Traffic Signal Specifications Information

This section provides design information that complements and is organized similar to SUDAS Specifications Section 8010.

The information below provides selective guidance on the specifications.

A. Part 1 - General

1. **Submittals:** There are several key submittals required of the contractor following award of the project. These are described below.

   a. **Schedule of Unit Prices:**
      1) **Document:** Prepared by the traffic signal designer and included within the contract documents or provided to the contractor prior to construction.
      2) **Purpose:** Establish unit pricing for change order work if needed. Used to estimate partial payments.
      3) **Includes:** Identification of major traffic signal items along with an estimate of quantity and units of measurement. Two additional blank columns are provided (unit price, and unit extension).
      4) **Contractor Action:** Within 30 days after award, the contractor is required to submit a completed schedule of unit prices to the contracting authority.
      5) **Engineer Action:** Review the schedule in a timely manner. Check the appropriateness of each unit price, the accuracy of each unit extension calculation, and ensure that the grand total for all unit extensions matches the lump sum bid item for traffic signalization.

   b. **Material and Equipment List:**
      1) **Document:** Prepared by the traffic signal designer or contractor.
      2) **Purpose:** Contracting authority approval of materials and equipment for all major traffic signal items.
      3) **Includes:** Identification of major traffic signal items along with an estimate of quantity and units of measurement. Two additional blank columns are provided (manufacturers name and each item's model number).
      4) **Contractor Action:** Within 30 days after award, the contractor is required to submit a completed list of materials and equipment to the contracting authority for approval.
      5) **Engineer Action:** Review the list in a timely manner. Check the appropriateness of each identified manufacturer and model number. Upon acceptance, sign and date the list and provide a copy to the contractor.

   c. **Contractor Certification:**
      1) **Document:** Prepared by the contractor on company letterhead.
      2) **Purpose:** Contracting authority verification of contractor qualifications.
      3) **Includes:** Name, contact information, and certification of the Level II International Municipal Signal Association (IMSA) Certified Traffic Signal Technician(s) working on the project, along with a copy of their IMSA certificate.
      4) **Contractor Action:** Within 30 days after award, the contractor is required to submit the contractor certification to the contracting authority.
      5) **Engineer Action:** Review the appropriateness of the information provided.

d. Shop Drawings:

1) **Document:** Prepared by the traffic signal pole supplier for the contractor.
2) **Purpose:** Contracting authority review of traffic signal poles, supports, and related hardware.
3) **Includes:** Shop drawing information detailing each traffic signal pole, accompanying parts, and necessary hardware.
4) **Contractor Action:** Within 30 days after award, submit shop drawings to the contracting authority for engineer review.
5) **Engineer Action:** Review the shop drawings in a timely manner. Check the appropriateness of each detail. Upon completion of the review, sign/initial and date the shop drawings and provide a copy to the contractor.

e. Catalog Cuts:

1) **Document:** Prepared by the traffic signal equipment supplier for the contractor.
2) **Purpose:** Contracting authority review of all items within the equipment and materials list as well as for supporting components.
3) **Includes:** Catalog cut information detailing the make, model number, manufacturer, and specific details for all traffic signal equipment.
4) **Contractor Action:** Within 30 days after award, submit catalog cuts to the contracting authority for engineer review.
5) **Engineer Action:** Review the catalog cuts in a timely manner. Check the appropriateness of each item. Upon completion of the review, sign/initial and date the catalog cut documents and provide a copy to the contractor.

2. **Measurement and Payment:** Traffic signal work is typically bid as a lump sum item of which no measurements are made. However, partial payments to the contractor are established through measuring or estimating installed quantities and applying these quantities to the appropriate unit price (see Schedule of Unit Prices above).

B. Part 2 - Products

1. **Underground:**

a. Handhole: Handholes are a critical component to traffic signal design. The designer should verify with the jurisdiction how handhole lids are to be labeled and whether cable hooks should be included in handholes (sometimes not included in fiber optic handholes).

Handholes can come in all shapes and sizes (see SUDAS Specifications Figure 8010.103) and must be specified by the Engineer.

