City of Mt. Juliet, TN
Public Works Department

Traffic Signal Design
Plan Preparation Guidelines
and
Construction Specifications

TABLE OF CONTENTS

Part A: General Information

Part A shall apply to all other Parts and Sections within this document.

Section A1: Abbreviations

The following are abbreviations referenced in this document:

COMJ – City of Mt. Juliet

TDOT – Tennessee Department of Transportation

FHWA – Federal Highway Administration

MUTCD – Manual on Uniform Traffic Control Devices

ITE – Institute of Transportation Engineers

ADA – Americans with Disability Act

IMSA – International Municipal Signal Association

NEMA – National Electrical Manufacturers Association

NESC – National Electric Safety Code

LED – Light Emitting Diodes

PVC – Polyvinyl Chloride

RGS – Rigid Galvanized Steel

Section A2: Purpose

The purpose of this document is to establish a set of standard requirements and procedures for the installation of a traffic signal maintained by the COMJ. These standard requirements and procedures include traffic signal design plan preparation guidelines and construction specifications.

Section A3: Traffic Signal Approval for New Installations

For new traffic signal installations, prior written approval must be received from either TDOT or the COMJ, whichever is applicable before the beginning of the design review process as described in ***Section B3***. The written approval shall be based on an engineering study of the traffic conditions, pedestrian characteristics, and physical characteristics of an intersection that includes an evaluation of the latest MUTCD traffic signal warrants. The MUTCD cautions that "the satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal".

Part B: Traffic Signal Design Plan Preparation Guidelines

Part B is intended to provide standardization in the preparation and review of traffic signal plans.

Section B1: Design References

Unless otherwise indicated in this document, the COMJ traffic signal design plans shall be prepared in accordance with the latest version of the FHWA MUTCD and the current TDOT design and construction requirements. These TDOT design and construction requirements include, but are not limited to, the TDOT Traffic Design Manual, TDOT Roadway Design Manual, TDOT Instructional Bulletins, TDOT Standard Drawing Library, TDOT Road and Bridge Construction Specifications, and TDOT Special Provisions. Links to the FHWA MUTCD and the TDOT design and construction documents are provided below:

FHWA MUTCD

http://mutcd.fhwa.dot.gov

TDOT Traffic Design Manual

http://www.tdot.state.tn.us/Chief_Engineer/assistant_engineer_design/design/Traffic_Design_Manual.pdf

TDOT Roadway Design Manual

http://www.tdot.state.tn.us/Chief_Engineer/assistant_engineer_design/design/DesGuide.htm

TDOT Instructional Bulletins

http://www.tdot.state.tn.us/Chief_Engineer/assistant_engineer_design/design/Instructional_Bulletins.htm

TDOT Standard Drawing Library

http://www.tdot.state.tn.us/Chief_Engineer/engr_library/design/Std_Drwg_Eng.htm

TDOT Road and Bridge Construction Specifications

http://www.tdot.state.tn.us/construction/specs.htm

TDOT Special Provisions

http://www.tdot.state.tn.us/construction/special_provisions.htm

Section B2: Plan Preparation

Plan Sheets

All traffic signal plan sheets shall be developed in accordance with the current MUTCD and TDOT design requirements. If the traffic signal plan sheets are not part of a larger set of plans, then a separate title sheet shall be required. All traffic signal plan sheets shall be prepared electronically in the latest version of MicroStation (.dgn) or AutoCad (.dwg). Each signalized intersection shall have a separate plan sheet drawn at a scale of either 1" = 20' or 1" = 30'. The intersection should be centered on the plan sheet with the major street (e.g. typically the street with the higher traffic volumes) being placed horizontal on the plan sheet. The north arrow should be oriented to point upwards, towards the right, or somewhere in between. In order to reduce the information shown on the intersection plan sheet, a separate signal detail sheet for an intersection should follow the immediately after the intersection plan sheet. This signal detail sheet typically contains construction notes, detail tables and charts, the wiring schematic diagram, and other detail items that are intersection specific.

