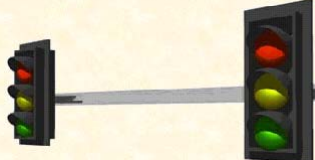


TOPIC 1: WHY?



Office of Traffic, Security & Operations (OTSO)



Traffic Signals 101

Topic 1 Why?

This chapter will address the issue as to why a traffic signal is installed. This includes:

- Who initiates a signal
- Traffic Signal Warrants
- Signal Justification Reports
- Associated Manuals



Office of Traffic, Security & Operations (OTSO)

Why?

➤ **Who initiates a signal?**

- Developer
- City/County
- Politician
- Public
- State

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2

A signal may be initiated in many ways. If a study shows such a signal is justified, then the signal must be programmed, that is, budgeted for and put into the letting schedule.



Why?

➤ Signal Warrants

- Traffic control signals should not be installed unless one or more of the signal warrants in the MN MUTCD are met
- The satisfaction of a warrant or warrants is not in itself **justification** for a signal
- Information should be obtained by means of engineering studies and compared with the requirements set forth in the warrants

The information contained in this section is established by the Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD), Chapter 4C, May 2005.

In addition to meeting a warrant, to be justified a signal should meet perceived safety or operational needs.

There are eight warrants contained in the MN MUTCD.

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Why?

➤ Signal Warrants

- Warrant 1 - Eight-Hour Vehicular Volume
- Warrant 2 - Four-Hour Vehicular Volume
- Warrant 3 - Peak Hour
- Warrant 4 - Pedestrian Volume

A detailed description of these warrants is included at the end of this topic. This information is a printout of Chapter 4C of the MN MUTCD and can be found on the Office of Traffic, Security & Operations web site. Please visit the website listed at the bottom of this page for the most current version of the MN MUTCD.

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Office of Traffic, Security & Operations publications website:

www.dot.state.mn.us/trafficeng/otepubl/index.html



Why?

➤ Signal Warrants

- Warrant 5 - School Crossing
- Warrant 6 - Coordinated Signal System
- Warrant 7 - Crash Experience
- Warrant 8 - Roadway Network

Other warrants are less strong, and require careful justification to avoid placing signals that cause more problems than they solve.

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Why?

➤ Warrant 3 Example

- The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street

This signal warrant shall be applied only in unusual cases. Such cases include, but are not limited to, office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

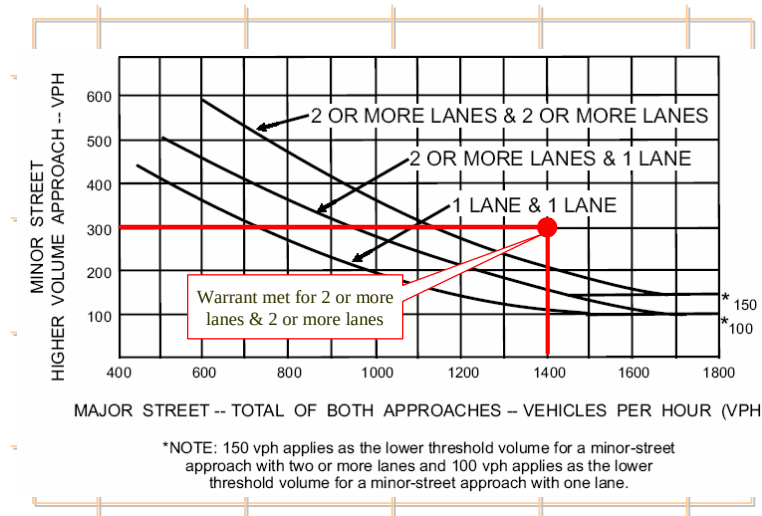
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Why?



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There are two categories for Warrant 3. Part B states: "The peak hour volume warrant is satisfied when the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher volume minor street approach (one direction only) for one hour (any four consecutive 15-minute periods) of an average day falls above the curve in Figure 4C-3 for the existing combination of approach lanes."