The designer should ensure that the contract documents clearly distinguish between handhole types, sizes, and desired locations. Handholes are typically uniquely numbered on the contract documents.

b. Conduit: The SUDAS Specifications allow both steel and flexible conduit. Steel conduit is typically used on all service risers and plastic PVC or HDPE is used at all other locations. A typical signal installation will use a variety of conduit sizes. Some jurisdictions may request a specific color for fiber optic conduit. When connecting HDPE conduit to PVC conduit, the designer should work with the Contractor to clarify the method or materials to be used.

The following is a conduit checklist to consider during signal design:

- Conduit size and cables listed.
- Correct symbol for in-place conduit.
- Correct symbol for proposed conduit.
- Check for conflict with in place underground utilities.
- Check if conduit fill is less than 40%.
- 3 inch minimum typical size conduit under all public traveled roadways.
- Possible spare conduit stub out of controller cabinet for future use, threaded and capped.
- Conduit runs for interconnect should be as straight as possible.
- No PVC above ground (for example: bridge crossings and wood pole systems).
- Size of bends and elbows in conduit according to National Electrical Code or UL guidelines.
- If conduit is suspended under a bridge, does the distance between supports conform to code, is a hanger detail given in plan, and are expansion fittings called for?

An online resource can be found through MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for considering conduit installation and features.

c. Wiring and Cable: Signalized intersections require a variety of standard wires and cables; however, the number, size, and quantity of extra conductors pulled can vary by agency. The designer should include sufficient details to ensure the clear identification of cable runs by conduit. The inspector should make sure all wires are terminated neatly and in an organized fashion. Cables for vehicle and pedestrian signal heads should be continuous from the pole base to the controller cabinet without splices in underground handholes. Video and emergency vehicle preemption cables should be continuous without splices from the unit to the controller cabinet. All plan terminology should be consistent for example:

- Cable callouts/symbols identifying the number of cables and the number and size of conductors (for example 1-12C#14, 2-5C#14, 2-2C#14, 1-1C#6 Ground, 1-1C#10 Tracer, etc.).
- Ped indications with separate 5/C #14 cables.
- Separate 2/C #14 detector lead-in cable for each group of loop detectors.
- Provide spares for future expansion of system, if necessary, and label them.

d. Foundations: Signalized intersections require footings or foundations for all poles, pad-mounted controller cabinets, and other service cabinets such as fiber optic hubs or electrical service panels. Cabinet footing details are shown on SUDAS Specifications Figure 8010.101. The designer should ensure that the plans reflect any desired future use spare conduit stubs out of the foundation.

Foundation size and depths vary according to pole style, mast-arm length, and pole loadings. The SUDAS Specifications provide figures for both pedestal poles and for mast-arm poles (SUDAS Specifications Figure 8010.102). SUDAS standard Type A mast arm pole foundation in soil designs (SUDAS Specifications Figure 8010.102 and Table 13A-5.01) are based on the following guidelines, parameters, and assumptions:

- Broms' method for lateral resistance (moment/shear design) per AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals*, 6th Edition, 2013 (AASHTO LTS-6), with a safety factor of 2.86, which accounts for the possible under capacity of the soil strength (0.7) and the overload factor for the loadings (2.0).
- Alpha method for torsion design per FHWA-NHI-10-016 *Drilled Shafts: Construction Procedures and LRFD Design Methods*, May 2010, with a safety factor of 1.0.

