SECTION 33 72 14 – SUBSTATION STEEL STRUCTURES

PART 1 - GENERAL

1.01 IDENTIFICATION OF PARTIES:

A. Owner
   1. Midwest Energy, Inc.
      1330 Canterbury Dr. Hays, KS 67601
   2. Owner Technical Contact: Randy VanAllen
      (rvanallen@mwenergy.com)
   3. Owner Commercial Contact: Nathan McNeil
      (nmcneil@mwenergy.com)

B. Engineer
   1. Burns & McDonnell 9400 Ward Parkway Kansas City, MO 64114
   2. Contact: David Kuhns
      (rkuhns@burnsmcd.com)

C. Supplier
   1. The firm, company or corporation with whom the Engineer may select for the purpose of supplying the structures described in this specification.

1.02 SUMMARY:

A. This Division covers the design, detailing, materials, fabrication, and labor necessary to furnish and deliver for the Owner all substation steel structures complete.

B. Major items to be furnished under this Division include the items listed below.
   1. Two (2) 115 kV H-frame dead-end structures
   2. Three (3) Static Masts

1.03 REFERENCE STANDARDS:

A. Design of the structures shall conform to the requirements of the following, as specified and as modified by provisions of this Specification:
   1. American Institute of Steel Construction (AISC):
      a. Manual of Steel Construction.
      b. Quality Criteria and Inspection Standards
   2. American Society of Civil Engineers (ASCE):
      a. Minimum Design Loads for Buildings and Other Structures, Standard No. 7 2022 Edition.
      b. Design of Steel Transmission Pole Structures, Standard No. 48.
      c. Guide for the Design of Steel Transmission Towers, Manual No. 52.
      d. Guidelines for Electrical Transmission Line Structural Loading, Manual No. 74.
      e. Substation Structure Design Guide, Manual No. 113 Second Edition.
   3. American Concrete Institute (ACI):
      a. 318 - Building Code Requirements for Reinforced Concrete 2019 Edition.
   4. International Code Council (ICC):
      a. International Building Code 2024 Edition
   5. Aluminum Association (AA):
      a. Aluminum Design Manual
   6. American National Standards Institute (ANSI):
      a. C2 - National Electric Safety Code
   7. American Welding Society (AWS):
      a. D1.1. - Structural Welding Code: Steel

b. D2.1. - Structural Welding Code: Aluminum

B. Structures shall be fabricated, assembled, and tested in conformance with the latest revision of the following, as applicable.
   1. American National Standards Institute (ANSI):
      a. B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
      b. B18.2.2 - Square and Hex Nuts.
   2. American Society for Testing and Materials (ASTM):
      a. A6 - General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use.
      b. A36 - Structural Steel.
      c. A90 - Test Method for Weight of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
      d. A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      e. A143 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
      f. A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      g. A239 - Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles by the Preece Test (Copper Sulfate Dip).
      h. A370 - Test Method and Definitions for Mechanical Testing of Steel Products.
      i. A384 - Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
      j. A394 - Zinc-Coated and Bare Steel Transmission Tower Bolts and Nuts.
      k. A449 - Quenched and Tempered Steel Bolts and Studs.
      l. A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
      m. A563 - Carbon- and Alloy-Steel Nuts.
      n. A572 - High-Strength Low-Alloy Columbium - Vanadium Steels of Structural Quality.
      o. A595 - Steel Tubes, Low-Carbon or High-Strength Low-Allow, Tapered for Structural Use.
      p. A615 - Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
      q. A678 - Quenched and Tempered Carbon-Steel and High-Strength Low-Alloy Plates for Structural Steel Applications
      r. A992 - Structural Steel Shapes
      s. B695 - Coatings of Zinc Mechanically Deposited on Iron and Steel
      t. B833 - Zinc and Zinc Mechanically Deposited on Iron and Steel
      u. E376 - Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods.
      v. F1554 - Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength
      w. F3125 - High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.
   3. American Welding Society (AWS):
      a. D.1.1. - Structural Welding Code: Steel
      b. D2.1. - Structural Welding Code: Aluminum

