MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
ENVIRONMENTAL SENSOR STATION TOWER

STM:MLO 1 of 7 APPR:EG:MS:06-06-23
FHWA:APPR:06-13-23

a. Description. This work consists of designing, furnishing, and installing an environmental sensor station (ESS) tower for the type and height shown on the plans, as a part of a road weather information system (RWIS). Perform this work in accordance with the standard specifications, and the contract except as modified herein.

b. Design.

1. Codes or Standards. Comply with the following:

A. *Federal Specifications RR-S-001301 - Safety Equipment, Climbing*.

B. *Lightning Protection Institute (LPI) Standards 175*.

2. Coordinate size and installation of power service, communication conduit and routing, lightning protection, and additional services in tower design loading.

3. Tower Tilt.

A. Design the tower so it can be tilted to the ground by one person for maintenance purposes.

B. Orient the tower with the tilting direction as specified on the plans or as directed by the Engineer.

C. Design the tower such that the winch for tilting the tower is permanently mounted to the structure.

4. Tower Height.

A. Ensure the overall height of the tower, when mounted on its pivot base, is in accordance with the manufacturer's requirements and dependent on planned sensors, but not less than 30 feet.

B. Ensure tilted tower height is at an elevation as to provide a technician access to all instruments on tower.

5. Tower Type. Ensure tower is open lattice type and utilizes instrument booms to reduce contamination of sensor data by turbulence and wind flow around the tower structure.

6. Design in accordance with *ANSI/TIA-222 Structural Standard for Antenna Supporting*

Structures, Antennas and Small Wind Turbine Support Structures.

A. Future Loadings. Show all future tower loadings on the plans. Document all design loads on the shop drawings and in the calculations.

B. Design Basic Wind Speed. Use a minimum 90 mph wind speed. Document the wind speed on the shop drawings and in the calculations.

C. Limit the owner routine inspection frequency to not less than once every 2 years.

7. Include cable support and routing schematics in the tower design. Snap-in hangers may be used as approved by the Engineer.

8. Ensure the tower is conductive through the hinge area and capable of conducting a lightning strike current from the top of tower and/or appurtenances to the grounding conductors of the ground rods in accordance with 20SP-826A - Grounding, Bonding, Lightning Protection and Surge Protection for Electrical Systems Equipment.

9. Design the tower in accordance with each device's mounting height and offset as shown in Table 1. These are minimum requirements. Verify site-specific loading requirements to be used for design of towers as shown on the plans.

Table 1: Typical Sensor/Device Requirements

Equipment	Mounting	Horizontal Offset from Tower	Weight
Air Temperature Sensor	Tower at 8 feet Above Ground Level (AGL)	12 inches	2 pounds
Relative Humidity Sensor	Tower at 8 feet AGL	12 inches	2 pounds
Barometric Pressure Sensor	In Remote Processing Unit (RPU) Cabinet (when pole mounted)	N/A	1 pound
Present Weather and Visibility Sensor	Tower at 8 feet-7 inches AGL	12 inches	34 pounds
Ultrasonic Anemometer	10 inches below top of tower (29 feet to 32 feet AGL)	24 inches	2 pounds
Pan/Tilt/Zoom (PTZ) Camera	10 inches below top of tower (29 feet to 32 feet AGL)	12 inches	10 pounds
RPU, Uninterruptible Power Source (UPS), Misc. Hardware	In RPU Cabinet	0 inches	90-120 pounds
Power and Incidental Cabinets	On or near RPU Cabinet	0 inches	Included in RPU weight
Microwave Vehicle Detection System (MVDS)	Tower at 20 feet to 30 feet AGL (site specific)	0 inches (Direct mount to tower)	5 pounds
Wireless Antenna	Near top of tower	0 inches	5 pounds
LED Luminaire/Flood Light	Tower 25 feet AGL	0 inches	32 pounds
Air Terminal	Tower top	0 inches	5 pounds
Infrared (IR) Illuminator	Below Camera	12 inches	4 pounds

c. Submittals. Ensure all submittals are in PDF files submitted to the Engineer.