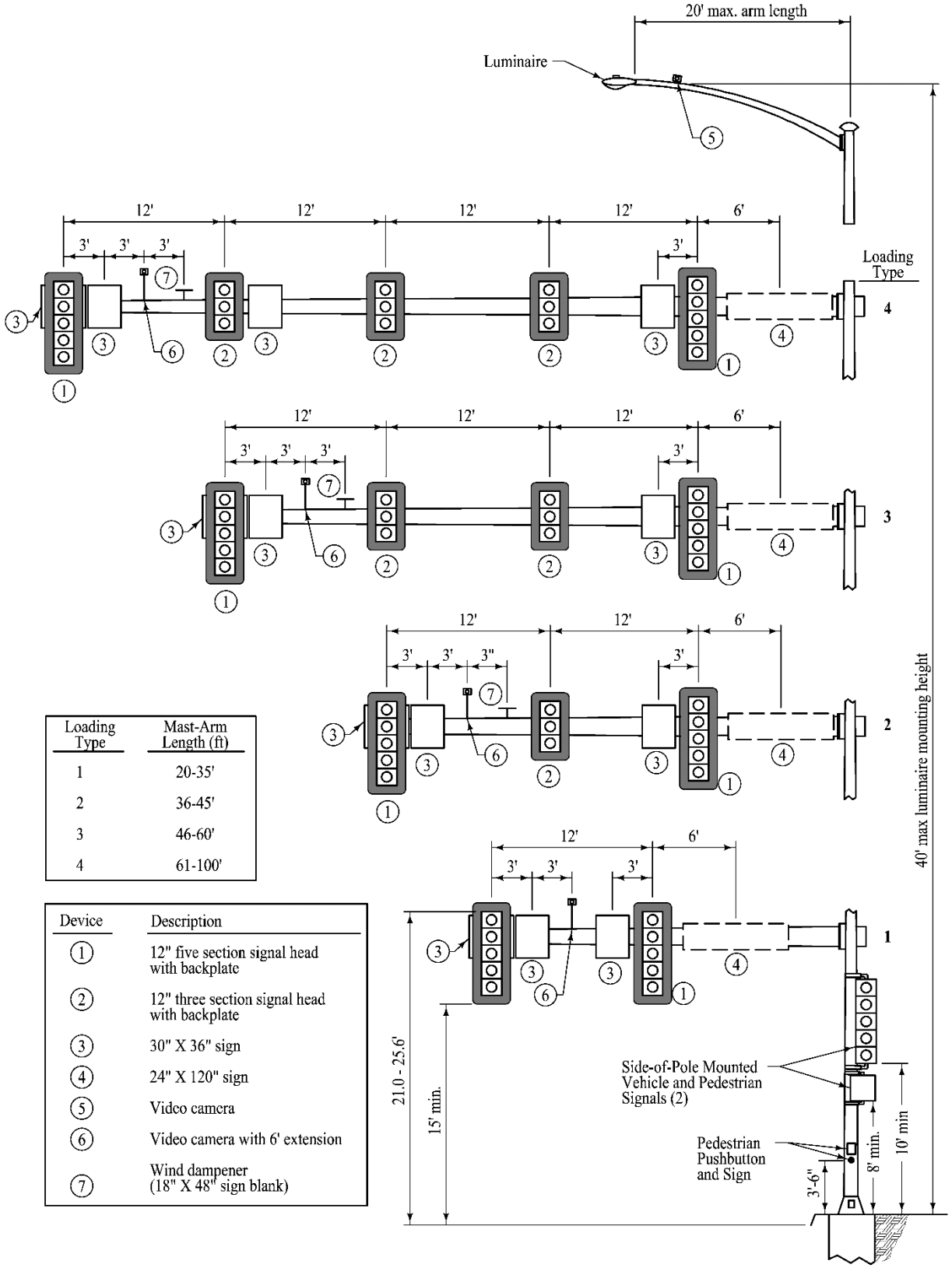
- Disturbed soil due to frost: 2.5 feet for moment/shear design, 5.0 feet for torsion design. Broms' method as presented in AASHTO LTS-6 includes an additional 1.5 diameters of foundation length to be added to the minimum foundation length required. The maximum value of 1.5 diameters or 2.5 feet shall be used when determining the disturbed soil for moment/shear design.
- Groundwater is present for moment/shear and torsion designs.
- Pole loadings as shown in Figure 13A-5.01, with poles designed per AASHTO LTS-6 specifications. Basic wind speed equals 90 mph with a 50 year mean recurrence interval and gust effect factor of 1.14 for strength design. Use Category II for fatigue design. Apply only natural wind gust loads (i.e. do not apply galloping loads, vortex shedding loads, or truck-induced gust loads) for fatigue design. Install vibration mitigation devices on all traffic signal pole mast arms over 60 feet in length as shown in the figures.
- Cohesive soils along the length of the foundation with an average blow count (N60) greater than or equal to 8, which equates to an average unconfined compressive strength (Qu) greater than or equal to 2.0 kips per square foot.
- Reinforced concrete design per AASHTO LTS-6 specifications.