1.04 APPROVED VENDORS

A. Structures designed and fabricated under this SECTION shall be designed and fabricated by one of the following:

1. MWE Approved Vendors

B. Third party materials furnished shall be from the following manufacturers, or as approved by the Owner or Engineer:
   1. For galvanized, non-painted structures, the following manufacturers shall be used for galvanized surface repair:
      a. ZRC Products Company - ZRC Cold Galvanizing Compound or approved equivalent.

1.05 SUBMITTALS:

A. Submittals shall be submitted as specified in this document:
   1. Foundation reactions and calculations within 2 weeks ARO
   2. Approval drawings within 2 weeks ARO
   3. Final fabrication drawings within 2 weeks ARA

B. A complete set of submittals shall be furnished for each individual substation. No common drawings for different substations will be allowed.

C. Photographic reproductions or copies of the Contract Documents or parts thereof will not be accepted as submittals.

D. Complete fabrication and erection drawings for each structure supplied shall be furnished including, but not limited to, the following:
   1. A scaled drawing showing the location and code marking (piece mark) of each piece in the structure, the location, size, grade, and number of bolts for all connections, anchor bolt size and projection, and the weight of the entire structure and major assemblies.
   2. Drawings showing each individual piece in sufficient detail for shop fabrication including shipping weight.
   3. Anchorage and structure setting plans showing the number, location, orientation and size of all anchoring.

E. The following design information shall be furnished for each structure.
   1. A scaled drawing showing the size and location of each member of the structure.
   2. A drawing showing the magnitude, direction, and point of application of each load for every loading condition with the resultant foundation reactions resolved into the vertical load and shears and moments along the principal axes of the structure at each base plate.
   3. Complete design calculations when used in the final design of each structure for the maximum loading condition:
      a. Strength design of structure using Load Resistance Factored Design (LRFD) per Table 3-18 in ASCE 113.
      b. Support reactions in accordance with the load combinations of Table 3-18 in ASCE 113.
      c. Deflection checks using the criteria provided in Part 2.02.D this SECTION.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Provide new materials free from defects and suitable for their application and the mechanical stresses to which they will be subjected.

B. All wire tensioned structures shall be designed for the loads indicated and be of tubular construction as defined below in paragraph 2.01C. All self-supporting single-column shield wire structures or masts shall be tubular. Direct embedment is allowed for shield wire or mast structures if site soil stratification is not highly variable.

C. All equipment structures shall be of tubular or HSS construction. A tubular structure is defined as one composed of closed sections (tubes) of circular, multi-sided, or elliptical cross section and may be tapered or untapered. Loads are carried in tension, compression, and bending with all members carrying calculated stresses.
D. All structures shall have a maximum foundation rotation of 0.5-degrees in any direction unless specifically specified elsewhere in the contract documents. Rotation is measured from the vertical axis of the column and rotated at the ground line.

2.02 LOADINGS:

A. For wire tensioned structures, the structures shall be designed with the loadings as indicated in the loading diagrams provided. For equipment mounted on the wire tensioned structures, the supplied loading diagram weather conditions shall apply.
B. All substation equipment structures shall be designed for the load combinations as identified in Table 3-18 of ASCE Manual of Practice 113.
C. The load cases specified shall include the following environmental requirements in accordance with ASCE 113:
    1. Extreme Wind: A 300 year MRI wind speed of 105 mph from any direction. Wind pressure shall be developed using an exposure category C and wind pressure equation from ASCE 113 equation 3-1.
    2. Combined Ice and Wind: A wind speed of 49 mph from any direction and a 100 year MRI radial ice thickness of 0.67 inches on the equipment and structure.
    3. Short Circuit: Symmetrical (rms) Short Circuit Fault.
        a. 115kV, rms fault of 8431.2A, X/R = 8.52
        b. 12kV, rms fault of 6565A, X/R = TBD
    4. Seismic: A maximum considered earthquake (MCE) ground motion of 0.2(Ss) second spectral response of 0.15g and a 1.0 (S1) second spectral response of 0.05g.
D. For deflection load cases, the extreme wind velocity shall be 70 mph. For the Ice with Wind load case, the 100 year MRI ice thickness of 0.67 inches shall be multiplied by a 0.4 conversion factor to be reduced to a design ice thickness corresponding to a 5 year mean recurrence interval, unless otherwise specified.

