9 MAST ARM

9.1 Definitions

Mast Arms are steel pole structures with one or more horizontal mast arm(s) used to support signals, luminaries, signs, cameras, and other appurtenances. The steel pole is supported on a drilled shaft concrete foundation with anchor bolts.

Other common terms which may be used when discussing Mast Arms include:

- *Mast:* The steel pole, or mast, is supported on a drilled shaft concrete foundation with either four or six anchor bolts, with six anchor bolts specified in the current MDOT standards. Beside mast arms supporting signals and signs, these structures may also have cantilevered arms supporting luminaires, cameras, or other appurtenances. Mast arms are designed with varying levels of resistance to fatigue, and as such may be labeled either Category I, II, or III.
- *Category I mast arms:* Largest Mast Arm structures designed for an “infinite” fatigue life. This means the structures’ details are subjected to stress ranges below which a particular fatigue detail can withstand an infinite number of repetitions without fatigue failure.
- *Category II and III mast arms*: Mast arm structures which may have finite fatigue lives.

Figure 9-1: MDOT Category I Mast Arm, note previous design in background before removal

Figure 9-2: MDOT Category II Mast Arm

Figure 9-3: MDOT Category III Mast Arm

9.1.1 INVENTORY ITEMS

Inspectors shall identify the pole and foundation material types. A mast arm is typically constructed of steel and may have a round cross-section or multi-sided. If the pole is steel, determine the type of coating – paint, galvanizing, or uncoated. All mast arms should be constructed on a concrete drilled shaft foundation with an elevated base plate connected to the concrete foundation with four or six anchor bolts. The mast arm may support a variety of attachments, both directly and indirectly, including luminaires and luminaire arms, signs, signals, cameras, and other miscellaneous attachments. The quantity and type of connections of these attachments to the structure should be noted. The types of connections may include direct bolting, bands, clamps, or brackets. Non-structural

attachments, such as signs, signals, and cameras, receive ratings under Miscellaneous Arm, Bracket, and Attachment and should be reported appropriately if they pose a safety risk. The connections of these attachments to the structure are rated. Also, note the presence of any secondary support elements of the pole.

The inspector shall 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 pole.

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 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 9.2.2.

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

9.1.2 ELEMENTS

Mast Arms are divided into three components: Foundation, Vertical Structure, and Horizontal Structure.

Foundation is further divided into elements: Concrete Foundation and Anchor Bolts and Leveling Nuts.

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

Horizontal Structure is further divided into elements: Mast Arm Member, Mast Arm Splice Connection, Mast Arm Attachment Connections, Luminaire and Luminaire Arm, and Miscellaneous Arm, Bracket, and Attachment.

The following guidelines for consistent location notation provide the framework for rating a sign element in accordance with the condition rating tables.

- Vertical Structure Locations – Distress locations along the cantilevered vertical support are referenced by using offsets measured from the base plate as measured in feet and prominent features (e.g., pole mounted cabinet).
- Horizontal Element Locations – Distress locations along the mast arm length are referenced by using offsets measured from the vertical support end.
- Attachments on Mast Arm Members – Attachments are identified in relationship to directionality (e.g., North/South, East/West, Right End/Left End looking at front of signal or sign, or Right/Left looking upstation or downstation).
- Other – When possible, identify other elements in relation to the defined elements above. Otherwise, photograph location and document distress. Annotate drawings and photos as necessary.

Table 9-1: Mast Arm Components and Elements

Component	Element	Element Code	Unit of Measure
Foundation	Concrete Foundation	19101	Each
Foundation	Anchor Bolts and Leveling Nuts	19102	Each bolt and nut unit
Vertical Structure	Base Plate	19201	Each
Vertical Structure	Vertical Support Column (Upright)	19202	Length, feet
Vertical Structure	Vertical Structure Connections	19203	Each
Horizontal Structure	Mast Arm Member	19301	Length, feet
Horizontal Structure	Mast Arm Splice Connection	19302	Each
Horizontal Structure	Mast Arm Attachment Connections	19303	Each
Horizontal Structure	Luminaire and Luminaire Arm	19304	Each
Horizontal Structure	Miscellaneous Arm, Bracket, and Attachment	19305	Each

9.1.3 COMPONENTS

Mast Arms are divided into three main components: Foundation, Vertical Structure, and Horizontal Structure.

Component ratings for mast arms are based on the following:

- ***Foundation*** – Consider the structure's foundation effect on overall stability of the traffic signal mast arm structure.
- ***Vertical Structure*** – Consider if the vertical structure may have damage that compromises the structural capacity such as fractures, significant twisting or kinking, impact damage, corrosion, section loss, or stress cracks in the metal.
- ***Horizontal Structure*** – Consider fractures in welds or base metal, corrosion, section loss, as critical to the overall horizontal structure.

A representation of the rating structure for Mast Arms is provided in Figure 9-4.

