12 HIGH MAST LIGHTING TOWER (HMLT)

12.1 Definitions

HMLT are light poles mounted on a concrete foundation with anchor bolts and a lighting array containing multiple luminaires. The poles may be constructed of galvanized or weathering steel and may be round or multi-sided. The poles are typically constructed from multiple pieces joined together with slip joints. The lighting array is mounted with a lowering device contained within the pole to allow for the array to be lowered for luminaire maintenance.

12.1.1 INVENTORY ITEMS

The inspector shall identify the number of anchor bolts on the foundation and shall determine the type of coating – paint, galvanizing, powder coated, or uncoated.

The tower may support a variety of attachments, both directly and indirectly. The quantity and type of these appurtenances and their attachments or connections to the structure should be noted. The types of connections may include direct bolting, bands, clamps, or brackets. Although the non-structural appurtenances such as luminaires do not receive ratings themselves, the general conditions should be noted and reported appropriately if they pose a safety risk.

The inspector shall provide a Work Rec if the mounts and attachments for the luminaires appear to be damaged or need the luminaires need replacement. The inspector shall also note the presence of any non-typical attachments that may not have been approved or been part of the original purpose or function of the HMLT. The inspector shall provide the Power Meter number.

The inspector shall confirm any pre-populated inventory data while recording information that is not already documented. It may not be possible to record or verify all measurements exactly due to access or other limitations; estimate and use experience and best judgement to record data to the most accurate extent possible. Take photos of the required inventory items listed in Section 12.2.2.

A complete list of inventory items is provided in the Ancillary Structures Data Dictionary.

12.1.2 ELEMENTS

HMLT are divided into two components: Foundation and Vertical Structure.

Foundation is further divided into elements: Concrete Foundation, Anchor Bolts.

Vertical Structure is further divided into elements: Base Plate, Vertical Support Column (Upright), Pole Splice Connections, and Lighting Array.

Table 12-1: High-Mast Lighting Tower Components and Elements

Component	Element	Element Code	Unit of Measure
Foundation	Concrete Foundation	22101	Each
Foundation	Anchor Bolts and Leveling Nuts	22102	Each bolt and nut unit
Vertical Structure	Base Plate	22201	Each
Vertical Structure	Vertical Support Column (Upright)	22202	Length, feet
Vertical Structure	Pole Splice Connections	22203	Each
Vertical Structure	Lighting Array	22204	Each

12.1.3 COMPONENTS

HMLT are divided into two main components: the foundation and the vertical structure.

Component ratings for HMLT are based on the following:

- ***Foundation*** – Consider the structure's foundation effect on overall stability of the HMLT.
- ***Vertical Structure*** – Consider if the vertical structure may have damage that compromises the structural capacity such as fractures, significant twisting or kinking, corrosion, section loss, or stress cracks in the metal.

See Section 1.7 for discussion on component ratings, element ratings, and condition states. A representation of the rating structure is provided in Figure 12-1. A sketch of a typical HMLT with components and elements is shown in Figure 12-2.