2.03 DESIGN:

A. Standard shape and HSS structures shall be designed in accordance with the AISC Manual of Steel Construction and ASCE 113.
B. Tubular structures shall be designed in accordance with ASCE 48.
C. Short circuit application for three phase structures shall have a convention where the middle phase receives a short circuit load in the opposite direction as the outside phases.
D. Structures shall have the number of support points (legs) and general layout indicated.
E. Lightning diversion masts without shield wires shall be designed to resist wind induced oscillations or provide devices to reduce motion.
F. All field connections shall use galvanized bolts and nuts as fasteners. No field welding shall be required. Furnish at least 10% spares of each size bolt, nut, washer, lockwasher, locknut, etc., required in assembly. Self-locking type nuts shall not be used.
G. All bolted shear connections shall be designed as bearing connections with the bolts' threads in the shear plane or planes.
H. Deflections of structures under all the specified loads shall be less than those specified in ASCE 113.
I. Baseplates and anchor bolts shall be designed for structures to be supported by leveling nuts on the anchor bolts without grouting. The dimension from top of foundation to bottom of base

plate shall be a maximum of 2.0 times the bolt diameter unless otherwise specified on drawings.

J. Arrange all structural members so that there are no pockets which can accumulate moisture without draining.

K. Provide all drilling, punching, mounting plates, brackets, etc., for addition of future equipment on the structures and for future extensions of the structures as indicated.

L. Provide all drilling, punching, mounting plates, brackets, etc., for all miscellaneous equipment to be mounted on the structures such as nameplates, fuse and terminal cabinets, phase identification tags, etc.

M. If direct embedded type structures are allowed, the structure shall be opened at the bottom with bearing plate.

2.04 DETAILS:

A. Each member of a structure shall have identifying numbers and letters (piece marks), keyed to the fabrication and erection drawings for each substation, with characters a minimum of 1/2 inch high stamped into the steel prior to galvanizing. Piece marks shall be circled with black indelible ink after galvanizing.

B. Provide specific instructions and torque values required for each type of connection.

C. For tapered - tubular structures, the supplier shall provide all necessary instructions and procedures for installation of slip-joints. The minimum overlap length shall be a minimum of 1.5 times the maximum inside diameter of the female section including fabrication tolerances.

D. Field welds shall not be permitted unless specified by Owner or Engineer.

E. Miscellaneous items:

1. Ground tabs with 9/16” diameter holes shall be provided at the base of each structure and maximum of six-foot (6’-0”) intervals vertically and four-feet (4’-0”) horizontally along at runs of ground cable required for grounding surge arresters, instrument transformers or other equipment. Provide additional mounting provisions for locations receiving conduits as required for instrument transformers at the same intervals indicated.
2. A NEMA 2-hole ground pad shall be supplied at no more than 1’-6” from the top of the baseplate for all structures.
3. Provide provisions for lightning and or camera mounts as indicated.
4. Provide mounting for junction boxes for all instrument transformers as indicated on structure columns. Center of boxes shall be 3’-6” from bottom of column baseplate.
5. Expanded metal grating shall be secured to ends of tubular beams to prevent intrusion by rodents and birds.

2.05 PROTECTIVE COATING:

A. All steel members shall be galvanized after all hole punching, drilling, bending, clipping, coping, welding, or other forming or fabricating operations have been completed.