Figure 9-4: Rating structure for Mast Arms

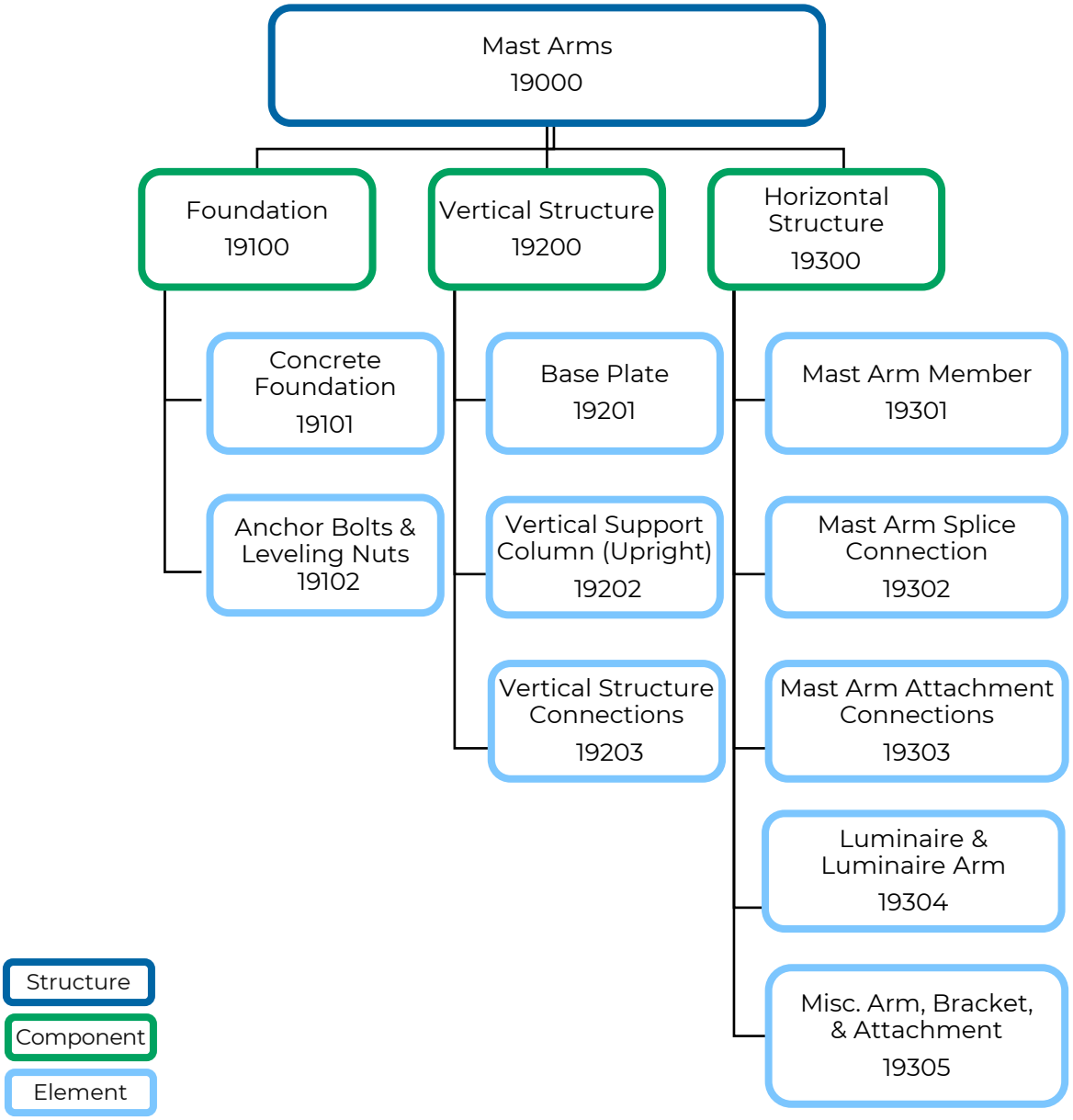
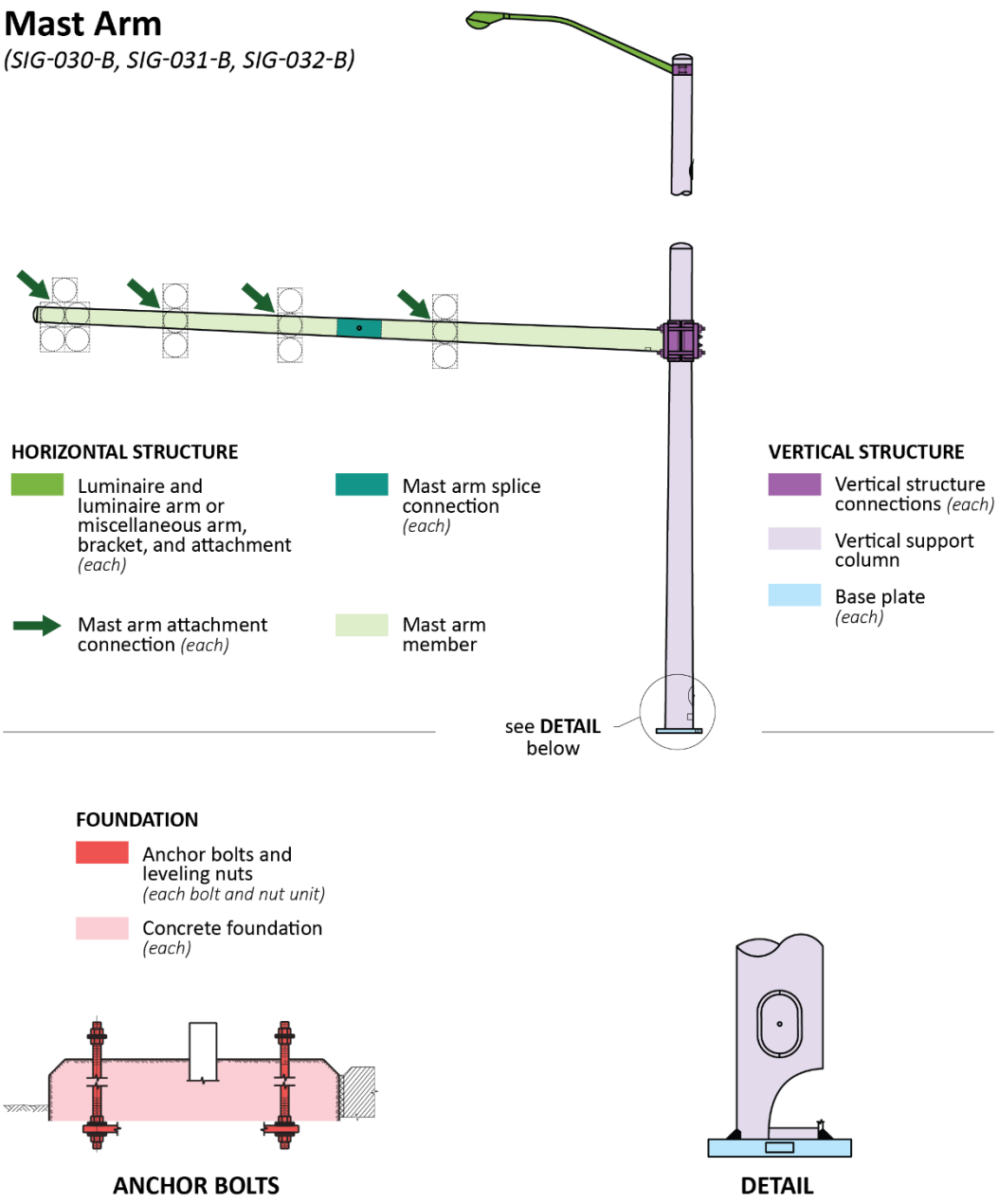


Figure 9-5: Elements and components for Mast Arm



9.2 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 9-2*.