Why?

➤ Signal Justification Report

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A signal justification report must be submitted for all new construction of signalized intersections, when a signal is completely rebuilt, when major work is done on a signal, or when a signal is upgraded preceding turn-back to the local jurisdiction.

A signal justification report need not be submitted for minor work done on a signal if the district still considers the signal a justified installation.

The purpose of a signal justification report is to document that an engineering study has been done and that engineering judgement has been used to demonstrate that a traffic signal installation is justified.

Office of Traffic, Security & Operations (OTSO)

Why?

➤ **Cover Manuals**

Minnesota Manual on Uniform Traffic Control Devices (MMUTCD)
March 2006

Signal & Lighting Certification

Signal Design Manual

Lighting Design Manual

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The MN MUTCD is the Minnesota Manual of Uniform Traffic Control Devices. It contains the warrants for traffic signals.

The Signal and Light Certification course Workshop offered by Mn/DOT covers the "nuts and bolts" of signals and lighting.

The Signal Design Manual covers the design of signal systems. It is a prerequisite for how to design a traffic system.

The Lighting Design Manual covers the design of roadway lighting systems.

Office of Traffic, Security & Operations (OTSO)

Why?

➤ **Cover Manuals**

Standard Specifications

Traffic Engineering Manual (TEM)

Signal Optimization and Timing Manual

Traffic Signal 101
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The Standard Specifications are used for all types of construction. Refer to Topic 13 of this workbook for more details.

The Traffic Engineering Manual (TEM) contains a variety of information related to signals.

The Signal Optimization and Timing Manual is a manual for how to run and operate a traffic signal and signal system.

Visit the Office of Traffic, Security & Operations website for up-to-date publications (including this manual).



Why?

- For up-to-date information, visit:
www.dot.state.mn.us/trafficeng/



Visit the Office of Traffic, Security & Operations website for a wide range of up-to-date resources.

Many of the references used in this Manual can be downloaded via the Publications link.

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Handout

Excerpts from MN MUTCD (Page 4C-1 to 4C-8)

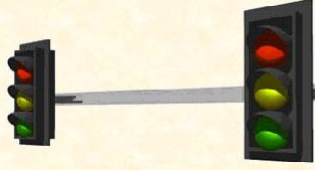
For the latest version of the MN MUTCD, please visit:

www.dot.state.mn.us/trafficeng/otepubl/index.html

TOPIC 2: AGREEMENTS



Office of Traffic, Security & Operations (OTSO)



Traffic Signals 101

Topic 2 Agreements

This topic will cover Agreements. This includes:

- Signal Agreements
- Cost Splits
- Type of Agreements written in the Traffic Office
- Agreements for State Let and City/County Let projects
- What agreements cover
- Items that may be covered in Agreements



Office of Traffic, Security & Operations (OTSO)

Agreements

➤ **Signal Agreements**

- An Agreement is a contract between the state and another entity defining who pays for what
- Cooperative agreements specify the sharing of cost, maintenance, and operation of signals

The State will not participate financially in a traffic signal that is not justified (see Topic 1 regarding justification of traffic signals).

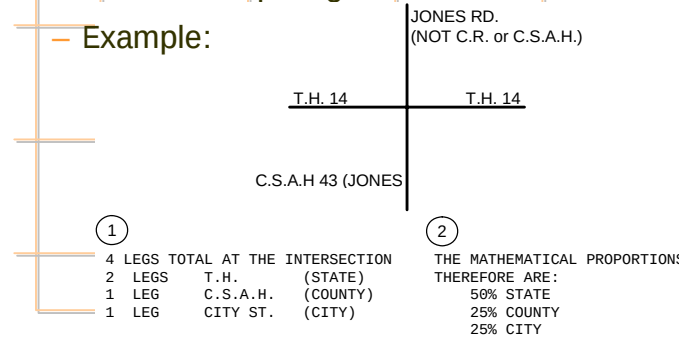


Agreements

➤ Cost Split

- The cost of constructing and maintaining a traffic signal shall be shared by the State and other municipal agencies

- Example:



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The construction cost is usually divided in the same ratio as the number of legs of the intersection under each jurisdiction. If a leg is split by a division boundary, that leg should be equally divided. A private entrance leg should be divided as a municipal leg.