For pole loading conditions greater than shown in Figure 13A-5.01, granular soils, or lower strength soils, special foundation designs will be required. Soil boring testing should be performed prior to construction to verify soil types and strengths if non-typical soils are suspected. If rock is anticipated at the project site and the designer intends to utilize the Type C mast arm pole foundation in rock or a Type B foundation (see SUDAS Specifications Figure 8010.102), determine rock quality through a subsurface investigation completed by a geotechnical engineer licensed in Iowa. If rock is encountered unexpectedly, the contractor may undertake a subsurface evaluation conducted by a geotechnical engineer licensed in Iowa to determine the quality of the rocks encountered. Based on that investigation, the Engineer may approve the use of a Type B or Type C foundation in rock if requested by the contractor.

Table 13A-5.01: Standard Mast Arm Pole Foundation Designs

Loading Type (Figure 13A-5.01)	Maximum Mast Arm Length (feet)
1	35
2	45
3	55
3	60
4	70
4	80
4	90
4	100

Figure 13A-5.01: Mast Arm Pole Loadings for Standard Foundation Designs



Loading Type	Mast-Arm Length (ft)
1	20-35'
2	36-45'
3	46-60'
4	61-100'

Device	Description
1	12" five section signal head with backplate
2	12" three section signal head with backplate
3	30" X 36" sign
4	24" X 120" sign
5	Video camera
6	Video camera with 6' extension
7	Wind dampener (18" X 48" sign blank)

The designer should ensure that foundations:

- Are located in compliance with applicable clear zone requirements (unless breakaway pedestal poles)
- Do not conflict with pedestrian walkways or ramps
- Are at the proper finish grade elevation
- Avoid or minimize conflicts with existing or proposed utilities
- Provide acceptable pedestrian pushbutton locations per MUTCD guidance
- Are located to provide adequate visibility of signal heads

An online resource can be found in MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for foundation types and installation details.

e. Bonding and Grounding: All traffic signal installations must be bonded and grounded according to the National Electrical Code.

Bonding is defined in the Code as the permanent joining of metallic parts required to be electrically connected. In a traffic signal, the term is used to describe the electrical and mechanical connection of conduit, metal poles, cabinets, and service equipment.

Grounding is defined in the Code as a conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conductive body that serves in place of earth.

The designer should ensure that the contract documents include sufficient notation for the traffic signalized intersection to be properly bonded and grounded. This includes placing ground rods at each traffic signal pole and at the controller as well as through use of bonding and grounding jumpers within the handholes.

An online resource can be found in MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for bonding and grounding details.

2. Detection: Detectors provide vehicle and pedestrian inputs to the traffic signal controller. Proper detector installation, operation, and maintenance is critical to the safe and efficient operation of any signalized intersection. An online resource to learn more about detection styles, modes, and typical layouts can be found within MnDOT's Traffic Engineering Manual. Since this document is a PDF, some of the information from this source is provided below.

Detector sizes and locations vary by agency and by location. SUDAS provides standard drawings for typical modified diamond and rectangular detector loops (SUDAS Specifications Figure 8010.104).

An online resource can be found in MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for installation and mounting details.

a. Inductive Loop Vehicle Detector: A common type of vehicle detection device in use today is the inductive loop. This is a loop of wire imbedded in the pavement (saw cut in existing concrete or NMC loop in new concrete) carrying a small electrical current. When a large mass of ferrous metal passes over the loop, the magnetic field is disturbed and generates, or induces, a change in resonant frequency in the wire. This change in frequency is then recognized by the detector amplifier and signals the controller that a vehicle is present.

b. Pedestrian Push Button Detector: There are a number of ways to provide pedestrian actuation at a signalized intersection. The most common equipment used by far is the pedestrian pushbutton detector. Pressing the button provides a contact closure that actuates the call. There are plenty of examples of good and bad pedestrian pushbutton placement; however, part of the problem is getting the pedestrian to use the button. Specific information regarding pedestrian detectors can be found in the MUTCD Section 4E.08 Pedestrian Detectors.