Mast Arm Required Photos:

- General view of the entire structure
- Each foundation
- Each vertical-to-horizontal connection
- Structure number stenciled on support

- Luminaire and Luminaire Arm
- Mast Arm Attachments

Table 9-2: Mast Arm Photograph Naming Convention

Photo Name	Description
MastArm_Entire	Entire Mast Arm structure
MastArm_Foundation	Foundation
MastArm_VH_Connection	Vert-Horiz Connection
MastArm_Lum	Luminaire and Luminaire Arm
MastArm_ID	Old ID and New ID
MastArm_Attachment Name	Replace “Attachment Name” with attachment or appurtenance (e.g., sensor, camera, etc.)

9.3 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 20 structures total inspecting Mast Arms or other truss structures. Multiple structure types shall have been inspected as part of the total project experience. Bolt inspection on cantilever or truss structures or other ancillary structure types is required 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
- 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
- MDOT structural bolting workshop for initial field installation verification
- Magnetic Particle Test (MT) – If a follow-up MT inspection is required for verification, then ASNT Level II (or per TC-1A) MT certified Level II is required
- Dye Penetrant Test (PT) – If a follow-up PT inspection is required for verification, then ASNT Level II (or per TC-1A) PT certified Level II is required

9.4 Routine Inspection

Mast Arms are also referred to as traffic signal mast arms. They serve a similar role to steel strain poles, supporting traffic signals along with signs, luminaires, and other

appurtenances. Damage or deterioration of mast arm structures may impact function or safety.

In most cases, mast arms are placed at intersections. They are supported on drilled shaft foundations and connected to the foundations with either four or six anchor bolts.

Mast Arm 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.

Table 9-3 provides guidance for inspecting reinforced and prestressed concrete cracking.

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.

Table 9-3: 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)

9.4.1 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. If safety concerns such as significant erosion, settlement or lateral displacement are noted, initiate an RFA. The routine inspection is performed on a regularly scheduled basis with frequency determined by AS type and includes the foundation component rating as determined by the element condition ratings of the concrete foundation and steel anchor bolts and nuts. It 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:

- Check around the foundation for erosion or soil displacement, and for any voids between concrete and soil.

- If sidewalk or other material covers the material surrounding the foundation check for signs of separation, settlement, or cracking at the surface.
- Check for signs of vehicle impact that may have damaged the foundation concrete or the anchor bolts.
- Inspect the foundation concrete for cracking, spalling, delamination, or other defects measuring sizes or quantities. Pay particular attention to the condition of the concrete immediately around the anchor bolts.
- Measure the anchor bolt standoff distance and check for any damage or corrosion of the bolts and nuts.
- Inspect the anchor bolt connections to the base plate. Note if any of the anchor bolts are out of vertical alignment and if any of the nuts have anything less than full bearing.
- Sound the anchor bolts and nuts to check for looseness. Note if any washers are missing or incorrectly sized.
- Perform ultrasonic testing of the anchor bolts to note any breaks, verify lengths, and repair galvanizing afterwards.
- Rate Component.
- Rate Elements.
- Provide photographs for all Poor or Severe condition state defects and submit the applicable Work Recs or RFAs.

9.4.1.1 Foundation Component Ratings

The mast arm's foundation overall characteristics are rated on its structural condition, ability to support the vertical structure, and possible negative impact to the entire structure, its operation, or the adjacent roadway. The foundation concrete, anchor bolts, and anchor bolt connection to the pole base plate are all considered as part of the component rating. When evaluating distresses consider that different distresses and the location on the foundation at which they occur are not of equal importance to the pole's function. The predominant characteristic determining overall condition is stability. Consider if the foundation has stable support from the soil, solid and durable concrete, and securely fastened anchor bolt connections.

Table 9-4: Component Rating Guidelines for Mast Arm Foundations

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	Minor damage or worn galvanizing of anchor bolt connections.
		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	Less than 25% loss of section. Fasteners may be considerably deteriorated.
		All	Considerable deterioration or misalignment affecting structural members. Considerable impact damage. 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 pole and embedment material.
		Steel	Protective coating failure affecting more than 10% of the surface area with Measurable loss of section in excess of 25%. Missing, cracked, or broken fasteners that do not warrant a structural review.
		All	Considerable deterioration or damage affecting structural members. Structural evaluation, hydraulic, and/or load analysis

Component Rating	Condition	Material	Description
			may be is necessary to determine if the structure can continue to function without immediate 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.

9.4.1.2 Concrete Foundation Element Condition States

Inspectors shall start by inspecting the condition of the soil around the foundation noting any erosion or settlement that could impact the foundation. A gap between the foundation and adjacent soil may indicate foundation movement. Inspect the concrete for cracking, spalling, and delamination noting the quantities and locations. Check for exposed or corroded reinforcing steel. Pay special attention to the concrete immediately surrounding the anchor bolts. Older foundations may be square in shape while current standards specify a circular drilled shaft. Look for signs of impact damage.

Figure 9-6: Six anchor bolt concrete foundation

Table 9-5: Mast Arm Concrete Foundations Element Distresses

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.

Element Number	Element	Description	Associated Distresses
19101	Concrete Foundation	Mast arm pole foundations	Cracking
			Spalling, delamination, and patching
			Exposed rebar
			Embedment erosion
			Impact damage

Details on the condition state rating schema are in Section 9.7, linked below:

Mast Arm Condition State Tables

9.4.1.3 Anchor Bolts and Leveling Nuts Element Condition States

The anchor bolt connection is a key element of the mast arm structure and frequent location of deficiencies. The anchor bolts should be plumb with all nuts tightly affixed to the base plate and the center of the connection should be centered on the foundation. The standoff distance is the distance from the bottom of the leveling nuts and the top of the concrete 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 9-7: Standoff measurement for a sound foundation (left) and standoff measurement with foundation concrete deterioration (right)

Flat washers should be placed between each nut and the base plate and completely cover the holes in the base plate. All washers and nuts should bear fully around their perimeter. Anchor bolts for a mast arm are pre-tensioned, meaning the nuts are tightened to produce a prescribed tension between the top nut and leveling nut at installation. This tension exceeds the stress that they would see under in-service loads and therefore prevents loosening and improves fatigue performance. Ultrasonic testing and sounding of the anchor bolts are required for all mast arm anchor bolts. The procedure is referenced in Section 9.4.4.

