Traffic Signal Specifications Information

This section provides design information that complements and is organized similar to SUDAS Specifications Section 8010, which includes:

Part 1 - General

Part 1 provides direction on general items such as submittals; substitutions; delivery, storage, and handling; scheduling and conflicts; and measurement and payment.

Part 2 - Products

Part 2 describes the products to be provided and is arranged as follows:

2.01 Underground
2.02 Detection
2.03 Communications
2.04 Cabinet and Controller
2.05 Poles, Heads, and Signs

Part 3 - Execution

Part 3 describes how these products should be installed and matches the arrangement described in Part 2, with the following additions:

3.06 Temporary Traffic Signal
3.07 Surface Restoration
3.08 Testing
3.09 Documentation

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 (generally attached to the back of the traffic signal specifications).
      2) Purpose: Contracting authority approval of the unit pricing for all major traffic signal items. 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 for engineer approval.
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. Upon acceptance, sign and date the document and provide a copy to the contractor.

b. **Material and Equipment List:**
   1) **Document:** Prepared by the traffic signal designer and included within the contract documents (generally attached to the back of the traffic signal specifications).
   2) **Purpose:** Contracting authority approval of the make and model numbers 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 engineer approval.
   5) **Engineer Action:** Review the schedule in a timely manner. Check the appropriateness of each identified manufacturer and model number. Upon acceptance, sign and date the schedule and provide a copy to the contractor.

c. **Contractor Certification:**
   1) **Document:** Prepared by the contractor on company letterhead.
   2) **Purpose:** Contracting authority approval of key project personnel.
   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.
   4) **Contractor Action:** Within 30 days after award, submit the contractor certification to the contracting authority for engineer approval.
   5) **Engineer Action:** Review the appropriateness of the information and on acceptance, sign and date the document, and provide a copy to the contractor.

d. **Shop Drawings:**
   1) **Document:** Prepared by the traffic signal pole supplier for the contractor.
   2) **Purpose:** Contracting authority approval 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 approval.
   5) **Engineer Action:** Review the shop drawings in a timely manner. Check the appropriateness of each detail. Upon acceptance, sign 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 approval 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 approval.
5) **Engineer Action:** Review the catalog cuts in a timely manner. Check the appropriateness of each item. Upon acceptance, sign and date the catalog cut documents and provide a copy to the contractor.

2. **Substitutions:** Comply with SUDAS Specifications Division 1 - General Provisions and Covenants.

3. **Delivery, Storage, and Handling:** Comply with SUDAS Specifications Division 1 - General Provisions and Covenants.

4. **Scheduling and Conflicts:** Comply with SUDAS Specifications Division 1 - General Provisions and Covenants.

5. **Special Requirements:** Comply with the current edition of the MUTCD as adopted by the Iowa DOT.

6. **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 installed quantities and applying these quantities to the appropriate approved 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 standard precast concrete handhole shown in Figure 13A-5.01 is typically used at all locations except where fiber optic cables are used and adjacent to the controller cabinet.

   Composite handholes can come in all shapes and sizes (see Quazite example table) and must be specified by the Engineer. These are typically made of a polymer concrete. Polymer concrete is made from selectively-graded aggregates in combination with a polymer resin system. When combined through a process of mixing, molding and curing, an extremely powerful cross-linked bond is formed. Precast polymer concrete is reinforced with fiberglass for strength and rigidity.

   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.

   An online resource can be found through Chapter 12 - Handholes, Pulling Vaults, and Junction Boxes from Mn/DOT’s Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for considering handhole features and functions along with execution issues such as installation, inspection, and key points to remember.
Figure 13A-5.01: Conduit and Handholes
(SUDAS Specifications Figure 8010.103)
b. **Conduit:** The SUDAS Specifications allow both steel and PVC plastic 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. When connecting HDPE conduit to PVC conduit, the designer should work with the Contractor to clarify the method or materials to be used.