An online resource can be found in MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for style, installation, and mounting details.

c. Video Detection Camera System: Vehicle detection by video cameras is a popular form of vehicle detection within Iowa. The rapid processing of video images provides the detection outputs to the controller. The designer should carefully consider the type of equipment necessary to provide video detection, the maintenance needs of this equipment, and the specific installation and mounting requirements necessary.

Designers should consider relevant manufacturer recommendations and other online resources.

d. Microwave/Radar Vehicle Detector: Microwave/radar detection is often used within Iowa during temporary signal control to provide simple, non-intrusive vehicle detection.

3. Communications: The designer may be required to provide supplemental specifications for these items given the highly proprietary nature of this equipment and the needs of the contracting agency. Generic specifications have been provided in the SUDAS Specifications.

4. Cabinet and Controller: The designer may be required to provide supplemental specifications for the controller, cabinet, and emergency vehicle pre-emption system given the highly proprietary nature of this equipment. Cabinet and controller options include TS1, TS2, ATC, and 2070. The need for controllers to collect high definition data should be considered. Generic specifications have been provided in the SUDAS Specifications; this section also includes references to UPS battery backup system and emergency vehicle preemption system. The designer should carefully consider the cabinet and mounting requirements of the battery back-up system.

An online resource can be found in MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for style, installation, and mounting details.

5. Poles, Heads, and Signs:

a. Vehicle Traffic Signal Head Assembly: Vehicle signal heads must comply with MUTCD Chapter 4D.

An online resource can be found in MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for style, installation, and mounting details.

b. Pedestrian Signal Head Assembly: Pedestrian vehicle signal heads must comply with Chapter 4E of the MUTCD.

c. Traffic Signal Poles and Mast Arms: Signalized intersections require poles and mast arms to achieve proper traffic signal and pedestrian head placement. The default is for the contractor to furnish one-piece poles and mast arms. The designer should include plan note information if two-piece poles and mast arms will be allowed. Mast arm details and typical loadings are shown on Figure 13A-5.01; additional mast arm details are shown SUDAS Specifications Figure 8010.105. The designer should ensure that the plan locations comply with all clear zone, sight restriction, and pedestrian criteria. Vertical clearance to overhead utility lines is a constant issue that designers should take note of during design. Although the minimum height from the pavement to the bottom of the signal housing is 15 feet, the designer should consider the street classification and the volume of large trucks in establishing the signal height above the pavement. However, the top of the signal housing cannot exceed 25.6 feet above the pavement. If the project being designed has specific requirements relative to the elevation of the end of the mast arm in relation to the connecting point on the vertical pole, include those requirements in the plans or special provisions of the contract documents.

An online resource can be found in MnDOT's Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for style, installation, and mounting details.

d. Traffic Signal Pedestal Poles: Pedestal poles are often used for pedestrian signals and pushbuttons, and are much easier to locate within a tight right-of-way. Pedestal pole details and typical head mounting information are shown on SUDAS Specifications Figure 8010.106.

e. Traffic Signs: The designer must ensure that all signs comply with Iowa DOT standards and the MUTCD.

C. Supplemental Requirements

A summary listing of items within SUDAS Specifications Section 8010 requiring supplemental requirements to be provided by the designer includes, but is not limited to, the following:

- Handholes - specify types, sizes, and lettering.
- Foundations - specify dimensions and any conduit stubs needed for future use.
- Communications - specify all traffic monitoring equipment along with any fiber optic equipment and materials.
- Cabinet, controller, battery backup, vehicle detection, pedestrian detection, PTZ camera, and emergency vehicle preemption - specify all relevant equipment.
- Traffic signal poles and mast arms - specify finish for pole.
- Traffic signs - specify sheeting, sign dimensions, street name sign letter series and sizes, and mounting requirements.

D. Temporary Traffic Signals

When a temporary traffic signal (SUDAS Specifications Figure 8010.107) is included in the work, the designer must address the following items:

- Type of vehicle detection equipment to include, if any.
- Type of emergency pre-emption equipment, if any.
- Number of signal heads for each direction.
- Signal control equipment, including pedestrian equipment if to be included.
- Basic signal timing and any modifications based on construction staging.
- Points for relocation of temporary traffic signal if a trailer mounted unit is specified.