenolic nameplate with engraved panel identification.
 - b. Be UL labeled
 - c. Hinged door with lock and catch combination in the front trim of all panelboards.
 - d. Phenolic nameplate on front of panel engraved with the panelboard designation. Nameplate to be approximately 1"x3" with 3/8-inch characters.
 - e. Breakers with trip rating and number of poles as shown on the drawings.
 - f. Twenty percent future breaker space for the number of poles.
 - g. Copper main buses of the capacity required in the contract documents.
 - h. Copper neutral bus with the same rating as the main bus.
 - i. The short-circuit current rating of the assembled panelboard shall be equal to or greater than the interrupting capacity of the highest rated branch breaker.
8. All lighting and convenience outlets shall be wired to the AC panelboard by this Contract.
9. Supply circuit breakers as required for loads and four spare 20-ampere breakers in each panelboard.
- C. Automatic Transfer Switch:
 1. Furnish and install one (1) automatic transfer switch as specified in Section 26 36 00 – Power Switching and Control Devices.
 2. Transfer switch shall connect station power from the two station service transformers in the substation.
 3. Transfer switch shall be installed with sufficient clearances to accommodate both bottom and top entry power conduits.
- D. DC Battery, Charger and Accessories:
 1. All DC batteries, chargers and accessories utilized within the control enclosure shall conform to Section 33 72 33 43 – Substation Battery, Battery Charger, and Battery Rack.
 2. Enclosures containing batteries shall be supplied with the following:
 - a. A hydrogen gas collection hood and exhaust vent above the battery.
 - b. A hydrogen monitoring system with visual alarm on exterior of Enclosures.
 - c. Audio alarms inside and external to Enclosures.
 - d. Acid resistant floor construction unless protected from acid accumulations.
 - e. A quick drenching of the eyes near the battery handling areas.
 - f. Provisions for remote alarm with a normally open and normally closed contact.
 3. Eye Wash Stations
 - a. Supplier shall provide a location for an eye wash station it shall be installed in close proximity to the DC supply batteries. The location chosen for installation shall be

SECTION 13 34 23 23 – FABRICATED SUBSTATION CONTROL ENCLOSURES: continued

as shown on the drawings. The mounting height for the self-contained unit shall be 42” above finish floor to the centerline of the eye wash station.

- b. Owner will provide eye wash station.

E. Lighting and Receptacles:

1. Interior Lighting:

- a. All interior lighting utilized within the control enclosure shall conform to Section 26 51 23 – Substation Interior Lighting and Receptacles.
- b. Provide Enclosures with LED lighting fixtures that are 120VAC controlled via three-way wall switches to be located at each entry door.
- c. Design interior light levels to provide a consistent 60 foot-candles of light at a level three feet above the floor.

2. Emergency Lighting:

- a. Furnish and install emergency lighting inside the Enclosure above each door and in other locations as required to maintain a minimum lighting level of four-foot candles in all aisles for 90 minutes during emergency operation.
- b. Each light shall be self-contained battery powered units with two directionally adjustable illuminating heads. Battery shall be maintenance-free with a minimum operational life of 10 years. An automatic battery charger shall be included as part of the light fixture.
- c. Each unit shall switch on automatically upon loss of AC power and provide continuous illumination for the specified duration, and then recharge when AC power is resumed.
- d. One (1) control head from each assembly shall be mounted on the exterior wall above each exit door.
- e. Emergency lighting fixtures and lighted exit signs may be provided together in a combination unit.

3. Exterior Lighting:

- a. Provide 120VAC, wall pack, 70-watt, LED, and polycarbonate refractor, controlled via photocell and switch. Locate exterior lights above each entrance and at halfway point on the other sides of the enclosure, for a total of 4 luminaries.
- b. Exterior light fixtures shall be wall mounted, suitable for use in wet locations and have individual automatic dusk to dawn photo control.

4. Receptacles:

- a. Furnish and install one (1) GFCI, duplex type receptacle rated 120VAC, 20A, near each door and along each interior wall. Each receptacle shall be no more than 30’-0” apart.
- b. Furnish and install two (2) GFCI type, weatherproof receptacles rated 120VAC, 20A, evenly spaced on the long sides of the enclosure for a total of four (4) receptacles.
- c. Exterior receptacles shall be installed such that they are not blocked by open doors.

5. All wiring shall be copper, type XHHW, #12 AWG minimum for power circuits, minimum #14 AWG for control circuits. For all control interconnection wiring, both ends of wire shall be provided with polyolefin sleeve type wire markers.

6. Use EMT conduit for interior applications. Use RGS conduit for outdoor applications. Use sealing fitting as required by NEC.