The top nuts shall be fully engaged on the anchor bolt, which means the top of the anchor bolt is flush or higher than the top of the nut. Inspect the connection for any signs of impact damage, including bent anchor bolts or damaged threads. Inspect the galvanizing of all components and note corrosion. Nut covers may be present covering the top nuts of the connection. These were used to protect the connection but are a detriment as they retain moisture and debris and can accelerate corrosion; they are no longer permitted.

Table 9-6: Mast Arm Anchor Bolt and Leveling Nuts Element Distresses

Unit of Measure: Each, note quantity of anchor bolt and nut units within each condition state

Element Number	Element	Description	Associated Distresses
19102	Anchor Bolts and Leveling Nuts	Anchor bolts and leveling nuts	Corrosion or coating damage
			Loose or missing anchor nut
			Cracked bolt
			Standoff distance
			Impact damage

Details on the condition state rating schema are in Section 9.7, linked below:

Mast Arm Condition State Tables

Figure 9-8: Four anchor bolt foundation with excessive standoff distance and corrosion

9.4.2 VERTICAL STRUCTURE ROUTINE INSPECTION

Routine inspection of the vertical structure is conducted from the ground and a bucket truck as needed to inspect the pole and pole connections. All elements of the component shall be visually inspected at an arm's length distance to determine the overall condition and detect deficiencies.

- Inspect the base plate and welds for cracks, deficiencies, and corrosion. Note and measure any warping or deformations of the base plate.
- Inspect the vertical alignment of the pole with a 4 ft level or similar. Note that some poles may be tapered and checking at several points around the perimeter at the same elevation may be necessary to obtain the complete picture of any misalignment.
- Inspect the protective coating – galvanizing, powder coated, and/or paint and note any corrosion or section loss.
- An ultrasonic testing device or thickness gauge should be used to verify the wall thickness when significant corrosion is present.
- Check for any cracks or deformations in the steel noting the size of deficiencies.
- Verify the handhole cover is securely fastened in place and check for cracks around the frame of the handhole.
- Check for signs of vehicle impact damage noting that impact in one location may affect the structure in other locations as well.
- Inspect the connection to the pole of the horizontal structure – mast arms, luminaire arms, and other arms. This includes band clamps, brackets, and other bolted

assemblies. Check for connections that are loose, missing, deteriorated or otherwise deficient.

- Pay particular attention to the mast arm connections to the pole: Inspect the tightness of bolts and look for gaps. Check welds in the connections for any cracks or deficiencies. Check for any signs of slippage in the connections which may be evidenced by damage to the protective coating.
- Provide photographs for all Poor or Severe condition state defects and submit the applicable Work Recs or RFAs.

9.4.2.1 Vertical Structure Component Ratings

The mast arm's vertical structure overall characteristics are rated on its structural condition, ability to support the horizontal structure, and possible negative impact to the entire structure, its operation, or the adjacent roadway. The base plate and base plate to pole connection, pole structure, and connections to the pole are all considered as part of the component rating. When evaluating distresses consider that different distresses and the location on the structure at which they occur are not of equal importance to the pole's function. The predominant characteristics determining overall condition are stability and resiliency. Consider if the pole has stable support in the embedment material, a robust and consistent pole cross-section, and the horizontal structure is securely fastened.

Table 9-7: Component Rating Guidelines for Mast Arm 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 of protective components and/or dirt contamination of structural components.
7	**GOOD**	Concrete	Insignificant cracks or moderate cracks that are sealed.
		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.

Component Rating	Condition	Material	Description
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. Cracks may be present. Welded connection deficiencies may be present. Fasteners may be loose, missing, or considerably deteriorated. Considerable impact damage.
		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 pole and embedment material.
		Steel	Measurable loss of section in excess of 25%. Extensive welded connection deficiencies may be present. Missing or broken fasteners or extensive cracking in pole.
		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

Component Rating	Condition	Material	Description
			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 condition. Notify Region and the Bureau of Bridges and Structures.

9.4.2.2 Base Plate Element Condition States

The base plate is part of the anchor bolt connection but is connected to the pole with a full penetration weld and considered part of the vertical structure along with the pole and its vertical structure connections. The base plate should be checked for warping, and corrosion. Pay particular attention to the weld between the base plate and pole and look for any cracks or weld deficiencies. A crack will typically appear in the galvanizing and may or may not extend into the weld metal. Additional non-destructive testing may be required to determine the extent of any cracks.

Figure 9-9: Mast arm base plate with four anchor bolts

Table 9-8: Mast Arm Base Plate Element Distresses

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

Element Number	Element	Description	Associated Distresses
19201	Base Plate	Base plate for mast arm	Corrosion or coating damage
			Weld defect or crack

Details on the condition state rating schema are in Section 9.7, linked below:

Mast Arm Condition State Tables

9.4.2.3 Vertical Support Column (Upright) Element Condition States

Mast arm poles are typically 30 ft in length and may be round or multi-sided. The poles should be checked for any vertical misalignment with a 4 ft level or similar, keeping in mind that poles may be tapered and multiple checks around the perimeter of the pole may be necessary. A hand hole is located near the base of the pole to allow for access to electrical components and there are typically additional electrical entry and exit ports higher on the pole. The handhole should be free from excess moisture and debris. The handhole 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 poles are hot dip galvanized and may have a single or multi-coat paint system on top of the galvanizing for aesthetic treatment. Any corrosion should be noted and if there is significant corrosion, the pole wall thickness should be checked for section loss with a thickness gauge or ultrasonic testing device. Inspect the length of the pole for impact damage and cracks and note that multi-sided poles have a longitudinal weld the length of the pole.

Figure 9-10: Mast arm impact damage and coatings repair

Table 9-9: Mast Arm Vertical Support Column (Upright) Element Distresses

Unit of Measure: Length, feet of vertical support within each condition state

Element Number	Element	Description	Associated Distresses
19202	Vertical Support Column (Upright)	Vertical Support (Upright) for mast arm	Corrosion or coating damage
			Weld defect or crack
			Out of plumb

Details on the condition state rating schema are in Section 9.7, linked below:

Mast Arm Condition State Tables

9.4.2.4 Vertical Structure Connections Element Condition States

For the vertical structure connections element consider all connections to the pole structure. There are several different types of connections that may be present. The primary connections to inspect are the mast arm member to pole connections. There may also be connections for luminaire arms or other arms supporting cameras or other miscellaneous attachments or appurtenances. In general, any steel portions of a connection should be securely in place, and free of corrosion, excess wear, missing pieces, cracks, or other deterioration. For attachments like cabinets and sensors the steel straps connecting the attachments directly to the pole are rated, and if they are failing or in some way pose a safety risk they should be noted.