Figure 12-1: Rating structure for High-Mast Lighting Tower

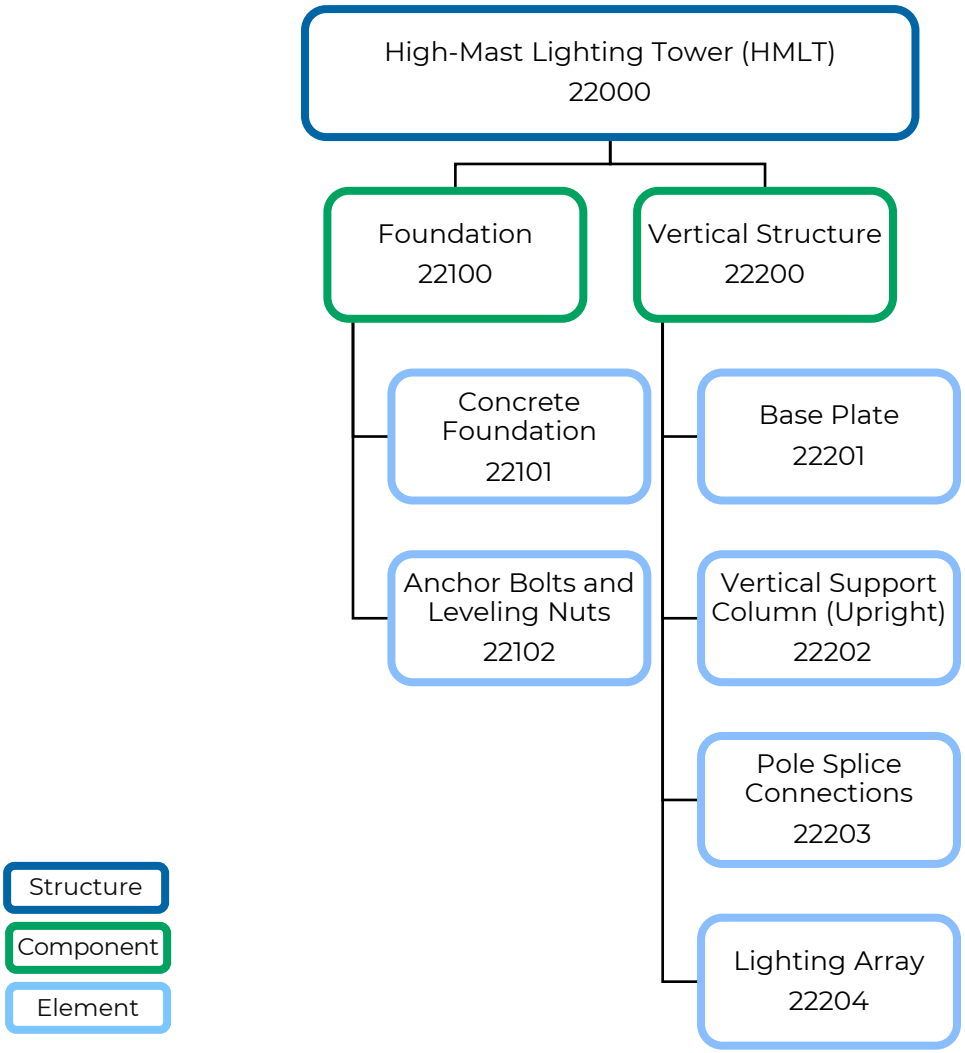
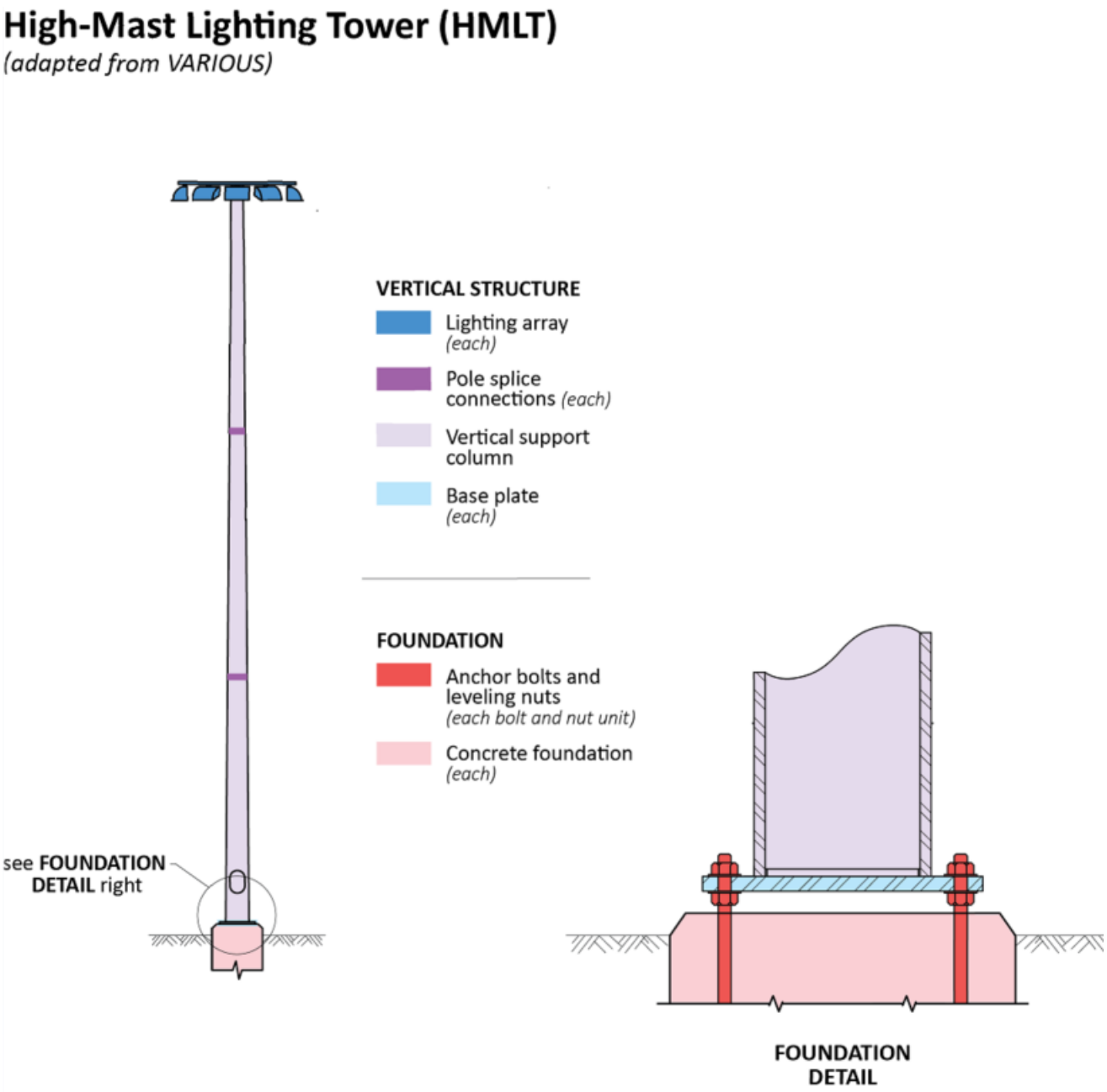


Figure 12-2: Elements and components for HMLT (adapted from MDOT Project Drawings, various)



12.2 Inventory Record Photographs

Inventory photos are captured during a routine inspection, saved as part of the inventory database, and follow the naming convention in *Table 12-2*.

High Mast Lighting Tower Required Photos:

- General view of the entire structure
- General view of the entire foundation

- General view of the top of the tower showing attachments, such as luminaires, communication equipment, cameras, or sensors

Table 12-2: High Mast Lighting Tower Photograph Naming Convention

Photo Name	Description
HMLT_Entire	Entire high mast lighting tower
HMLT_Foundation	Foundation
HMLT_Splice_Connection	Splice Connection, typical
HMLT_Lum	Lighting array
HMLT_ID	Old ID and new structure number
HMLT_UAS_#	Still photographs extracted from UAS video of the high mast lighting tower, numbered sequentially, if applicable

*** Where # is a sequential number ranging from 1-X. One image will be accepted if all items can be captured in a single image that provides enough detail. If this level of detail cannot be obtained in a single image, then take photos needed to provide this level of visibility.**

12.3 Inspector Minimum Technical Qualifications

At least one member of the field inspection crew shall possess the following certifications and training:

- A minimum experience of two projects with a minimum of 10 structures total inspecting towers (High Mast, ESS, or Communication). Bolt inspection experience on towers, cantilever or truss structures, or other ancillary structure type. Multiple structure types shall have been inspected as part of the total project experience
- Ancillary structures inspection procedures training
- Working knowledge of inspection tools, their use, application, and limitations for the structure type being inspected
- MDOT structural bolting workshop for initial field installation verification
- Certified Welding Inspector – American Welding Society, Certified Welding Inspector (CWI) (Current)
- Ultrasound qualification – Current ASNT Level II (ASNT or per ASNT TC-1A guidelines) qualification in straight beam ultrasonic testing. In conditions where a weld needs ultrasonic testing (UT) then Level II in shear wave is required
- Visual Testing (VT) – Current ASNT or CWI qualifications

12.4 Routine Inspection

High-mast lighting typically consists of a tall pole with lighting attached at the top pointing to the ground. High Mast Lighting Tower (HMLT) ancillary structures are constructed and designed to support lighting arrays along roadways. They are rigidly anchored to their foundations, with heights ranging from 60 to 200 feet. They are typically freestanding

structures and include a self-supporting tower. Splices between support column sections may be butt welded or have overlap slip joints. Poles are typically tapered and are connected to the concrete foundation with anchor bolts.

HMLT standard inspection frequency is once every 4 years, unless otherwise identified for more frequent inspection.

The acceptable tolerance for intervals of less than 24 months for the next inspection is up to two (2) months after the month in which the inspection was due. The acceptable tolerance for intervals of 24 months or greater for the next inspection is up to three (3) months after the month in which the inspection was due. Exceptions to the inspection interval tolerance due to rare and unusual circumstances should be approved by MDOT's Ancillary Structures Program Manager in advance of the inspection due date plus the above tolerances.

It is recognized that severe weather, inspector safety, inspection quality, resource optimization, technological difficulties, or other unique situations may be a reason to adjust the scheduled inspection date. In these situations, the adjusted inspection date should not extend more than two (2) months after the month the inspection was due for any inspection interval less than 24 months and not extend more than three (3) months after the month the inspection was due for any inspection interval 24 months or greater. Inspection interval tolerances are intended to provide some flexibility. When tolerances are applied, the longest time period prescribed between inspections is the applicable interval plus the prescribed tolerance. For example, a routine inspection on a 12-month interval could be performed during the 14th month if the tolerance is applied. Repeatedly applying the tolerance to the next inspection will create inspection date creep and may impact an owner's ability to perform future inspections in a timely manner due to other limitations (e.g. available resources, inspection workload, schedule, seasonal weather conditions, technological difficulties, etc.). Exceptions to inspection interval tolerances due to rare and unusual circumstances should be approved by MDOT's Ancillary Structures Program Manager in advance of the inspection due date, plus the tolerance. For example, if an inspection with an interval of 24 months is due on June 17, an exception request should be approved by MDOT's Ancillary Structures Program Manager before the end of the 3-month tolerance (i.e. September 30). However, a request for exception should be made when the potential for not meeting the tolerance becomes known to provide MDOT's Ancillary Structures Program Manager with adequate time for review and approval.

Figure 12-3: High-Mast Lighting Tower, aerial view of tower and lighting array from UAS

Table 12-3 provides guidance for inspecting reinforced and prestressed concrete cracking.

Table 12-3: Standard Cracking Widths

Description	Reinforced Concrete	Prestressed Concrete
Hairline (HL)	<1/16” (0.0625”)	< (0.004”)
Narrow (N)	1/16” to 1/8” (0.0625” to 0.125”)	(0” to 0.009”)
Medium (M)	1/8” to 3/16” (0.125” to 0.1875”)	(0.010” to 0.030”)
Wide (W)	>3/16” > (0.1875”)	> (0.03”)

Source: FHWA Bridge Inspector’s Reference Manual (Publication No. FHWA NHI 03-001, October 2002)

12.4.1 FOUNDATION ROUTINE INSPECTION

The routine inspection assesses the foundation’s ability to safely support the structure and transfer all loads to the surrounding soil or subsurface materials. The routine inspection is

performed on a regularly scheduled basis and includes the foundation component rating as determined by the element condition ratings of the concrete foundation and steel anchor bolts and nuts. Steel anchor bolt and nut connections may have lock washers or use turn-of-nut method. The inspection should cover these features as applicable. Routine inspection consists of observations and measurements needed to determine the physical and functional condition of the foundation, to identify any changes from initial or previously recorded conditions, and to ensure that the foundation continues to satisfy present service requirements. All elements of the component shall be visually inspected at a distance that is close enough to determine the overall condition and to detect deficiencies.

A sample foundation routine inspection would consist of:

- Note vegetation growth impeding access to the structure.
- Inspect ground line for any material washing out around foundation.
- Examine the foundation visually and by sounding with a standard inspection hammer.
- Verify anchor bolt diameter and length, then scan for defects.
- Examine anchor bolts for tightness and embedment using a standard inspection hammer. Inspect visually for corrosion, section loss, and plumbness.
- Examine anchor bolts for any eccentricity. Note any noticeable eccentricity measurements.
- Perform ultrasonic testing of anchor bolts to note any breaks and verify lengths.
- Provide photographs for all Poor or Severe condition state defects and submit the applicable Work Recs or RFAs.

12.4.1.1 Foundation Component Ratings

The component rating for the foundation depends on the condition of the foundation concrete and surrounding soil, and the anchor bolts and nuts that connect the structure to the foundation. Assessing these factors with respect to the overall ability of the foundation to safely support the structure, along with the element condition ratings, provides the appropriate component rating. Note that the base plate is considered as part of the vertical structure component, not the foundation component.