SECTION 13 34 23 23 – FABRICATED SUBSTATION CONTROL ENCLOSURES: continued

F. Equipment Nameplates:

1. Provide and install phenolic engraved nameplates for all control enclosure equipment, including panelboards, enclosures, emergency light switches, and safety switches. Nameplate list shall be approved by Owner/Engineer before fabrication.
2. Black satin finish on surface with engraved white letters.
3. 1-1/2 inches high and 6 inches long for "Master" nameplates, such as for control panels, equipment enclosures, and the like.
4. 1 inch high and 3 inches long for individual device nameplates.
5. Engraving:
 - a. Gothic style.
 - b. 3/8-inch-high characters with 45-mil line width on "Master" nameplates.
 - c. 3/16-inch-high characters with 30-mil line width on individual device nameplates.
 - d. Engraving designations shall be approved by Engineer.
6. Adhesive: Mastic backing as manufactured by Minnesota Mining and Manufacturing Company (3M).
7. Install on equipment cover or on wall as applicable.

2.09 WIRING:

- A. All Wires and Cables utilized within the control enclosure shall conform to articles included in Section 33 72 43 11 – Substation Wire, Cable and Accessories.
- B. No single conductor wire shall be used unless installed in metallic conduit.
- C. Cable conductor shall be copper, not smaller than No. 12 AWG with 75-degree temperature rating.
- D. Conductors shall be continuous from terminal to terminal. No splices shall be permitted without approval from Engineer. Wires shall be neatly trained in all trays and boxes. Sufficient lengths shall be pulled into panels, boxes, etc. to permit a neat arrangement.
- E. Wire shall be protected from mechanical damage and moisture. No sharp bends over conduit bushings will be allowed. Areas where wires and/or cables pass over or through sheet metal panels, wireway sections, floor cutouts, etc. shall be protected with grommeting material.
- F. Enclosure wiring shall be installed in dedicated raceway systems. Cable tray shall be reserved for relay switchboard or communication wiring.

2.10 CABLE TRAY AND WIREWAYS:

- A. All cable tray and wireways utilized within the control enclosure shall conform to Section 33 72 33.36 – Cable Tray and Wireway for Utility Substation.
- B. Furnish and install cable tray where shown on the drawings. When bolting together sections of the tray, place bolt heads inside tray with bolt projecting outside of tray. Cable tray shall be aluminum, ladder type with a maximum of 12" rung spacing. Cable tray shall have outward facing side rails with tubular rungs. Cable support surface on top of rungs to be flattened. Cable tray shall be manufactured in accordance with NEMA VE-1.
- C. Cable tray nominal inside depth shall be 4".
- D. Fittings shall be as indicated on the drawings and have a minimum radius of 12".
- E. Cable tray shall be manufactured by B-Line, Globe, Square D, T.J. Cope or approved equal.
- F. Furnish and install hanger rods, clamps, miscellaneous steel, and hardware capable of supporting the weight of the fully loaded cable tray and cables. Support members shall be electro-galvanized or hot-dipped galvanized. Structural members shall be Unistrut or approved

SECTION 13 34 23 23 – FABRICATED SUBSTATION CONTROL ENCLOSURES: continued

equal. The distance between supports shall not exceed 6 ft. on centers and shall be capable of supporting the weight of the fully loaded cable tray and cables.

- G. Furnish removable covers with fasteners for outdoor vertical sections.
- H. Provide bare #4/0 stranded soft-drawn copper wire in all cable tray. Clamp wire securely to cable tray. All panelboards, junction boxes, equipment, raceways, and conduit shall be grounded to the #4/0 wire per NESC and NEC requirements.
- I. The #4/0 ground wire shall also be routed to the perimeter ground bus.

2.11 CONDUIT:

- A. All conduit utilized within the control enclosure shall conform to Section 33 72 33.33 – Raceway and Boxes for Utility Substations.
- B. Furnish and install conduit and wireways as necessary to wire the control enclosures.
- C. Concealed where possible. All exposed wiring along the walls and ceiling shall be in EMT raceway.
- D. All enclosure cable and raceway systems shall be in accordance with the requirements of the NEC for Manufactured Buildings.
- E. Conduits and wireways shall be run parallel or perpendicular to the enclosure and equipment with right angle turns consisting of symmetrical bends or fittings. All bends and offsets shall be avoided where possible. Raceway installation shall meet all requirements of the National Electric Code (NFPA-70).
- F. Conduits shall be securely fastened to all sheet metal outlet boxes with locknuts and bushings or approved type of threadless connector. Conduits shall be joined by conduit couplings and shall have end butts in all cases where couplings are used. Where conduits cannot be joined by standard threaded couplings, conduit unions shall be used. All couplings and unions shall be mechanically strong and shall make good electric ground contact between the conduits connected. Set-screw type connectors are not acceptable.