Mast arm members are usually connected to the pole with saddle clamps. The two halves of the clamps are tightened against the pole with bolting assemblies on either side. Additional bolts connect the back of the clamp through the pole wall. The saddle clamp connections are reinforced with several gusset plates and associated welds Consider the typical steel deterioration modes and inspect the clamps for any distortion, cracks, or weld deficiencies. Luminaire arms or other miscellaneous arms (for cameras or other sensors) used to connect attachments to the pole may use bracket assemblies or other types of steel connections. Consider the typical steel and fastener deterioration modes for these connections.

Figure 9-11: Mast arm to pole vertical structure connection, saddle clamp type

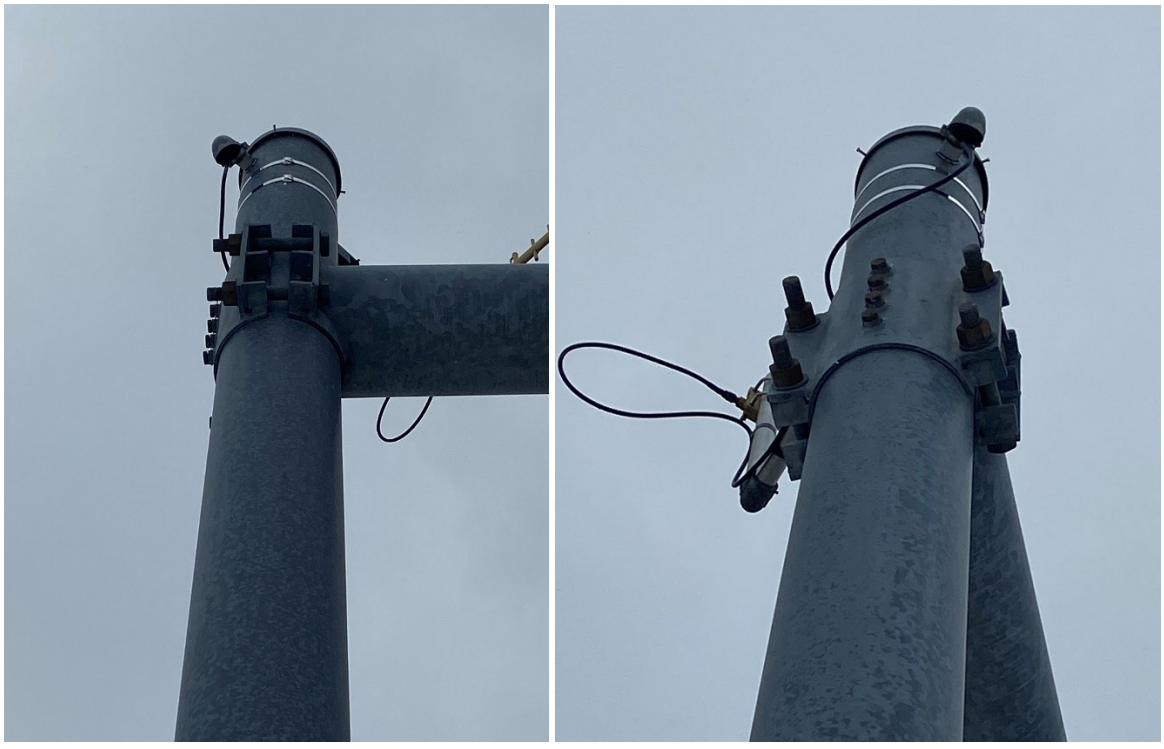


Figure 9-12: Mast arm to pole vertical structure connection, welded box type

Figure 9-13: Mast arm vertical structure connection, note missing vertical weld on gusset plate

Table 9-10: Mast Arm Vertical Structure Connection Element Distresses

Element Number	Element	Description	Associated Distresses
19203	Vertical Structure Connection	Bracket assemblies, pole band clamps, stainless steel straps, through bolts, or other connections to mast arms	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 9.7, linked below:

Mast Arm Condition State Tables

9.4.3 HORIZONTAL STRUCTURE ROUTINE INSPECTION

Routine inspection of the horizontal structure is conducted from the ground or using a bucket truck. Inspectors shall:

- Inspect the vertical clearance of the horizontal structure and its attachments, the alignment, and the operational function.
- Check for corrosion or section loss on the mast arms or any other portions of the horizontal structure.
- Inspect arms for any cracked welds or other deterioration.
- Inspect mast arm splices for any signs of displacement or deterioration. Verify splice connections are securely fastened. Verify slip connections are secure and do not have any cracks.
- Check signals and other attachments to the horizontal structure for connections that are loose, missing, deteriorated or otherwise deficient.
- Provide photographs for all Poor or Severe condition state defects and submit the applicable Work Recs or RFAs.

9.4.3.1 Horizontal Structure Component Ratings

The mast arm's horizontal structure overall characteristics are rated on its structural condition, ability to support the connected attachments, and possible negative impact to the structure's operation and the roadway below. The mast arm members, other arms, and the attachment connections to them, in addition to the internal arm splice connections are all considered as part of the component rating. When evaluating distresses consider that different distresses and the location on the structure at which they occur are not of equal importance to the horizontal structure's function. The predominant characteristic determining overall condition is resiliency. Consider if the mast arm members have a robust and consistent cross-section, the internal connections are secure, and the attachments are securely connected.

Table 9-11: Component Rating Guidelines for Mast Arm Horizontal 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 of protective components and/or dirt contamination of structural components.
7	GOOD	Concrete	Insignificant cracks or moderate cracks that are sealed.
		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.
		Steel	Pole protective coating failures is limited to less than 10% of the surface area with no loss of section. Surface corrosion with no section loss attachment connections.
		All	Minor deterioration affecting structural components.
5	FAIR	Concrete	Moderate delamination or spalling.
		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.
		Steel	Up to 25% loss of section. Welded connection deficiencies may be present. Mast arm may be misaligned, or attachments may have less than 17 ft of vertical clearance. Fasteners may be considerably deteriorated.
		All	Considerable deterioration affecting structural members. Structural review may be warranted.
3	SERIOUS	Concrete	Extensive cracking and spalling.
		Steel	Section loss in excess of 25%. Extensive welded connection deficiencies may be present.