Intersection Plan Sheet Information

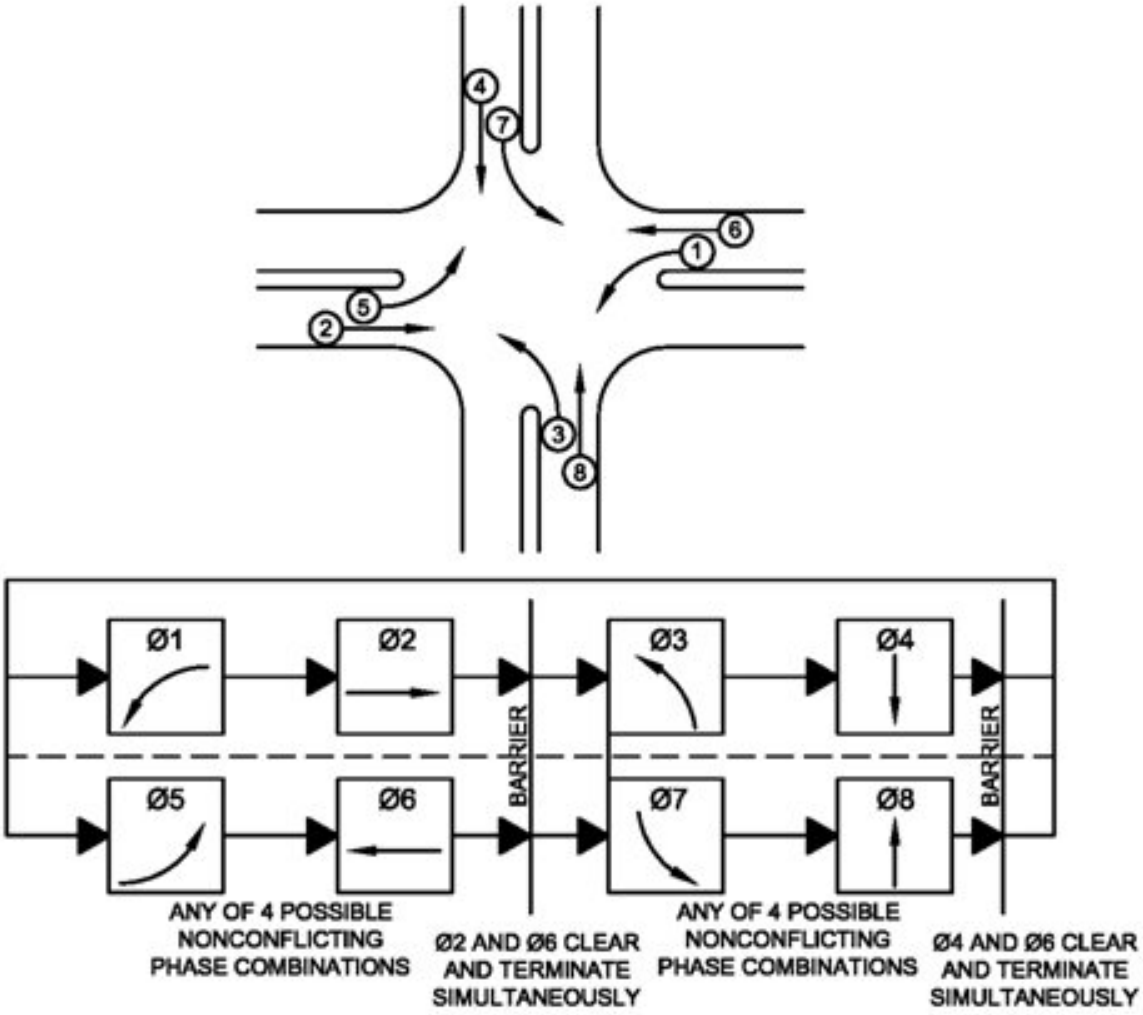
Information contained on the intersection plan sheets shall include, but not be limited to, the following items:

- North Arrow and Scale
- Centerlines and Stations [if surveyed]
- Edge of Pavements and Travel Lanes
- Right-of-Way (ROW) Lines
- Utilities [Overhead and Underground]
- Electrical Service Connections
- Signal Poles
- Signal Pole Detail Chart
- Pedestrian Pedestals
- Controller Cabinets [Pole or Ground Mounted]
- Signal Phasing Diagram
- Initial Timing Chart
- Vehicular and Pedestrian Signal Heads
- Detectors [Loops, Video, Radar, etc.]
- Detection Assignment Chart
- Pull Boxes, Conduits, and Risers
- Cables and Wires
- Wiring Schematic Diagram
- Signage [Overhead and Post Mounted]
- Pavement Markings
- Sidewalks and Handicap Ramps [if present]

Signal Phase Numbering

The signal phase numbering shall be in accordance with NEMA convention standards shown in ***Figure 1***. Signal Phase 2 (Ø2) should be on the major street (typically the street with the higher traffic volumes) and oriented in the northbound or eastbound direction.

Figure 1 – NEMA Signal Phase Numbering



Private Streets or Driveways

When signalization plans are being designed to control a private street or driveway, the developer shall be required to provide a permanent easement adequate for the placement of traffic signal equipment such as signal poles and ground mounted controller cabinets. This easement shall be sufficient to allow signal technicians access to the traffic signal equipment for all necessary maintenance activities.

Signal Poles and Pedestals

All signal poles at intersections shall be mast arm installations. Span wire installations shall not be permitted unless written approval is obtained from the COMJ. The mast arm length shall be calculated in five (5) feet increments (i.e. 20', 25', 30', etc.). The minimum mast arm length shall be twenty (20) feet and the maximum mast arm length shall be sixty (60) feet unless otherwise approved by the COMJ. Signal poles and pedestals shall be located shall be located on level terrain and not in a low area (i.e. areas prone to flooding or ponding of water) and near sidewalks (if present) at a location to provide for the best visibility of the signal faces with considerations also given to minimum clear zone requirements, utility locations, drainage and other structures, sidewalks, handicap ramps, right-of-way, maintenance forces needs, and being struck by errant vehicles. All proposed signal poles shall be detailed in a Signal Support Detail Chart containing, but not limited to, the location of poles (station and offset), attachment heights from signal pole base, pole base and attachment height elevations, and lateral distances from signal poles for of all traffic control devices on the mast arms (i.e. signal heads, signage, detectors, etc.).

Signal Controllers and Cabinets

For additional signal controller information, see ***Sections C4 and C5***. Controller cabinets shall be specified on the signal plans as either ground-mounted or pole-mounted type. A ground mounted controller cabinet shall be located on level terrain and not in a low area (i.e. areas prone to flooding or ponding of water) and near sidewalks (if present) with considerations also given to minimum clear zone requirements, utility locations, drainage and other structures, signal poles, handicap ramps, right-of-way, maintenance forces needs, and being struck by errant vehicles. The controller cabinet shall be oriented such that maintenance personnel can view signal faces while facing the controller. If practical, the controller cabinet should be located in the quadrant nearest the power service point.

Electrical Service Connections

Electrical service connections for the traffic signal shall be obtained from the nearest practical power pole and approved by the local electric company. All electrical service cables shall be placed in separate conduits and risers away from other signal cables and wires. The electrical service pole connection including the power pole shall be located on the signal plans.

Vehicular Signal Heads

The housing for all vehicular signal heads shall be aluminum with twelve (12) inch LED's for lenses. The housing for all vehicular signal heads shall contain a louvered backplate with a yellow 3" wide retroreflective strip around the edge of the backplate. The mounting hardware shall be aluminum.

Pedestrian Signal Heads

All pedestrian signal heads shall be aluminum and contain LED's. The pedestrian signal head locations shall meet the minimum requirements contained in the latest version of the MUTCD (Chapter 4E) for location and visibility. The pedestrian indications shall consist of the international symbols (e.g. fully populated "Walking Figure" and "Upraised Hand"). The countdown pedestrian signal indications shall be in accordance with current ITE specifications. The mounting hardware shall be aluminum. If attached to a signal pole, all pedestrian signal heads shall be mounted utilizing "clamshell" type hardware.