2.12 SUBSTATION CONTROL PANELS:

- A. All control panels shall comply with Section 33 72 33 16.
- B. The control panel assembly and equipment shall be arranged as indicated in the Contract Drawings.
- C. Dimensions shown for the arrangements are approximations. Supplier shall be responsible for the proper fit and operation of the equipment. If any modification to the arrangements is needed, prior approval is required.
- D. All equipment specified for installation in the control panels shall be factory installed unless specified to be field installed.

2.13 AUXILIARY EQUIPMENT:

- A. Door Alarm Switches:
 - 1. Furnish one (1) security door alarm switch for each exit door.
 - 2. Switch shall have one (1) “normally open” and one (1) “normally closed” dry contact, each rated at 125VDC.

Supplier will install the wiring between the door alarm and a wall-mounted junction box for all miscellaneous control enclosure controls and alarms. Owner will wire from the junction box to COMM/SCADA equipment.

SECTION 13 34 23 23 – FABRICATED SUBSTATION CONTROL ENCLOSURES: continued

- B. Smoke/Heat Detectors:
 - 1. Each smoke detector shall detect abnormal quantities of smoke that may occur in a building and shall properly operate in the normal environmental conditions of said building.
 - 2. A minimum of two (2) surface mounted ceiling detectors are required and shall not be installed more than 30 feet apart.
 - 3. Detectors shall be powered by 120VAC, and be equipped with one “normally open” and one “normally closed” isolated dry contact. Both dry contacts shall be rated for use at 125VDC.
 - 4. Supplier shall install the wiring between the AC panelboard and the smoke/heat detectors. Supplier shall install the alarm wiring between the smoke/heat detector(s) and a wall-mounted junction box for all miscellaneous control enclosure controls and alarms. Owner will wire from the junction box to COMM/SCADA equipment Hydrogen Gas Detectors:
 - 5. Furnish and install one (1) hydrogen gas detector near the DC Battery System.
 - 6. Detector shall be equipped with one “normally open” and one “normally closed” isolated dry contact. Both dry contacts shall be rated for use at 125VDC.
 - C. Supplier shall install the alarm wiring between the hydrogen gas detector and a wall-mounted junction box for all miscellaneous control enclosure controls and alarms. Owner will wire from the junction box to COMM/SCADA equipment Battery Exhaust Fan:
 - 1. Furnish and install one (1) battery exhaust fan, controlled by a timer, above the battery bank.
 - 2. Exhaust fan shall be rated 120VAC, have a minimum diameter of eight inches, a minimum capacity of 230 cubic feet per minute, and capable of cyclic operation.
 - 3. Fan shall be explosion-proof, or have a shaded pole (non-sparking) motor. The thermal overload shall be wired such that it is operational.
 - 4. Exhaust fan shall be supplied with an internal replaceable dust filter, perimeter weather-stripping, and bird screen. There shall be a drip shield mounted over the fan on the exterior wall.
 - 5. Timer shall be rated at 120VAC, with contacts capable of switching 20 amps. It shall include a 24-hour dial, with skip feature, capable of being set to operate for one hour at a time and twice daily.
 - D. Fire Extinguishers:
 - 1. Owner to provide
- 2.14 LANDING, STAIRS, AND HANDRAIL:
- A. Galvanized steel landing and stairs with handrail shall be provided at each exterior door location.
 - B. Landing and stairs shall be two feet wider than the door opening.
 - C. Length of landing shall meet IBC requirements.
 - D. Landing and stair treads shall be grating capable of supporting loads specified by OSHA.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Supplier shall be responsible to ensure all fabricated materials meet the requirements of the accepted Shop Drawings and conform to the Contract Documents. All materials shall be adequately protected from damage during delivery, storage, and installation.

3.02 INSTALLATION:

- A. Install all equipment complete as specified or required for operation and continuous service at the location indicated.
- B. Conform to equipment manufacturer's recommendations.
- C. Provide all openings in floors, walls, roofs, and other structures necessary for complete equipment installation, unless such openings are specifically indicated as being provided by others. Include openings through floors or walls for future cables to connect to spaces provided for future equipment indicated.
- D. Install all necessary wiring or interconnections as required.
- E. Make all connections as required.
- F. Check all connections, especially current transformer secondary short circuiting jumpers, and tighten as required.