Component Rating	Condition	Material	Description
			Missing or broken fasteners or excess displacement of mast arm.
		All	Considerable deterioration or damage affecting structural members. Structural evaluation, is necessary to determine if the structure can continue to function without immediate 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.

9.4.3.2 Mast Arm Member Element Condition States

Mast arm members are typically 20-50 ft in length and may be constructed of several sections spliced together. Some mast arm structures may have multiple arms. For the mast arm member element condition consider the alignment of the arms and their structural and material conditions. Alignment is checked visually and any excess deflection, or rotation of the arm should be noted. Check for excess movement under wind loading. The alignment can be deceptive so make sure to check from multiple angles. Check the arm for missing arm cap, any impact damage or other deformation and cracking. Inspect the coating, which may be hot dip galvanizing or hot dip galvanizing covered in paint for deterioration and corrosion. Any attachment connected to the mast arm member should have a minimum vertical clearance to the top of pavement of 17 ft. While this may not be able to be measured, note and report any vertical clearance that looks out of the ordinary.

Figure 9-14: Mast arm structure with single arm

Table 9-12: Mast Arm Member Element Distresses

Element Number	Element	Description	Associated Distresses
19301	Mast Arm Member	Inboard and outboard arm sections of a traffic signal mast arm	Corrosion or coating damage
			Weld defect or crack
			Impact damage
			Misalignment
			Missing arm cap
Unit of Measure: Each mast arm within the condition state			

Details on the condition state rating schema are in Section 9.7, linked below:

Mast Arm Condition State Tables

9.4.3.3 Mast Arm Splice Connection Element Condition States

Many mast arm members contain a telescopic field splice, which may be located at any point along the arm. When referring to the two sections being spliced, the larger diameter arm is called the outboard arm, while the smaller diameter arm being seated inside the outboard arm is called the inboard arm. The field splices should have a horizontally mounted connection bolt securing the two arms together. Inspect the splice for any wear, corrosion, cracking, or damage and make sure the connection bolt is securely in place.

Figure 9-15: Mast arm member splice with connection bolt

Table 9-13: Mast Arm Splice Connection Element Distresses

Element Number	Element	Description	Associated Distresses
19302	Mast Arm Splice Connection	Field splices, splice bolts	Corrosion or coating damage
			Cracking
			Impact damage
			Missing or loose bolt

Unit of Measure: Each connection within the condition state

Details on the condition state rating schema are in Section 9.7, linked below:

Mast Arm Condition State Tables

9.4.3.4 Mast Arm Attachment Connections Element Condition States

Attachments connected to the mast arm member include signals, signs, cameras, sensors, or other appurtenances. The attachments may be connected using various brackets and fixtures which may be welded or bolted. Consider the typical steel and fastener deterioration modes for these connections: loose connections, wear, corrosion, cracking, and deformation. The signals, signs, and appurtenances themselves are rated and if there is noticeable deterioration that could impact safety, it should be reported.

Figure 9-16: Mast arm signal and sign attachment connections

Table 9-14: Mast Arm Attachment Connections Element Distresses

Element Number	Element	Description	Associated Distresses
19303	Mast Arm Attachment Connections	Signal head hangers, case sign attachments, camera or other ITS attachment connections	Corrosion or section loss
			Loose, missing, or cracked hardware
			Deformed or worn parts
Unit of Measure: Each connection quantity within the condition state			

Details on the condition state rating schema are in Section 9.7, linked below:

Mast Arm Condition State Tables

9.4.3.5 Luminaire and Luminaire Arm Connections Element Condition States

Luminaires are usually mounted on a luminaire arm but may also be mounted directly on the pole or using some other pole mounting device. The arms are typically the single member type. Note that the bracket assembly or band clamps or other method of attaching the luminaire arm to the pole is considered part of the vertical structure connections element. The arms should be inspected for steel condition and the condition of any welds. The condition of the luminaire connection to the arm mounting device should be inspected for material defects and connection type defects such as looseness and wear. The luminaire itself includes the light source, any fixtures or assemblies, and the housing. Note any visibly broken portions of the luminaire.

Figure 9-17: Mast arm structure supporting signals, sign, luminaire, camera, and sensor

Table 9-15: Mast Arm Luminaire and Luminaire Arm Element Distresses

Element Number	Element	Description	Associated Distresses
19304	Luminaire and Luminaire Arm	Lighting sources, fixtures and assemblies, bracket arms, truss arms, tenon mounts, shepherds crooks, or other pole mounting devices	Broken lighting source or assembly
			Damaged or cracked housing, cover
			Corrosion or section loss
			Weld cracks/defects
			Deteriorated gasket/seal
Unit of Measure: Each luminaire and luminaire arm within the condition state			

Details on the condition state rating schema are in Section 9.7, linked below:

Mast Arm Condition State Tables

9.4.3.6 Miscellaneous Arm, Bracket, and Attachment Element Condition States

Attachments or appurtenances may be mounted on a bracket or arm but may also be mounted directly on the pole, the mast arm, on a tenon, or using some other pole mounting device. The arms may be a single member type or truss type. Note that the bracket assembly or other method of attaching the miscellaneous bracket or arm to the pole is considered part of the vertical structure connections element. The miscellaneous arms, brackets, and attachments should be inspected for steel condition and the condition of any welds. The condition of the attachment connection to the bracket, arm, or tenon

should be inspected for material defects and connection type defects such as looseness and wear. Cameras and other sensors may also be attached to the pole using the same types of arms and connections as luminaires.