A conduit check list from Mn/DOT Signal Design Documents, Checklists, and Worksheets is noted below: The designer should ensure the following:

- Conduit size and cables listed.
- Correct symbol for in-place conduit.
- Correct symbol for proposed conduit.
- Check for conflict with in place underground utilities.
- Conduit fill less than 40% (Check).
- 3 inch RSC minimum size conduit under all public traveled roadways.
- Spare 4 inches of conduit 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).
- All conduits except those within pads shall drain.
- Primary power shall be in a separate conduit run and separate hand holes.
- Size of bends and elbows in conduit in accordance with 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?
- Conduit placed under in-place pavement does not need to be labeled (bored or pushed).

An online resource can be found through Chapter 11 - Conduits and Fittings from Mn/DOT’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. With the exception of detector lead-in wires, no splices are allowed within handholes. All plan terminology should be consistent for example:

- Cable symbols correct (3/C #12, 2/C #14, 3/C #20 all different, for example).
- Ped indications on different phases shall have separate 3/C #12 cables.
- Separate 2/C #14 for each detector.
- Provide spares for future expansion of system, if necessary, and label them.

An online resource can be found through Chapter 15 - Wiring from Mn/DOT’s Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for labeling and training wires (very Mn/DOT specific though).

d. **Foundations:** Signalized intersections require footings or foundations for all poles, controller pads, and other service cabinets such as fiber optic hubs or electrical service panels. Controller footing details are included for NEMA controller cabinets as shown in Figure 13A-5.02. The designer should ensure that the plans reflect any desired future use spare conduit stubs out of the foundation.
Figure 13A-5.02: Cabinet Footing Details
(SUDAS Specifications Figure 8010.101)
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 (Figure 13A-5.04). SUDAS standard Type A mast arm pole foundation in soil designs (Table 13A-5.01 and Figure 13A-5.04) 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-5.03, 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-5.03, 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 Figure 13A-5.04), 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>
<thead>
<tr>
<th>Loading Type (Figure 13A-5.03)</th>
<th>Maximum Mast Arm Length (feet)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>35</td>
</tr>
<tr>
<td>2</td>
<td>45</td>
</tr>
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<td>3</td>
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</tr>
<tr>
<td>4</td>
<td>90</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>
Figure 13A-5.03: Mast Arm Pole Loadings for Standard Foundation Designs

<table>
<thead>
<tr>
<th>Loading Type</th>
<th>Mast-Arm Length (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20-35'</td>
</tr>
<tr>
<td>2</td>
<td>36-45'</td>
</tr>
<tr>
<td>3</td>
<td>46-60'</td>
</tr>
<tr>
<td>4</td>
<td>61-100'</td>
</tr>
</tbody>
</table>

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 damper
(18" X 48" sign black)
The Type A Foundation is the commonly required foundation construction. When rock is encountered, the Engineer may approve the use of the Type B or C Foundation. Prior to the use of the Type B or C Foundation, the Engineer must consult a geotechnical engineer licensed in the State of Iowa.

1. Shape top 1 inch with forms. See Detail X.
2. Furnish nut, nut and plate, or nut and anchor bolt assembly ring plate on embedded end.
3. Install rodent guard or non-shrink grout with wrap pole.

Figure 13A-5.04: Pole Foundation Details (SUDAS Specifications Figure 8010.102)
Figure 13A-5.04 (Continued): Pole Foundation Details
(SUDAS Specifications Figure 8010.102)
Figure 13A-5.04 (Continued): Pole Foundation Details
(SUDAS Specifications Figure 8010.102)
Figure 13A-5.04 (Continued): Pole Foundation Details

(SUDAS Specifications Figure 8010.102)
The designer should ensure that all foundations:
- Are located in compliance with applicable clear zone requirements
- Do not conflict with pedestrian walkways or ramps
- Are at the proper finish grade elevation

An online resource can be found through Chapter 10 - Foundations and Equipment Pads from Mn/DOT’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 Book 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 through Chapter 13 - Grounding and Bonding from Mn/DOT’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 Chapter 9 - Traffic Signals from Mn/DOT’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 a standard drawing for a typical rectangular detector loop (Figure 13A-5.05).