3.03 FACTORY ACCEPTANCE TESTING:

- A. Factory testing shall include at a minimum:
 - 1. Continuity testing of all installed wire and cables.
 - 2. Megger all power cables.
 - 3. Power testing of all enclosure circuits (i.e. lights, receptacles, etc.).
 - 4. Functional testing of all relay inputs/outputs.
- B. Owner shall be notified two weeks prior to any factory tests. Witness of factory tests shall be provided. Owner's travel expense for attending factory acceptance testing will be paid by Owner.
- C. Equipment Enclosure:
 - 1. After the enclosure is fabricated and the electrical equipment is installed, Supplier shall perform a wet spray test, an electrical inspection, and a quality inspection. Copies of completed and certified test reports shall be made available upon request.
- D. Control Panels/Termination Cabinets:
 - 1. After factory assembly and wiring of equipment, conduct functional tests per Section 33 72 33.16 to prove correct wiring and operation of equipment.
- E. Panelboards:
 - 1. Prior to energization of panelboards, check all accessible connections to manufacturer's tightening torque specifications.
 - 2. Prior to energization of panelboards, check panelboard circuits for short circuits, electrical continuity of circuits, enclosure grounding and neutral grounding at service entrance.
 - 3. Prior to energization of panelboards, check with insulation resistance tester: phase-to-phase and phase-to-ground insulation resistance levels of each phase bus to ensure requirements are fulfilled.
- F. Manufacturer shall provide certified test reports.

SECTION 13 34 23 23 – FABRICATED SUBSTATION CONTROL ENCLOSURES: continued

3.04 SHIPPING:

- A. Enclosure shall be shipped to the designated location after it has passed all tests and has been inspected for compliance to the Specification.
- B. When shipping sections are necessary, provide the following:
 - 1. Plywood cover mounted on a 2-inch thick wooden frame for each open end/sides of each shipping section, with all seams caulked, for temporary protection from the weather during transportation and storage.
 - 2. Miscellaneous NEMA 1 junction boxes at the shipping splits for easy breakdown of the enclosure's wiring for shipment and reconnecting at Project Site.
 - 3. Manufacturer shall provide a shipping plan for fiber optic cables that require disconnection for shipping.
- C. Components that are not fastened to the enclosure at time of shipment will be securely packed inside the enclosure, if possible. Each item will have an identifying tag and will be listed on the packing list.
- D. Furnish a spreader bar for lifting the enclosure along with a sketch and calculations. Manufacturer shall be responsible for delivery of the spreader bar to the site and return after enclosure is assembled.
- E. Furnish any special tools required to adjust or dismantle each type of equipment. Tools shall be new and shipped in the enclosure in a suitable container that is clearly marked with the name of the equipment for which the tools are intended.
- F. Provide shipping notice describing each shipment of material and/or equipment at least 15 days in advance of the expected shipping date. At that time, Owner will advise Supplier of acceptable delivery hours.

3.05 FIELD SERVICES:

- A. The Work of this Contract includes:
 - 1. Manufacture, deliver, and off-load P.O.D (Point of Delivery) all Equipment and Materials as specified.
 - 2. Fully construct the control enclosure on-site and install all electrical, mechanical materials and systems furnished by this contract.
 - 3. Provide bills of material, Equipment Shop Drawings, design drawings, control building detail drawings, calculations, test reports, and instruction manuals for the control building electrical Equipment and Materials and steel structures specified and as required by the Contract Documents.
 - 4. Performance of all specified Manufacturers Field Services at the Site.
- B. Manufacturer, deliver, and off-load P.O.D (Point of Delivery) spare parts and lubricants required for complete installation and commissioning.
- C. Deliver Prefabricated Control Enclosure including preassembled enclosure, complete with factory-installed equipment, f.o.b. jobsite unless noted otherwise, freight prepaid and allowed.
- D. Receiving, unloading, storage (if required), and installation will be by Supplier.
- E. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package roof and wall panels for protection during transportation and handling

3.06 COORDINATION:

- A. Other contractors will be working in the vicinity. Supplier shall work in coordination with others to facilitate a safe and efficient work environment. The Owner, or their appointed

SECTION 13 34 23 23 – FABRICATED SUBSTATION CONTROL ENCLOSURES: continued

representative, shall the have ultimate authority for granting work access to all areas in the Substation.

3.07 PERSONAL PROTECTIVE EQUIPMENT (PPE):

- A. Supplier(s) personnel are responsible for procuring and wearing all PPE required to work at the Project Site in accordance with the Owners' Health and Safety Program.

3.08 TESTING AND CHECKOUT:

- A. After assembly of the enclosure, the following tests shall be performed to assure proper functioning assembly prior to shipping to the switchyard site.
- B. General:
 - 1. Wet spray test for water leaks.
- C. Perform continuity and/or functional checks of all wiring installed by the Supplier.
 - 1. Check to assure that lighting fixtures, outlets, lighting contactor, and photocell, as specified, are firmly mounted and operational.
 - 2. Verify operation of the following equipment installed by Supplier:
 - a. HVAC Units.
 - b. Door entry alarm contacts.
 - c. Door closers
 - d. Lights and switches
 - e. Electrical outlets
 - f. Smoke/heat detector and alarm contacts.
 - g. Hydrogen exhaust system.

END OF SECTION 13 34 23 23