Table 9-16: Embedded Pole Miscellaneous Arm, Bracket, and Attachment Element Distresses

Element Number	Element	Description	Associated Distresses
19305	Miscellaneous Arm, Bracket, and Attachment	Power sources, fixtures and assemblies, bracket arms, truss arms, tenon mounts, shepherds crooks, or other pole mounting devices	Broken power source or assembly
			Damaged or cracked housing, cover
			Corrosion or section loss
			Weld cracks/defects
			Deteriorated gasket/seal
Unit of Measure: Each miscellaneous arm, bracket, and attachment within the condition state			

Details on the condition state rating schema are in Section 9.7, linked below:

Mast Arm Condition State Tables

9.4.4 REFERENCES

MDOT Mast Arm Installation Inspection Procedure, describing UT and Sounding Testing

MDOT Traffic and Safety Standards and Special Details

SIG-030-series Traffic Signal Mast Arm Pole and Mast Arm Details – Category I

SIG-031-series Traffic Signal Mast Arm Pole and Mast Arm Details – Category II

SIG-032-series Traffic Signal Mast Arm Pole and Mast Arm Details – Category III

SIG-040-series Traffic Signal Mast Arm Standard Foundations

SIG-301-series Mast Arm Mounted T.S. Bracket Assembly

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

9.5 Work Recommendation Guidance

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 9-17: Work Recommendations for Mast Arms

Number	Description of Work Recommendation	Material involved	Quantity/Unit of Measure
1	Repair guardrail (protecting pole)	Galvanized Steel	Linear feet
2	Correct erosion at foundation (prevent undermining)	Stone/Soil	Cubic feet
3	Repair/monitor foundation	Concrete	Cubic feet
4	Repair/replace handhole cover	Galvanized Steel	Each cover
5	Remove non-MDOT or unauthorized attachments to structures	Various	Each item
6	Remove graffiti	n/a	Square foot
7	Repair galvanizing	Galvanic Paint	Square inch
8	Repair protective coatings system	Metal Coatings System	Square foot
9	Tighten leveling nut	Galvanized Steel	Each nut
10	Address loose bolts	Galvanized Steel	Each bolt
11	Weld repair	Steel	Each weld
12	Replace mast arm	Galvanized Steel	Each mast arm
13	Replace mast arm splice bolt	Galvanized Steel	Each bolt
14	Replace mast arm attachment connection	Galvanized Steel	Each attachment connection
15	Replace end cap	Galvanized Steel	Each cap
16	Replace end cap bolt	Galvanized Steel	Each bolt
17	Replace connectors such as clevis pins or other	Galvanized Steel	Each connector
18	Replace luminaire	Various	Each luminaire
19	Replace luminaire arm	Galvanized Steel	Each attachment
20	Replace luminaire arm clamp	Galvanized Steel	Each clamp
21	Replace bracket assembly	Galvanized Steel	Each assembly
22	Replace signal head	Various	Each signal head

Number	Description of Work Recommendation	Material involved	Quantity/Unit of Measure
23	Replace case sign	Various	Each sign
24	Replace misc. attachment	Various	Each attachment
25	Replace miscellaneous arm or bracket	Various	Each arm or bracket
26	Replace fatigue mitigation device	Various	Each device
99	Other		

9.6 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, and significant section loss of steel reinforcement

b. Ultrasonic test failure of an anchor bolt

c. Major soil erosion or undermining of the foundation element(s) evidenced by lateral displacement or vertical out of plumb alignment

d. Major section loss due to corrosion which impacts the capacity or short-term resiliency of the structure

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

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

g. Multiple loose or missing bolts in a high strength bolted connection or in attachment connection assemblies

h. Loose or missing nut at 1 anchor bolt on a 4-bolt foundation or 2 or more anchor bolts on a 6-bolt foundation.

i. Multiple loose or missing bolts where connections do not have load-path redundancy and bolt tensioning is not possible

j. Major cracks present in the base metal or weld(s) on the base plate to column connection or for single column supports or the column to mast arm connection

k. Cracked or failing tenon/bracket assembly/luminaire or miscellaneous attachment mounting device

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

m. Major cracking or failing splice connection in a mast arm

n. 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. Pole is significantly out of vertical alignment
d. Significant base plate distortion or section loss around anchor bolts
e. Standoff distance more than twice the bolt diameter where no bending of anchor bolts is evident
f. Anchor nuts are engaged with some gaps and/or bolts are misaligned
g. Loose bolts in a high strength bolted connection or in attachment connection assemblies where there is acceptable load-path redundancy, but significant impact to capacity or durability
h. Loose or missing nut at 1 anchor bolt on a 6-bolt foundation
i. Loose or missing hardware or miscellaneous attachment, significant section loss, or displacement of a mast arm field splice
j. Significant corrosion of primary elements or connections is present
k. 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
l. Structural cracks in secondary members that could potentially propagate through welded connections into main members
m. Significantly loose or misaligned tenon/bracket assembly/luminaire mounting device
n. 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
c. Pole is moderately out of vertical alignment
d. Moderate corrosion of primary elements or connections is present
e. Moderate base plate distortion or section loss around anchor bolts
f. Standoff distance more than one bolt diameter but less than two bolt diameters with no bending of anchor bolts
g. Misaligned tenon/bracket assembly/luminaire mounting device
h. Moderate weld deficiencies, which do not meet code but do not impact function where significant redundancy is also present

i. Loose connections where there is adequate redundancy and moderate impact to structural capacity or durability

j. Moderate structural damage to foundation, anchor bolts, upright, or other elements, which moderately impacts capacity or function, clearance, safety, or durability of the structure

9.7 Element Condition States

Element Number	Element	Condition States Defects Note	Link to Discussion in Section 9
19101	Concrete Foundation	Use the appropriate condition state table	Concrete Foundation Element Condition States
19102	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
19201	Base Plate	Use the appropriate condition state table	Base Plate Element Condition States
19202	Vertical Support Column	Use the appropriate condition state table	Vertical Support Column (Upright) Element Condition States
19203	Vertical Structure Connections	Use the appropriate condition state table	Vertical Structure Connections Element Condition States
19301	Mast Arm Member	Use the appropriate condition state table	Mast Arm Member Element Condition States
19302	Mast Arm Splice Connection	Use the appropriate condition state table	Mast Arm Splice Connection Element Condition States
19303	Mast Arm Attachment Connections	Use the appropriate condition state table	Mast Arm Attachment Connections Element Condition States
19304	Luminaire and Luminaire Arm Connections	Use the appropriate condition state table	Luminaire and Luminaire Arm Connections Element Condition States
19305	Miscellaneous Arm, Bracket, and Attachment	Use the appropriate condition state table	Miscellaneous Arm, Bracket, and Attachment Element Condition States

Element 19101 – Concrete Foundation

Description	This element defines a concrete foundation for a mast arm pole, regardless of foundation type such as drilled shaft or reinforced concrete pile.			
Quantity Calculation	The quantity for this element is measured as “each.”			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Concrete Foundation Defects	The concrete shows no deterioration or damage. 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 shows 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 of section. Embedment erosion or major impact damage is present.