Pedestrian Pushbuttons

All pedestrian pushbuttons shall be ADA compliant. The pedestrian pushbutton locations shall meet the minimum requirements contained in the latest version of the MUTCD (Chapter 4E) for location and accessibility. A pedestrian actuation sign shall supplement the pushbuttons to indicate the crosswalk direction of each pushbutton.

Vehicle Detection

Detection on each approach to the intersection shall be controlled by radar devices. Inductive loops in the pavement or video detection shall not be permitted unless written approval is obtained from the COMJ.

Pull Boxes

All pull boxes shall be TDOT Type B (28”x16”x12”). If additional room inside the pull box is needed because it contains a large number of conduits, cables, and wires (e.g. the pull box nearest the controller cabinet), those pull boxes may need to be upgraded to a TDOT Fiber Optic Type A pull box (36”x26”x32”). All pull boxes shall be located on level terrain and not in a low area (i.e. areas prone to flooding or ponding of water). Where possible, pull boxes shall be placed located adjacent to the sidewalk. If sidewalk is not present, the location of pull boxes shall consider future sidewalk locations. Along uncurbed roadways, the location of pull boxes shall not be within the roadway shoulder and at least ten (10) feet from the paved edge if right-of-way permits.

Conduits

All conduits shall be Schedule 80 PVC with the exception of RGS conduit which shall be located under roadways and driveways. The number of conduits shall meet minimum TDOT requirements and shown in the wiring diagram. A spare conduit shall be installed between pull boxes extending across roadway intersection legs.

Cables and Wires

All signal cables and wires shall meet minimum IMSA standards. The number of conductors in each cable shall meet minimum TDOT requirements and shown in the wiring diagram.

Pavement Markings

All pavement markings shall be in accordance with the latest version of the MUTCD standards. Unless otherwise directed, all pavement markings shall be thermoplastic type. Long line pavement markings (e.g. lane lines, edge lines, centerlines, etc.) may be sprayed. Stationary and short length pavement markings (e.g. arrows, words, dotted lines, etc.) shall be preformed. Stop lines shall be twenty-four (24) inches wide and can be either sprayed or preformed. All crosswalks shall be the longitudinal type. Crosswalks within the intersection shall contain ADA-compliant ramps at begin and ends of the crosswalks. All new pavement markings in transition areas shall match and extend twenty (20) feet into existing pavement markings.

Overhead Signs

All overhead signs shall be in accordance with the latest version of the MUTCD standards. An overhead street name sign shall be located on the mast arm for each approach to the intersection.

Other Signal Plan Sheets

Other signal plan sheets shall be required for general notes, special notes, special provisions, communication layouts, bid items including bid descriptions, and quantity summaries. These sheets shall be prepared in accordance with current TDOT requirements.

Section B3: Plan Review Stage Submittals

Note for Developer/Designer: When traffic signals are located on state routes, additional project review time shall be scheduled and allowed to account for TDOT's review time.

Draft Review Stage

Traffic signal plans shall be prepared in accordance with ***Section B2***. When ready, the traffic signal plans shall be submitted to the COMJ for a draft review. At the draft review stage, the traffic signal plans are considered complete along with the identification of all proposed bid items. However, quantities for the identified bid items can be absent.

Final Review Stage

After receiving comments from the COMJ's draft review stage, the designer shall address these comments and revise the traffic signal plans accordingly. Quantities shall also be calculated for the final review stage. When ready, the traffic signal plans shall be submitted for a final review. At the final review stage, the complete signalization bid package shall be submitted.

Approval Stage

After receiving comments from the COMJ's final review stage, the designer shall address these comments and revise the traffic signal plans accordingly. When all of the final review stage comments have been addressed to the satisfaction of the COMJ, then written notice of the approval the signalization bid package shall be provided to the developer and/or designer.

Final Submission Requirements

After receiving written notice of the approval the signalization bid package, the designer shall submit a copy of the approved signalization bid package to the COMJ in both paper and electronic forms for their records. These requirements shall include, but not limited to, one full-size and two half-size copies of the complete traffic signal plans, three copies of the bid specifications and other related documents, an electronic version of the entire signalization bid package in both the original format and a PDF format shall be submitted on a compact disc (CD). In addition, the traffic signal plans and specifications shall be signed and sealed by a professional engineer currently licensed in Tennessee. Electronically verified seals on the bid documents are acceptable.