B. Galvanizing for structural members shall be done in accordance with ASTM A123 and ASTM A143.

C. Bolts and hardware shall be galvanized in accordance with ASTM A153.

1. Finish: Provide a galvanized coating that is continuous, adherent and free of uncoated spots, blisters, chemical flux and projections which will interfere with the intended use of the structure and assemblies. Holes shall be clean and free of superfluous spelter.
2. The steel Supplier shall be responsible for all field repair of damage to the galvanized coating occurring during shipping process. A minimum of two gallons of a suitable cold galvanizing compound shall be supplied for field repair.

D. Thermal Spraying:

1. Thermal spraying is acceptable for field repair only.
2. Surface preparation: Pre-clean by dry abrasive blasting using compressed air with oil and moisture separators in the lines to obtain a thoroughly cleaned and roughened base. Abrasives shall be angular and sharp and kept free from contamination and excessive fines.

2.06 ANCHOR BOLTS:

A. Anchor bolts shall be ASTM F1554 grade 36, at a minimum. Supply each anchor bolt with three nuts and two flat washers per bolt.
B. For wire tensioned structures, anchor bolts are allowed to be ASTM A615 grade 75.
C. Nuts and washers shall be galvanized per ASTM A153. The threaded portion and a minimum of six additional inches shall be galvanized per ASTM A153.
D. In general, anchor bolts shall be designed for embedment in pier with concrete having a minimum compressive strength of 4,000 psi in accordance with ACI 318. For rebar anchor bolts, size in accordance with ASCE 48.
E. Anchor bolts shall either be shipped as preassembled clusters for anchor bolt lengths greater than 5 feet or shall have steel templates adequate to properly align the bolts for each individual base plate shipped with them. If used, bottom templates shall be circular and not be more than 1-inch larger than the bolt circle. Additionally, the diameter of the center cutout shall be no less than 1” smaller than the bolt circle.
F. Hooked anchor bolts shall not be allowed.
G. Excluding rebar anchor bolts, anchor bolts shall be of a unique and consistent length for each diameter anchor bolt supplied. For each diameter used, the length shall vary by a minimum of 3 inches.
H. If possible, anchor setting plans (patterns) shall be unique and consistent for each diameter of anchor bolt supplied. All anchor bolt patterns shall be symmetric about the longitudinal and traverse axis.
I. For substation pre-assembled bolt clusters, provide V-notches or equivalent indicator on top of anchor bolt templates on each side of the transverse axis. The anchor bolt pattern shall be symmetric about the transverse axis.

2.07 PACKING AND SHIPMENT:

A. The project site is located near Hays, Ellis County, Kansas.
B. Structure shall be shipped via motor freight as completely assembled as possible insofar as is consistent with good shipping practice. The structure shall be carefully blocked and secured for shipment. If items must be disassembled for shipping, they shall be tagged and stenciled with proper identifications A complete packing list shall also accompany each shipment.
C. Prior to shipment, the Supplier shall inform Owner of the estimated time in shipment, routing, shipping company and PRO number, if shipped by a common carrier. Delivery time shall be confirmed with the Owner 24 hours prior to arrival.

PART 3 - EXECUTION

3.01 FIELD SERVICES

A. Field services of representatives of the equipment and materials shall be provided in a timely manner to correct errors, discrepancies, or omissions in the structures furnished as required by the Owner or by the Engineer.

3.02 CORRECTIONS:

A. Correction of errors, discrepancies, or omissions shall be made immediately upon notification from the Owner or Engineer in order to prevent delay of construction. All corrections resulting from errors, discrepancies, shipping damage, etc., approved by the Owner or Engineer to avoid delay of construction and required for the installation and proper use of the structures shall be paid for by the Supplier.

B. The Engineer shall be contacted prior to field corrections. However, if time is critical, the Owner reserves the right to decide whether to correct the member or have a replacement member furnished.

END OF SECTION 33 72 14