1. Use a Professional Engineer licensed in the State of Michigan with a minimum of 2

years' experience in ESS tower design to seal and design the structural calculations and plans for the tower assembly (the Designer). Ensure the calculations and plans are checked by another Professional Engineer licensed in the State of Michigan (the Checker) with qualifications meeting or exceeding those of the engineer who created the calculations and plans. Furnish design calculations and explanatory notes that demonstrate the design criteria have been met. Submit calculations and shop drawings to the Engineer within 10 working days of notice to proceed (NTP), or in a time frame as agreed upon by the Engineer, for review and approval. Written approval of calculations and shop drawings is required prior to any fabrication or construction.

A. Calculations. Furnish detailed design calculations, notes and material specifications on 8.5 by 11 inch sheets and include the Department's project designations (Control Section and Job Number), tower identifier, page number, date of preparation and initials of the Designer and Checker.

Include all details, dimensions, quantities, and cross sections in the calculations including, but not limited to the following items:

(1) Design Standards. Show all design standards used in the calculations.

(2) Loadings. Document all design loads in the calculations including weights and locations of all equipment. Clearly indicate the load combinations used in the calculations. Furnish tower base and anchor foundation reactions.

(3) Analysis Model. Include a description of the structural analysis model used and whether P-delta effects were considered.

(4) Design Basic Wind Speed. Do not use less than 90 mph. Clearly indicate the exposure category, topographic category and crest height used in the calculations.

(5) Ice Loading. Clearly indicate if ice loading is considered in the calculations. If so, clearly indicate the design ice thickness, the concurrent wind load, and the temperature reduction.

(6) Structure Class. Clearly indicate the structure class in the calculations.

(7) Materials. Clearly indicate the material type and strength, including but not limited to all members material, welding electrode and anchor bolts.

B. Shop Drawings. Prepare shop drawings in accordance with subsection 707.03.A. Submit shop drawings as a separate, single PDF file. Provide a title block in the lower right-hand corner of each sheet. Include the sheet number, tower identifier, the Department's project designations (Control Section and Job Number), and initials of the Designer and Checker within all title blocks. Include all details, dimensions, quantities, and cross sections on the shop drawings necessary to construct and install the tower including, but not limited to the following items:

(1) Document all design loads on the shop drawings.

(2) Show the tower and its equipment including the exact orientation of the tower, tilt direction and hinge height.

(3) Include tower base and anchor foundation reactions, tower sections details, hardware, mounts and attachment details, and cable routing data.

(4) Include the owner's manual.

(5) Revisions to shop drawings after approval require the Designer to stamp the revised pages.

2. Furnish the Engineer a base plate and anchor bolt template for review and approval prior to construction to properly set anchors as shown on the plans. Ensure template plates and anchor bolt cage are shop fabricated, assembled, and approved by MDOT designated representatives prior to shipping.

3. Furnish all erection drawings on 11 by 17 inch sheets, including parts lists, to the Engineer for review and approval a minimum of 10 working days prior to installation. Do not begin installation until the approval/authorization is received from the Engineer.

4. Before installation, provide final hardware installation plans to the Engineer.

5. Before installation, submit to the Engineer the exact location, coordinates, and orientation of the tower for review and approval.

d. Materials.

1. Structural Materials. Furnish *ASTM A572/A572M Gr 50* steel and hot-dip galvanize in accordance with *ASTM A123/A123M* or furnish 6061-T6 grade aluminum.

2. Hardware.

A. Use AISI Series 300 stainless steel threaded fasteners and lock washers, or use high strength bolts, nuts, and washers for structural joints meeting subsection 906.07 of the Standard Specifications for Construction. Hardware connecting aluminum components must meet subsection 906.07 of the Standard Specifications for Construction and may not be stainless steel.

B. All bolted connections except foundation anchor bolts require a locking device. Use regular, helical spring type lock washers in accordance with *ANSI B18.21.1*.

C. Furnish stainless steel grade cotter pins, AISI Series 300 Grade 18-8.

3. Anchor Bolts. Furnish anchor bolts meeting subsections 908.14.A and 908.14.B of the Standard Specifications for Construction (as modified by 20SP-908A – Miscellaneous Metal Products Revisions).

e. Construction.

1. General.

A. Prior to construction, contact all utility owners and verify the location of all the utilities in the area. The Engineer will provide any information that is available.

B. Secure all necessary building permits prior to the tower's installation. Coordinate specific permit requirements with MDOT. FAA coordination is required.