Part C: Traffic Signal Construction Specifications

Part C is intended to provide specific COMJ traffic signal construction specifications that supplements TDOT Standard Construction Specifications, specifically Section 730 (Traffic Signals).

Note for Designer/Contractor: Nothing in these specifications shall relieve the contractor from his responsibilities toward the safety and convenience of the general public.

Section C1: General

All traffic signal and overhead sign installation procedures including construction equipment and materials shall meet both TDOT requirements and the current edition of the MUTCD.

Once a contractor begins his work at an existing signalized intersection, the contractor shall be responsible to maintain the traffic signal operation throughout the duration of the project until final acceptance of the traffic signal from the COMJ. The cost to maintain the existing signal operation shall be included in the price bid for other items of construction.

Field observations during construction for all traffic signal installations will be performed by the COMJ or their designated project engineer. All construction activities shall be ADA compliant including accessibility guidelines leading into and within the project construction site.

The contractor shall notify the COMJ a minimum of thirty (30) days prior to the activation of a new traffic signal. For new installations, the traffic signal shall be placed in flash operation for a minimum of seven (7) days and a maximum of fourteen (14) days prior to the activation of the traffic signal to normal operation.

After completion of construction, the contractor shall provide the COMJ with two (2) sets of “as-built” drawings for each intersection identifying those items that have been changed from the original drawings.

The contractor shall carefully disassemble and deliver all existing signal equipment that is salvageable from the project to a location at the discretion of the COMJ. Other materials such as conduits and signal cables shall be disposed of by the contractor at his expense. If needed, the contractor shall contact the COMJ at 615-773-7957 to determine which items are to be disposed of and which items are to be salvaged by the COMJ.

If conflicting information is shown on the signal plans regarding the traffic signal equipment or materials, the contractor shall notify the COMJ of the discrepancy and for clarification. For clarifications purposes, refer to the information contained in this document or the latest TDOT design and construction documents, whichever is applicable.

Section C2: Utilities and Electrical Service Connections

The contractor is responsible to identify and verify the location of all utilities prior to construction. Prior to commencing work, the contractor shall notify each utility owner of his plan of operation near their respective utility. Some utilities can be located by calling the Tennessee One Call System at 811 at least three (3) working days in advance of any construction.

The contractor is responsible for securing all necessary permits from utilities. In addition to securing its permit, the contractor is responsible for coordinating the necessary electrical service connections with the appropriate local electric company and for providing the electrical service connections to the signal controller and any other signal equipment requiring an electrical service connection. A one (1) inch minimum steel conduit riser and weather head shall be included in the electrical service connection.

The signal installation shall meet the NESC and local utility requirements for clearances and attachments heights. Proper clearances between signal poles/arms/cables and the existing utility lines shall be maintained. The contractor is responsible for coordinating with local utilities for any adjustment or relocation work required.

The contractor is responsible for providing all necessary measures to safeguard existing utilities from damage during construction. The contractor is also responsible for coordinating with the local utilities for any “make ready” work required including furnishing any special equipment to work over and around the utilities. The cost to protect utilities from damage, “make ready” work, and furnishing any special equipment shall be included in the price bid for other items of construction.

Section C3: Poles and Pedestals

The proposed locations of the signal poles and pedestals shown on the plans are approximate. Some field adjustments may be required in order to avoid conflicts with either overhead or underground utilities. The contractor is responsible for staking all proposed signal pole and pedestal locations and for notifying the COMJ of any field adjustments.

The contractor (or their signal pole fabricator) is responsible to determine the size and design of all signal poles and mast arms including their foundations. Shop drawings shall be submitted to the COMJ for review and approval prior to ordering signal poles and pedestals.

All signal pole and pedestal foundations shall have a spare three (3) inch stub-out parallel to the adjacent roadway. No grout shall be placed at the base of the signal pole/pedestal between the pole/pedestal base and the foundation. The base of the pole/pedestal shall remain open to permit drainage and air circulation.