Table 12-4: Component Rating Guidelines for HMLT Foundation

Component Rating	Condition	Material	Description
9	**NEW**	All	No deficiencies in any of the structural components that will affect long term performance.
8	**VERY GOOD**	All	All structural components are sound and functioning as designed. There may be superficial cracking or weathering of protective components and/or dirt contamination of structural components.
7	**GOOD**	Concrete	Insignificant cracks or moderate cracks that are sealed.

Component Rating	Condition	Material	Description
		Soil	Insignificant displacement or erosion of soil.
		Steel	Protective coating failure in very small and scattered locations.
		All	All components retain full section properties and function as designed.
6	SATISFACTORY	Concrete	Unsealed moderate-width or map cracks. Minor delamination or spalling.
		Soil	Minor displacement or erosion of soil.
		Steel	Protective coating failures is limited to less than 10% of the surface area with no loss of section.
		All	Minor deterioration affecting structural components. Minor misalignment.
5	FAIR	Concrete	Moderate delamination or spalling.
		Soil	Moderate displacement or erosion of soil. Minor gaps may be present between pole and embedment material.
		Steel	Minor loss of section. Loose fasteners may be present but the connection is in place and functioning as intended.
		All	Moderate deterioration affecting structural components including minor settlement, or impact damage. Moderate misalignment. All members continue to function as designed.
4	POOR	Concrete	Considerable cracking and spalling.
		Soil	Considerable displacement or erosion of soil.
		Steel	Protective coating failure and less than 25% loss of section of anchor bolts and leveling nuts. Loose anchor bolts or leveling nuts may be present but are in place and functioning as intended.
		All	Considerable deterioration or misalignment affecting structural members. Structural review may be warranted.
3	SERIOUS	Concrete	Extensive cracking and spalling.
		Soil	Extensive displacement or erosion of soil. Large gaps may be present between tower and embedment material.
		Steel	Measurable loss of section in excess of 25%. Missing or broken anchor bolts and leveling nuts.
		All	Considerable deterioration or damage affecting structural members. Structural evaluation, is necessary to determine if the structure can continue to function without repairs.

Component Rating	Condition	Material	Description
2	CRITICAL	All	Deterioration has progressed to the point where the structure will not support design loads and emergency repair or removal is required.
1	IMMINENT FAILURE	All	Road is closed to traffic due to imminent failure, but corrective action may put it back in service.
0	FAILED	All	Road is closed due to condition of structure. Notify Region and the Bureau of Bridges and Structures.

12.4.1.2 Concrete Foundation Element Condition States

The foundation stabilizes and secures the entire structure. The purpose of inspection is to identify and record any minor to severe deficiencies throughout the lifespan of the foundations. Inspect the condition of the concrete foundation, noting any cracking, spalling, voids, impact damage, and general deterioration. Typical issues include cracking throughout the foundation, spalling, chipping, delaminated or broken sections of the foundation, exposed aggregate and rebar, and soil erosion around the foundation.

Table 12-5: HMLT Concrete Foundation Element Distresses

Element Number	Element	Description	Associated Distresses
22101	Concrete Foundation	Frangible and non-Frangible pole structure foundations	Cracking
			Spalling, delamination, and patching
			Exposed rebar
			Embedment erosion
			Impact damage
Unit of Measure: Each foundation, note number of foundations within each condition state. Typically, a single foundation which will then be rated as a single condition state.			

Details on the condition state rating schema are in Section 12.7, linked below:

HMLT Condition State Tables

Figure 12-4: HMLT concrete foundation, spalling deterioration

12.4.1.3 Anchor Bolts and Leveling Nuts Element Condition States

The anchor bolts transfer load from the structure into the foundation. For HMLT, this element addresses the bolts in connection with the concrete foundation only.

The purpose of the anchor bolt inspection is to identify any degradation of the nuts, flat washers, leveling nuts, and anchor bolts connecting the tower base to the concrete foundation. Typical issues include corrosion, damaged threads, loose connections, missing or damaged anchor bolts and leveling nuts, soil or debris between the upright base and concrete foundation, ultrasound indications, excessive leveling nut to foundation standoff distance, bent or warped base plates, and bent or warped anchor bolts. All nuts should be tight and fully bear on connected surfaces. Loose nuts, nuts that don't fully bear on

adjacent steel, nuts not fully engaged, or damaged or cracked anchor bolts can lead to connection movement, load redistribution, and ultimately failure.

Inspection of the anchor bolts includes a visual inspection, and a determination of the tightness of the bolts and nuts. A sounding test, and a straight beam ultrasound scan (UT test) of 10 inches into the anchor bolts are recommended. Published procedures for the sounding and UT test are provided in references found in Section 12.4.3.

Visually inspect the base looking for missing or damaged anchor bolts or nuts connected to the foundation. Note any damage or corrosion and any bolt that shows signs of bending. Check for any gaps between the nuts, washers, and base plate. Check for excessive standoff distance between the underside of the leveling nut and the top of the foundation (or the top of sound concrete in cases of foundation deterioration).

The standoff distance is an indication of whether or not the anchor bolts are subjected to bending moment stress. For double-nut connections, if the clearance between the bottom of the leveling nuts and the top of the concrete foundation is less than or equal to one bolt diameter, bending stresses in the anchor bolts can be disregarded (AASHTO LRFD Specifications for Structural Supports, sec. 5.16.3.1). Any distance greater than one bolt diameter may be cause for concern.