An online resource can be found through Chapter 16 - Vehicle Detection from Lighting and Signal Certification Field Guide, which provides the designer with a photographic resource for installation and mounting details.

a. **Inductive Loop Vehicle Detector:** The most 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.
Figure 13A-5.05: Inductive Loop Vehicle Detectors
(SUDAS Specifications Figure 8010.104)
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 MUCTD Section 4E.08 Pedestrian Detectors.

An online resource can be found through Chapter 19 - Accessible Pedestrian Signal Push Buttons from Mn/DOT’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 such as the Guidelines for Using Video Detection at Intersections and Interchanges by Bonneson at Texas Transportation Institute.

d. **Microwave Vehicle Detector:** Microwave detection is often used within Iowa during temporary signal control to provide simple, non-intrusive vehicle detection. A variety of styles and levels of sophistication exist in the market today.

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. Generic specifications have been provided in the SUDAS Specifications. New information was added to the specifications regarding uninterruptable power supply battery back-up system. The designer should carefully consider the cabinet and mounting requirements of the battery back-up system.

An online resource can be found through Chapter 22 - Traffic Signal Cabinets from Mn/DOT’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 the following MUTCD sections:

   - Section 4D.16 Number and Arrangement of Signal Sections in Vehicular Traffic Control
   - Section 4D.17 Visibility, Shielding, and Positioning of Signal Faces
   - Section 4D.18 Design, Illumination, and Color of Signal Sections
An online resource can be found through Chapter 18 - Signal Heads from Mn/DOT’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 the following MUTCD sections:

- [Section 4E.01 Pedestrian Signal Heads](#)
- [Section 4E.02 Meaning of Pedestrian Signal Head Indications](#)
- [Section 4E.03 Application of Pedestrian Signal Heads](#)
- [Section 4E.04 Size, Design, and Illumination of Pedestrian Signal Head Indications](#)
- [Section 4E.05 Location and Height of Pedestrian Signal Heads](#)
- [Section 4E.06 Accessible Pedestrian Signals](#)
- [Section 4E.07 Countdown Pedestrian Signals](#)

c. **Traffic Signal Poles and Mast Arms:** Signalized intersections require poles and mast arms to achieve proper traffic signal and pedestrian head placement. Mast arm details and typical loadings are shown on Figure 13A-5.03; additional mast arm details are shown on Figure 13A-5.06. The designer should ensure that the plan locations comply with all clear zone, sight restriction, and pedestrian flow criteria. Vertical clearance to overhead utility lines is a constant issue that designers should take note of during pre-design field activities. 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 special provisions of the contract documents.

An online resource can be found through Chapter 17 - Mast Arm Poles and Pedestals from Mn/DOT’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 provide alternate mounting heights for signal and pedestrian heads and are much easier to locate within a tight right-of-way. Pedestal pole details and typical head mounting information are shown in Figure 13A-5.07.

e. **Traffic Signs:** The designer must ensure that all signs comply with Iowa DOT standards and the MUTCD.
Figure 13A-5.06: Mast Arm Pole Details
(SUDAS Specifications Figure 8010.105)

1. Ensure the top of the signal housing is not more than 8 feet above the pavement. Ensure the bottom of the signal housing and related attachments are at least 8 feet above the pavement.

2. Ensure the bottom of the signal housing is located over a roadway a minimum of 8 feet and a maximum of 10 feet above the sidewalk, above the pavement grade at the center of the roadway.

3. Mount pedestrian signal heads with the bottom of the signal housing (including the signal head) not less than 3 1/2 feet and no more than 4 feet above the sidewalk level at the beginning of the controlled intersection.

4. Position and adjust heads to provide the required visibility and to conform to the applicable standards.

5. Use backplates to secure the signals to the mast arm.
Figure 13A-5.07: Pedestal Pole and Pedestrian Post Details
(SUDAS Specifications Figure 8010.106)
C. Items Requiring Supplemental Specifications

A summary listing of items within SUDAS Specifications Section 8010 requiring supplemental specifications to be provided by the designer includes the following:

- Composite handhole and cover - specify materials and dimensions.
- 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, and emergency vehicle preemption - specify all relevant equipment.
- Traffic signal poles and mast arms - specify specialty finish for pole if necessary.
- Traffic signs - specify sheeting, sign dimensions, and mounting requirements.