All wiring and cables shall be clearly identified and labeled in the signal pole and pedestal bases. Wiring and cable ID tags shall be permanently fastened to the respective wires and cables.

Section C4: Controllers

The type of signal controller shall be the latest version of Peek Advanced Traffic Controller including firmware, or approved equal. A cut sheet containing specifications for the Peek ATC-1000 controller is provided in ***Appendix A***. The designer shall contact the COMJ at 615-773-7957 to verify the latest Peek requirements.

The controller shall be an eight (8) phase signal controller, regardless of the number of phases indicated on the plans, and if located within a traffic signal system, be able to communicate with the other, existing or new, COMJ traffic signal controllers. The contractor shall install the initial signal timings in the controller.

A "D" Module will be required in the controller if signal pre-emption is included in the signal operation or copper communications are present. A separate internal module will be required if multi-mode fiber communications are present.

Section C5: Controller Cabinets

The proposed location of the controller cabinet shown on the plans is approximate. Some field adjustment may be required in order to avoid conflicts with either overhead or underground utilities. The contractor is responsible for staking the proposed controller cabinet location and for notifying the COMJ of any field adjustment.

The type of controller cabinet shall be NEMA TS-1. The NEMA TS-1 controller cabinet assembly shall meet, as a minimum, all applicable sections of the NEMA Standard Publication No. TS1-1989, or the latest version.

The NEMA Conflict Monitor Unit (CMU) shall be the latest version of the Peek Double Diamond Series Monitors, or approved equal. A cut sheet containing specifications for the Peek Double Diamond Series Conflict Monitor Units is provided in ***Appendix A***.

The traffic signal controller cabinet shall be complete with all incidental and auxiliary equipment necessary for installation and operation required to fully operate the traffic signal as shown on the construction plans.

All signal cables shall be clearly identified and labeled in the controller cabinet. Signal cable ID tags shall be permanently fastened to the respective signal cables.

All ground mounted controller cabinet foundations shall have a spare three (3) inch stub-out parallel to the adjacent roadway.

Wireless interconnect equipment for communications between controllers shall be an Encom Broadband Wireless Ethernet System (5.8 GHz High Capacity), or approved equal.

Section C6: Vehicle and Pedestrian Signal Heads

All LED's shall meet the minimum ITE requirements and contain an "incandescent" look. No individual LED's shall be noticeable. Screw-in LED modules are not acceptable.

All vehicular and pedestrian signal heads that are visible, but not operational, shall be completely covered.

Pedestrian signals with pushbuttons shall be wired separately.

Section C7: Vehicle Detection

Vehicle detection on each approach to the intersection shall be controlled by the latest version of Wavetronix SmartSensor Matrix radar devices, or approved equal. A cut sheet containing specifications for the Wavetronix SmartSensor Matrix radar devices is provided in ***Appendix B***. The designer shall contact the COMJ at 615-773-7957 to verify the latest Wavetronix SmartSensor Matrix radar detection requirements.

Section C8: Pull Boxes, Conduits, Risers, Cables, and Wires

Pull boxes shall not be installed in sidewalks, handicap ramps, or roadways including shoulders. A pull string shall be provided in each conduit between pull boxes, signal poles, and the controller cabinet. No cable splices shall be permitted between the controller cabinet and the terminal block on the signal equipment it services.

All conduits installed under existing paved roadways and driveways, unless they are being reconstructed, shall be bored. The contractor shall not cut open any existing paved roadway or driveway without prior written approval from the COMJ.

All visible sections of signal cables shall be clearly identified and labeled in all pull boxes. Signal cable ID tags shall be permanently fastened to the respective signal cables.

The contractor shall seal all open conduit entrance holes, with or without cables, with conduit duct seal putty. If signal cables are present, the protectant sealant shall be applied after installing the cable.

APPENDIX A

PEEK CUT-SHEETS

PEEK ATC-1000

ADVANCED TRAFFIC CONTROLLER

PEEK DOUBLE DIAMOND SERIES

CONFLICT MONITOR UNITS

APPENDIX B

WAVETRONIX CUT-SHEETS

WAVETRONIX SMARTSENSOR MATRIX