Figure 12-5: Standoff measurement for a sound foundation (left) and standoff measurement with foundation concrete deterioration (right)

Table 12-6: HMLT Anchor Bolt and Leveling Nuts Element Distresses

Element Number	Element	Description	Associated Distresses
22102	Anchor Bolts and Leveling Nuts	Anchor bolts and leveling nuts at HMLT foundation	Corrosion or coating damage
			Loose or missing anchor nut
			Cracked bolt
			Standoff distance
			Impact damage
Unit of Measure: Each, note quantity of anchor bolt and nut units within each condition state			

Details on the condition state rating schema are in Section 12.7, linked below:

HMLT Condition State Tables

12.4.2 VERTICAL STRUCTURE ROUTINE INSPECTION

The uprights directly support the lighting arrays. The routine inspection assesses the vertical structure's ability to safely support the lighting array and transfer all loads to the foundation. As the high mast tower is a single tower, it is non-redundant and can be considered fracture critical. The structures are susceptible to effects of solar heating from the sun, with the side exposed to sunlight typically exhibiting tensile stress cracks. The lighting array is typically comprised of a ring with multiple luminaires mounted to it, which lights a large area. Towers have winches that can be used to raise or lower the lighting array for routine maintenance.

The routine inspection is performed on a regularly scheduled basis and includes the vertical structure component rating as well as the condition state element ratings of the baseplate, vertical support column (upright), pole splice connections, and lighting array. It consists of observations and measurements needed to determine the physical and functional condition of the vertical structure, to identify any changes from initial or previously recorded conditions, and to ensure that the vertical structure continues to satisfy present service requirements. Routine inspection does not include raising and lowering the lighting array to check for mechanical or moving functionality.

Visually inspect all elements of the component at a distance close enough to determine the overall condition and to detect deficiencies. Historically, binoculars have been used as a visual aid while closer review has been accomplished with mechanical lift equipment or climbing. Recently, the employment of UAS equipment has been accepted given the ability to provide close-up, high-resolution imagery from many different angles around a tower. UASs have been shown to reduce risk to the inspection team and public as generally no lane closures or large equipment in the right-of-way are required.

An example of a typical vertical structure routine inspection would be:

- Note condition of base plate above top of foundation.
- Examine rodent screen (if present) visually for holes, connection, and corrosion. Note vegetation growth impeding access to the structure.

- Inspect the welds around hatches and handholes and all transverse welds near the base of the high mast pole for potential cracking.
- Examine the pole using visual methods outlined above. Note deterioration of the material, such as cracking, corrosion, and/or pack rust, noting the width, length, depth, and/or orientation of the deterioration.
- Pay specific attention to splice connections and distresses at those locations.
- Examine light ring for loose hardware or cords not properly secured, cracked lenses, damaged housing, and levelness of ring.
- Provide photographs for all Poor or Severe condition state defects and submit the applicable Work Recs or RFAs.

12.4.2.1 Vertical Structure Component Ratings

The component rating for the vertical structure depends on the condition of the baseplate, vertical upright(s), vertical support column, pole splice connections, and the lighting array. Assessing these factors with respect to the overall ability of the vertical structure to safely support the lighting, other attached appurtenances, and transfer loads to the foundation provides the appropriate component rating.

Examination of the inside of the pole Examine inside of pole for corrosion, section loss, cracking, water accumulation, and/or pack rust by removing handhole cover is not part of the Routine Inspection Procedure. If the handhole cover is missing, consider the condition of the interior of the visible portion of the pole as part of the component rating.

Table 12-7: Component Rating Guidelines for HMLT Vertical Structure

Component Rating	Condition	Material	Description
9	**NEW**	All	No deficiencies in any of the structural components that will affect long term performance.
8	**VERY GOOD**	All	All structural components are sound and functioning as designed. There may be superficial cracking or weathering.
7	**GOOD**	All	Protective coating failure in very small and scattered locations on the tower steel. All components retain full section properties and function as designed.
6	**SATISFACTORY**	Steel	Protective coating failures is limited to less than 10% of the surface area with no loss of section.
		All	Minor deterioration affecting structural components. Minor misalignment.
5	**FAIR**	Steel	Minor loss of section. Loose connections and splice deterioration may be present, but the connections and splicing are in place and functioning as intended.
		All	Moderate deterioration affecting structural components including impact damage.

Component Rating	Condition	Material	Description
			Moderate misalignment. All members continue to function as designed.
4	POOR	Steel	Protective coating failure and less than 25% loss of section. Cracks may be present. Fasteners, bracing, connections, and splices may be considerably deteriorated. Considerable damage from impact or attachments.
		All	Considerable deterioration or misalignment affecting structural members. Structural review may be warranted.
3	SERIOUS	Steel	Measurable loss of section in excess of 25%. Missing or broken fasteners or extensive cracking in tower.
		All	Considerable deterioration or damage affecting structural members. Structural evaluation, is necessary to determine if the structure can continue to function without repairs.
2	CRITICAL	All	Deterioration has progressed to the point where the structure will not support design loads and emergency repairs, or removal is required.
1	IMMINENT FAILURE	All	Road is closed to traffic due to imminent failure, but corrective action may put it back in service.
0	FAILED	All	Road is closed due to condition. Notify Region and the Bureau of Bridges and Structures.

12.4.2.2 Base Plate Element Condition States

Visually inspect for any damage to the base plate welds and gusset plates, such as gouges, distortion, impact damage, or warping. Note galvanizing damage and the degree of corrosion present. Areas of galvanizing that appear to have been repaired are monitored closely throughout the lifespan of the structure. If that area was not thoroughly cleaned prior to repair, corrosion might not show through the repair immediately but could appear in later years.

Perform a visual inspection of the gusset welds and base weld looking for cracks or other weld defects. Document questionable fillet or groove weld discontinuities. The base weld is a full-penetration weld and any crack identified in the toe or throat of the weld is considered as severe, and the appropriate procedure such as an RFA or Work Rec initiated.