C. Refer to the plans for the tower identifier, location, and height.

2. Information pertaining to access to MDOT sites will be given when scheduling work.

3. Manufacture and Workmanship.

A. Fabricate and weld in accordance with section 707 of the Standard Specifications for Construction, the *AWS D1.1 Structural Welding Code – Steel* (as modified by 20SP-707A - Structural Steel and Aluminum Construction) hereafter called AWS D1.1, except as modified herein, and the *AWS D1.2 Structural Welding Code - Aluminum* (as modified by 20SP-707A - Structural Steel and Aluminum Construction) hereafter called AWS D1.2.

B. Fabricate tower sections with the precision to permit any like section to be joined to any other like section, allowing interchangeability of sections.

C. Supply the tower complete with all parts, fittings, and hardware; completely erected, with the specified finish; and ready for use.

D. Label all towers with a permanent identification tag that identifies the manufacturer and the date of fabrication.

4. Ensure a representative of the tower manufacturer is in attendance during installation of the first tower to ensure proper construction.

5. Notify the Engineer if the foundation's physical conditions differ from those required for the tower installation, including foundation size, orientation, anchor bolt pattern, alignment, and/or size. Coordinate all foundation requirements necessary for a proper and complete installation of the tower.

6. Use the approved base plate and anchor bolt template in the construction of the foundation.

7. Install anchor bolts and pretension using the Turn-of-Nut (TON) method in accordance with subsection 810.03.N of the Standard Specifications for Construction (as modified by 20SP-810H – Permanent Traffic Signs and Supports Revisions).

8. Install the tower plumb and true. Field adjust the tower. Level the tower at the base by using only the leveling nuts and a steel plate of suitable size and thickness per the tower manufacturer's recommendations. Grouted base plates are prohibited. Submit any alteration to the orientation or locations on the plans to the Engineer for approval. Document changes on the plans.

9. Site preparation and restoration.

A. Preserve the area around the tower to minimize site restoration. Restore the grounds to their original condition.

B. Place a 15 foot by 15 foot stone pad, Approach, Cl II, 6 inch, per section 307 of the Standard Specifications, centered on the ESS tower, using pay item Approach, Cl II, 6 inch. Restore all disturbed areas to their original condition and dispose of any excess materials.

10. Ground and equip the tower with a site ground ring. Make grounding connections as soon as the first section is installed. Follow allowable grounding requirements identified in 20SP-826A - Grounding, Bonding, Lightning Protection and Surge Protection for Electrical Systems Equipment. Grounding is paid for separately.

11. Mount lightning rod to protect ESS equipment. Paid per 20SP-826A - Grounding, Bonding, Lightning Protection and Surge Protection for Electrical System Equipment using the pay item Lightning Protection, Structure, Environmental Sensor Station Tower.

12. Install anti-climb panels on all towers to restrict persons from climbing the tower lattice structure.

13. Determine the exact size and placement of the equipment holes on the tower. Fill unused pre-drilled holes using appropriately sized nuts and bolts.

14. Shipping and Delivery.

A. Package materials to protect against damage.

B. Deliver in accordance with the project schedule.

C. Indicate how equipment or systems are to be delivered, identifying carrier, and notify the Engineer of shipping dates.

D. Notify the Engineer of any changes in shipping dates.

E. Notify the Engineer within 48 hours of equipment delivery.

F. Retain the title and ownership of the equipment and systems until formal system acceptance by the Engineer.

G. Charges for freight, express, cartage, or packing are included in the pay item for ESS Tower.

H. Ensure every package, bill of lading, shipping memorandum, and invoice is marked with the purchase order number of the purchaser.

I. Include MDOT’s purchase order number on the itemized delivery tickets left with the equipment.

J. If delivery is made by carrier, attach an itemized delivery ticket to the outside of the package.

15. Storage.

A. Provide secure storage for all equipment.

B. Ensure storage is available throughout the duration of the project in accordance with the Contractors installation schedule.

C. Ensure storage areas are available to MDOT representatives for inspection and inventory.

D. Obtain approval from the Engineer for the storage location to be used. Deliver all equipment and components to the installing Contractor's storage location.

E. Verify the correctness of the material lists and the suitability of the devices proposed.

F. Provide for transportation and delivery of all material between storage areas and MDOT work sites.

f. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay item:

Pay Item	**Pay Unit**
ESS Tower	Each

ESS Tower includes designing, furnishing, fabricating, and installing the tower, hardware, anchor bolts, mounting hardware, cabling, and other necessary materials.