Element 19102 – Anchor Bolts and Leveling Nuts

Description	Anchor bolts and leveling nuts attaching the upright to the foundation.			
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 or damage. The elements are fully engaged, and the sounding test produces a sharp ringing sound. Anchor bolt standoff distance is less than 1”.	Minor corrosion of the elements may be present. The elements are fully engaged and functioning as intended. The sounding test produces a sharp ringing sound. Anchor bolt standoff distance is less than 1”. No	Moderate corrosion/section loss of the elements may be present. Anchor nuts may not be fully tightened. The sounding test produces a dull sound. Anchor bolt standoff distance is greater than 1” but less than two times the bolt diameter. Evidence of minor impact damage may be present	Severe corrosion/section loss of the elements may be present. Nuts are loose/missing. The sounding test produces a dull sound. Anchor bolt standoff distance is greater than two times the bolt diameter. UT testing indicates cracks or breaks in bolts. Evidence of major impact damage may be present.

Description	Anchor bolts and leveling nuts attaching the upright to the foundation.			
Quantity Calculation	The quantity for this element is each anchor bolt and nut unit.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
		evidence of impact damage.		

Element 19201 – Base Plate

Description	Base plate which connects the upright element to the anchor bolt and leveling nut element.			
Quantity Calculation	The quantity for this element is measured as “each.”			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Base Plate Defects	No evidence of active corrosion or weld defect. Surface coating is sound.	Minor surface corrosion may be present. Protective coating failure with no section loss. Base element welds have no evidence of defects.	Moderate corrosion/ section loss 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.

Element 19202 – Vertical Support Column (Upright)

Description	This element is defined by all upright supporting mast arms, regardless of material type or protective coating.			
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.	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. The inside of the pole may contain minor moisture and debris.	Moderate corrosion/ section loss may be present. Protective coatings are failing. Element welds have no evidence of defects and/or cracking. Support may be moderately out 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.
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.
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.

Element 19203 – Vertical Structure Connections

Description	This element consists of the connections along the mast arm for various attachments. Connections may include bracket assemblies, pole band clamps, stainless steel straps, through bolts, or other connections.			
Quantity Calculation	The quantity to be collected includes each connection location.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Vertical Structure Connection Defects	Pole clamps, saddles, bracket assemblies, and other connection hardware are functioning as intended with no evidence of wear or corrosion.	Minor surface corrosion or wear may be present. Pole clamps, saddles, bracket assemblies, and other connection hardware are functioning as intended.	Moderate corrosion/section loss or wear is present. Pole clamps, saddles, bracket assemblies or other connection hardware may be loose, but the conditions do not significantly affect serviceability and/or function.	Major corrosion/section loss is present. Protective coatings are significantly failing. Members may have cracks/defects or major wear. Pole clamps, saddles, bracket assemblies or other connection hardware are loose or failing.

Element 19301 – Mast Arm Member

Description	This element consists of the inboard and outboard arm sections of a traffic signal mast arm.			
Quantity Calculation	The quantity for this element is measured as “each.”			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Mast Arm Member Defects	New or like-new condition with no deficiencies. Arm cap is not missing.	Minor corrosion or superficial damage may be present. Arm cap may be missing. No weld defects or cracks.	Moderate corrosion and section loss or damage is present. Arm cap may be missing. No weld defects or cracks. Arm may be misaligned.	Multiple or major element defects or section loss is present. Arm is excessively misaligned. Major impact damage may be present.

Element 19302 – Mast Arm Splice Connection

Description	This element is defined field splices and splice bolts connecting mast arms.			
Quantity Calculation	The quantity to be collected is the number of spliced connections.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Mast Arm Splice Connection	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. Bolt and splice may be loose or damaged but are functioning as intended.	Major corrosion/section loss is present. Protective coatings are failing. Members may have cracks/defects or major wear. Splice bolt may be missing.

Element 19303 – Mast Arm Attachment Connections

Description	This element is defined by the Signal head hangers, case sign attachments, camera or other ITS attachment connections to the mast arm.			
Quantity Calculation	The quantity to be collected is the number of connections for span wires.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Mast Arm Attachment Connection	New or like-new condition with no deficiencies	Minor corrosion or wear of the elements or superficial damage to the component parts may be present. Hardware is fully engaged. No gaps are present.	Moderate corrosion and section loss or wear/damage is present to one or more component parts. Hardware is fully engaged but gaps may be present. The conditions do not significantly affect serviceability and/or function.	Multiple or major element defects, wear or section loss is present. Gaps are present. Hardware is loose or missing. Major impact damage may be present. Connection is not functioning as intended.

Element 19304 – Luminaire and Luminaire Arm

Description	This element consists of lighting sources, fixtures and assemblies, bracket arms, truss arms, tenon mounts, shepherds crooks, or other pole mounting devices.			
Quantity Calculation	The quantity is collected as each luminaire and luminaire arm unit.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Luminaire and Luminaire Arm	Lighting source, housing/cover, waterproofing-gasket/seal, arm, and connections to pole do not have evident wear or corrosion and are functioning as intended.	Gasket/seal may have minor deterioration. Lighting source, housing/cover, arm, and connections may have minor wear or corrosion.	Gasket/seal may be moderately deteriorated. Lighting source, housing/cover, arm, and connections may have moderate wear or corrosion, but the conditions do not significantly affect serviceability and/or function.	Major deterioration of gasket/seal is present. Lighting assembly or hardware is broken or missing. Major failure of protective coatings with corrosion/pitting/section loss is present. Welds have cracks/defects.

Element 19305 – Miscellaneous Arm, Bracket, and Attachment

Description	This element consists of power sources, fixtures and assemblies, bracket arms, truss arms, tenon mounts, shepherds crooks, or other pole mounting devices.			
Quantity Calculation	The quantity is collected as each miscellaneous arm, bracket, and attachment unit.			
	Condition State Descriptions			
Defect Type	**Good**	**Fair**	**Poor**	**Severe**
Miscellaneous Arm, Bracket, and Attachment	Power source, housing/cover, waterproofing-gasket/seal, and arm do not have evident wear or corrosion.	Gasket/seal may have minor deterioration. Power source, housing/cover, or arm may have minor wear or corrosion.	Gasket/seal may be moderately deteriorated. Power source, housing/cover, or arm have moderate wear or corrosion, but the conditions do not significantly affect serviceability and/or function.	Major deterioration of gasket/seal is present. Assembly or hardware is broken or missing. Major failure of protective coatings with corrosion/pitting/section loss is present. Welds have cracks/defects.