Table 12-8: HMLT Base Plate Element Distresses

Element Number	Element	Description	Associated Distresses
22201	Base Plate		Corrosion or coating damage

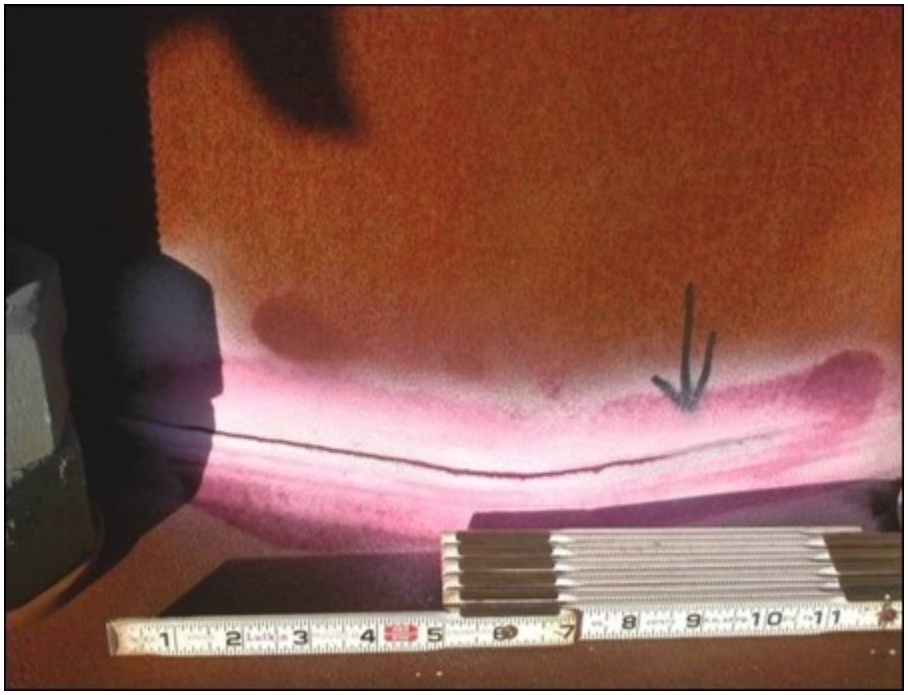
Base plate for High-Mast Lighting Tower	Weld defect or crack

Unit of Measure: Each, percentage of base plate within each condition state

Details on the condition state rating schema are in Section 12.7, linked below:

HMLT Condition State Tables

Figure 12-6: Crack at connection of HMLT vertical support column to base plate



12.4.2.3 Vertical Support Column (Upright) Element Condition States

Verify that the structure number is stenciled on the front of the upright (facing traffic) and is still legible. If necessary, use black paint to stencil the number on the vertical support (upright). Unless a mechanical lift or other means of working at heights (i.e., UAS) are utilized, binoculars are used as a visual aid to inspect the tops of vertical supports.

Note any galvanizing damage on the upright. Additional measures may be needed if the corrosion protection included painting over galvanizing. If nothing of note was found, spray “cold galvanizing” compound or zinc rich paint, after properly cleaning or preparing the surface, on any area where galvanizing was removed.

The uprights should be checked for any vertical misalignment with a 4 ft level or similar, keeping in mind that HMLT uprights may be tapered and multiple checks around the perimeter may be necessary. A hand hole may be located near the base of the upright to allow for access to electrical systems. The hand hole cover should be securely fastened, and the hand hole frame inspected for any cracks in the welds or base metal, along with any other welded components. The uprights are typically galvanized and may have a single or multi-coat paint system on top of the galvanizing for FAA compliance or other reasons such as aesthetics. Any corrosion should be noted and if there is significant corrosion, the

upright wall thickness should be checked for section loss with a thickness gauge or ultrasonic testing device.

Inspect the length of the upright for impact damage and cracks. If any type of impact damage is present (gouges, dents), clean the area (if accessible) and visually inspect for any cracks. Damage may also be caused by attachments to the vertical support column.

Table 12-9: HMLT Vertical Support Column (Upright) Element Distresses

Element Number	Element	Description	Associated Distresses
22202	Vertical Support Column (Upright)	Vertical Support (Upright) for HMLT	Corrosion or coating damage
			Weld defect or crack
			Out of plumb
			Impact damage
			Handhole defects
Unit of Measure: Length, feet of vertical support within each condition state			

Details on the condition state rating schema are in Section 12.7, linked below:

HMLT Condition State Tables

12.4.2.4 Pole Splice Connections Element Condition States

Spliced connections are present at the connection between sections of vertical support column. Pole splice connections include slip joints and circumferential welds for the column support of the structure. Poles greater than 50 feet in length are typically spliced together as separate pieces. Splices are often slip joints, with an upper section fitting over the top of the section below it. The splice transfers the load between sections. Occasionally, pole sections are connected with welds instead of the more typical splices.

Typical issues include weld discontinuities, galvanizing damage, or flange connection gaps. Note any gaps between steel in the spliced connections or cracked welds. Gusset, lacing, or stiffener plates may be present; note any cracks or corrosion in these plates. If plates are present at the connections, record any bolting components that are missing, deteriorated, or damaged. Record any signs of corrosion.

Table 12-10: HMLT Pole Splice Connections Element Distresses

Element Number	Element	Description	Associated Distresses
22203	Pole Splice Connections	Splices to support sections of vertical support columns on HMLT	Weld defects or cracks
			Corrosion or coating damage
			Loose, missing, or failing hardware
Unit of Measure: Each connection quantity within the condition state			

Details on the condition state rating schema are in Section 12.7, linked below:

HMLT Condition State Tables

Figure 12-7: HMLT pole splice

12.4.2.5 Lighting Array Element Condition States

Lighting arrays are comprised of many different parts including structural framing, brackets, luminaires, wiring and electrical connections/hardware. The arrays should be visually inspected for weld defects or cracks, corrosion, coating damage, hardware issues, etc.

Figure 12-8: HMLT lighting array, as seen from a UAS

Table 12-11: HMLT Lighting Array Element Distresses

Element Number	Element	Description	Associated Distresses
22204	Lighting Array	Lighting array which supports luminaires on High-Mast Lighting Tower	Weld defects or cracks
			Corrosion or coating damage
			Loose, missing, or failing hardware
Unit of Measure: Each connection quantity within the condition state			

Details on the condition state rating schema are in Section 12.7 linked below:

HMLT Condition State Tables

12.4.3 REFERENCES

MDOT Tower Lighting Unit Installation Inspection Procedure, describing UT and Sounding Testing

AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 2015 (AASHTO Signs)

12.5 Work Recommendation Guidance

HMLT Work Recs are recorded to initiate preventive maintenance actions. These Work Recs are presented on the Ancillary Structures (AS) Inspection Report Form. Loose bolts are frequently the cause of Work Recs. Isolated or limited loose or missing bolts would qualify as a Work Rec but could increase to an RFA if bolt conditions worsened with time.

The Work Recs are not meant to be all-inclusive and other Work Recs may be added to supplement those noted.

Photographs should include sufficient information to determine the relationship of the defect to the element or component or entire structure. Close-up photos of each defect with connection deficiencies marked on the photo should be provided.

Table 12-12: High-Mast Lighting Tower Work Recommendations

Code	Name	Material Involved	Quantity/Unit of Measure
1	Correct erosion at foundation (prevent undermining)	Stone/Soil	Cubic Feet
2	Repair/monitor foundation	Concrete	Cubic Feet
3	Address loose or damaged grounding wire/ground rod	Steel	Each
4	Address loose or damaged lightning rod	N/A	Each
5	Tighten leveling nut	Galvanized Steel	Each Nut
6	Repair/replace handhole cover	Galvanized Steel	Each Covert
7	Remove graffiti	N/A	Square Foot
8	Repair galvanizing	Galvanic Paint	Square Inch
9	Repair painting	Paint	Square Inch
10	Weld repair at upright to base plate connection	Steel	Each Weld
11	Weld repair at splice connections	Steel	Each Weld
12	Replace luminaire	Various	Each Light
13	Replace lighting array	Steel	Each Array
14	Repair/service lowering device	Various	Each Device
15	Repair/replace ID stencil on upright	Paint	Each Stencil

12.6 Request for Action Guidance

Examples of applicable priority level items include, but are not limited to:

Priority 1 Level Items

a. Major foundation deterioration including concrete cracking/spalling/delamination, thread damage, steel reinforcement corrosion, anchor bolt corrosion, ultrasonic test failure, failure of anchor bolts, and significant section loss of steel reinforcement or anchor bolts

b. Major soil erosion or undermining of the foundation element(s) evidenced by lateral displacement or vertical out of plumbness

c. Major base plate distortion or section loss around anchor bolts

d. Standoff distance more than twice the bolt diameter, where bending of anchor bolts is evident

e. Multiple loose bolts in an anchor bolt connection

f. Major cracks present in the base metal or weld(s) on the base plate to column connection

g. Major section loss due to corrosion of a main element which impacts the capacity or short-term resiliency of the element or structure

h. Presence of major cracks or active corrosion on main members (base metal) or connections (welded or slip) where presence of new or recent cracking shows non-corroded, minimally corroded, or progressively corroded-cracked steel surfaces is observed as opposed to a heavily corroded-cracked surfaces which have been present for some time

i. Major structural damage to foundation, anchor bolts, upright, or other elements, which impacts capacity or function, clearance, safety, or short-term resiliency of the structure

Priority 2 Level Items

a. Significant foundation deterioration including concrete cracking/spalling/delamination, steel reinforcement corrosion and section loss

b. Significant soil erosion or undermining of the foundation

c. Significant base plate distortion or section loss around anchor bolts

d. Standoff distance more than twice the bolt diameter where no bending of anchor bolts is evident

e. Pole is significantly out of vertical alignment

f. Anchor nuts are engaged with some gaps and/or bolts are misaligned

g. Significant weld deficiencies that have not initiated cracking but do not meet current code or will lead to Priority Level 1, but acceptable redundancy and/or resiliency is present

h. Structural cracks in secondary members that could potentially propagate through welded connections into main members

i. Significant corrosion of primary elements or connections is present

j. Significant section loss or weld deficiencies at a field splice

k. Loose lighting connection assemblies where there is acceptable load-path redundancy, but significant impact to capacity or durability

l. Incident resulting in significant structural damage

Priority 3 Level Items

a. Localized moderate foundation deterioration including concrete cracking/spalling/delamination, or exposed steel reinforcement, but section loss is negligible
b. Moderate erosion around the foundation element(s)
c. Moderate corrosion of the anchor bolt connections or high strength bolted connections
d. Moderate corrosion of the base plate, which includes moderate section loss
e. Anchor bolt standoff distance more than one bolt diameter but less than two bolt diameters with no anchor bolt bending present
f. Pole is moderately out of vertical alignment
g. Moderate weld deficiencies, which do not meet code but do not impact function where significant redundancy is also present
h. Missing or loose nuts or other elements of a lighting connection assembly where there is adequate redundancy and moderate impact to structural capacity or durability
i. Moderate section loss at a field splice

12.7 Element Condition States

Element Number	Element	Condition States Defects Note	Link to Discussion in Section 8
22101	Concrete Foundation	Use the appropriate condition state table	Concrete Foundation Element Condition States
22102	Anchor Bolts and Leveling Nuts	Use the appropriate condition state table. Use UT testing result to assist in the condition assessment.	Anchor Bolts and Leveling Nuts Element Condition States
22201	Base Plate	Use the appropriate condition state table.	Base Plate Element Condition States
22202	Vertical Support Column	Use the appropriate condition state table.	Vertical Support Column (Upright) Element Condition States
22203	Pole Splice Connections	Use the appropriate condition state table.	Pole Splice Connections Element Condition States
22204	Lighting Array and Lowering Device	Use the appropriate condition state table.	Lighting Array Element Condition States

Elements 22101 – Concrete Foundation

Description	This element defines a concrete foundation for an HMLT, regardless of foundation type such as drilled shaft or reinforced concrete pile.			
Quantity Calculation	The quantity is collected in each.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Concrete Foundation Defects	The concrete shows no deterioration. Superficial cracking, discoloration, or efflorescence may be present. No exposed reinforcing.	Minor cracks and/or spalls may be present in the concrete. No exposed reinforcing, embedment erosion, or impact damage.	Moderate cracks and/or spalls may be present. Some reinforcing may be exposed. Incidental loss of section or surface pitting of reinforcing may be present. Element may show evidence of some embedment erosion or impact damage.	Major cracks and/or spalls are present. Major corrosion of exposed reinforcing. Extensive steel and/or concrete loss or embedment erosion is present. Major impact damage may be present.

Elements 22102 – Anchor Bolts and Leveling Nuts

Description	Anchor bolts and leveling nuts attaching the upright to the foundation for HMLT.			
Quantity Calculation	The quantity for this element is each anchor bolt and nut unit.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Anchor Bolts and Leveling Nuts Defects	There is no deterioration. Anchor bolt standoff distance meets standard. No evidence of impact damage. The elements are fully engaged, and the sounding test produces a sharp ringing sound.	Minor corrosion of the elements may be present. Anchor bolt standard off distance meets standard. No evidence of impact damage. The elements are fully engaged and functioning as intended. The	Moderate corrosion/ section loss of the elements may be present. Anchor bolt standoff distance is not excessive. The sounding test produces a dull sound. Anchor bolts may have some evidence of impact damage and slight bending.	Major corrosion/section loss of the elements may be present. Nuts are loose/missing. The sounding test produces a dull sound. Excessive anchor bolt standoff distance. Major evidence of impact damage and anchor bolt bending or out of plumbness. UT testing

Description	Anchor bolts and leveling nuts attaching the upright to the foundation for HMLT.			
Quantity Calculation	The quantity for this element is each anchor bolt and nut unit.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
		sounding test produces a sharp ringing sound.		indicates cracks or breaks in bolts.

Elements 22201 – Base Plate

Description	Base plate which connects the upright element to the anchor bolt and leveling nut element for the HMLT.			
Quantity Calculation	The quantity for this element is each base plate.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Base Plate Defects	No evidence of active corrosion. Surface coating is sound.	Minor surface corrosion or superficial damage may be present. Protective coating failure with no section loss. Base element welds have no evidence of defects.	Moderate corrosion/section loss or damage may be present. Protective coatings are failing. Base element welds have no evidence of defects and/or cracking. Base plate may exhibit minor warping.	Major corrosion/section loss is present. Base element welds may have cracks/defects. Base plate has moderate to major warping.

Elements 22202 – Vertical Support Column (Upright)

Description	This element is defined by all uprights supporting an HMLT.			
Quantity Calculation	The quantity is collected in length in feet of vertical support.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Vertical Support Column (Upright) Defects	No evidence of active corrosion. Surface coating is sound and functioning as intended.	Minor corrosion or superficial damage of the elements may be present. Protective coating failure with no section loss. No element weld defects or cracking are evident. Minor superficial impact damage may be present.	Moderate corrosion/ pitting/section loss may be present. Protective coatings are failing. Element welds have no evidence of defects and/or cracking. Support may be out moderately of plumb.	Major corrosion/section loss is present. Protective coatings are significantly failing. Element welds may have cracks/defects. Support may be majorly out of plumb.
Handhole Defects	Handhole cover and attachment to pole is securely fastened. The inside of the pole is free of excess moisture, and debris.	Handhole cover is in place but loosely fastened or minimally damaged. Handhole attachment to pole may have minor deficiencies. The inside of the pole may contain minor moisture and debris.	Handhole cover is moderately damaged or missing fasteners. Handhole attachment to pole may have moderate deficiencies. Moisture and debris may be present inside the pole creating moderate corrosion and/or section loss of material.	Handhole cover is missing or majorly damaged. Handhole attachment to pole is failing. Moisture or debris inside the pole is creating major corrosion and/or section loss of material.
Impact Damage	No damage caused by vehicular impact.	The element has minor damage caused by vehicular impact.	The element has moderate damage caused by vehicular impact.	Impact damage is major and affects the integrity of the structure.

Elements 22203 – Pole Splice Connections

Description	This element consists of the splices to support sections of vertical support columns on an HMLT.			
Quantity Calculation	The quantity is collected as each splice.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Pole Splice connection defects	New or like-new condition with no deficiencies.	Minor surface corrosion or superficial damage may be present.	Moderate corrosion/ section loss or wear is present but splice is functioning as intended.	Major corrosion/section loss is present. Protective coatings are failing. Members may have weld cracks ordefects.

Elements 22204 – Lighting Array and Lowering Device

Description	This element consists of the lighting array and associated lowering device which supports luminaires on HMLT.			
Quantity Calculation	The quantity is collected as each array. A single rating is anticipated.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Lighting Array and Lowering Device Defects	No evidence of corrosion, loose, or damaged component. No imbalance or misalignment of structure. Hardware components are sound and function as intended.	Minor corrosion, coating loss, loose, or damaged component may be present. Minor element imbalance or misalignment may be visible. Any minor defect present does not affect serviceability and/or function of structure.	Moderate corrosion, loose, or damaged component may be present. Major element imbalance or misalignment may be visible. Any defect present does not significantly affect serviceability and/or function of structure.	Major corrosion, loose, missing, or damaged component may be present. Major element imbalance or misalignment may be visible. Element conditions have majorly affected the serviceability or integrity of the structure.