Agreements

➤ Types of Agreements written in the Traffic Office:

- Traffic Control Signal
- Flashing Beacon
- Emergency Vehicle Pre-emption (EVP)
- Highway Lighting

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The costs for the signal may include intersection roadway lights, intersection roadway signs, emergency vehicle preemption (EVP) as well as the cost of construction, engineering, inspection and maintenance.



Agreements

➤ Agreements are written for both State Let Projects and City/County Let Projects. State Let Projects - Agreement Classifications

- Receivable
- Payable / Receivable
- Maintenance
- Reimbursable Maintenance
- State Force Account

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Traffic signal plans handled by Mn/DOT for other agencies, with or without the state aid process, are handled differently depending on whether the project has federal funding participation, and whether or not the intersection involved is on or off the trunk highway system.

If a signal at a trunk highway intersection is being built or revised by any other agency, the District/Division Traffic Engineer shall approve the final plans before bids are opened on the project. The Traffic Engineer shall approve the plans whether or not there is any federal funding participation.



Agreements

➤ City/County Let Projects - Agreement Classifications

- Payable / Receivable
- Payable
- Receivable
- Maintenance
- Reimbursable Maintenance
- City Force Account
- City / State Force Account
- Agency

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If a proposed signal is not at a trunk highway location, and the job involves federal funding participation, the Traffic Engineer will indicate concurrence with the design by means of a memorandum to the State Aid office.

If a proposed signal is not at a trunk highway location, and the job does not have federal funding participation, the Traffic Engineer may indicate approval by means of a memo to the State Aid Office; however, the district/division may recommend approval of such a project if the plans have been certified by both a master electrician and licensed engineer.



Agreements

➤ What Agreements Cover

- Costs (Construction costs and appropriate shares)
- Maintenance
- Operation (Timing)
- Electrical Energy (Power)

Agreement terms (cost participation, power supply, design responsibilities, operation responsibilities and major/minor maintenance responsibilities) should be defined as early as possible within any project - regardless of whether the project is going to be administered by the Department or a local agency. Agreement terms are a byproduct of appropriate and timely local agency and Department contact regarding any project.

Refer to the Cooperative Purchasing Venture at the following web site:

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www.mmd.admin.state.mn.us/cpv2.htm



Agreements

➤ Items that may be covered in the Agreements

- Signals
- Street Lights
- Advanced Warning Flashers
- Signal Ahead Flashers
- Interconnect
- Emergency Vehicle Pre-emption
- Type "D" Signs

The cost is also split by leg for interconnect.

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Agreements

➤ Items that may be covered (continued)

- Internally Lit Signs
- Cross-walk markings
- Intersection Improvements
- Beacons
- Lighting Systems
- Lighting Units
- Preliminary Engineering

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Agreements

➤ Items that may be covered (continued)

- Engineering & Inspection
- State Furnished Materials (Cabinet and Controller)
- City / County Furnished Materials

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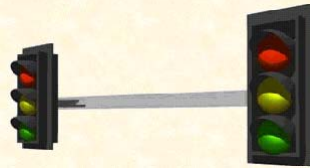
Traffic Signal 101

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TOPIC 3: FIELD COMPONENTS



Office of Traffic, Security & Operations (OTSO)



Traffic Signals 101

Topic 3 Field Components

In this topic you will be introduced to some common field components used with traffic signals.

At the end of this topic you will find a copy of the pertinent Standard Plates. These are current at the time of publication of this manual.



Office of Traffic, Security & Operations (OTSO)

Field Components



Full Intersection Picture

This is a picture of a signalized intersection.

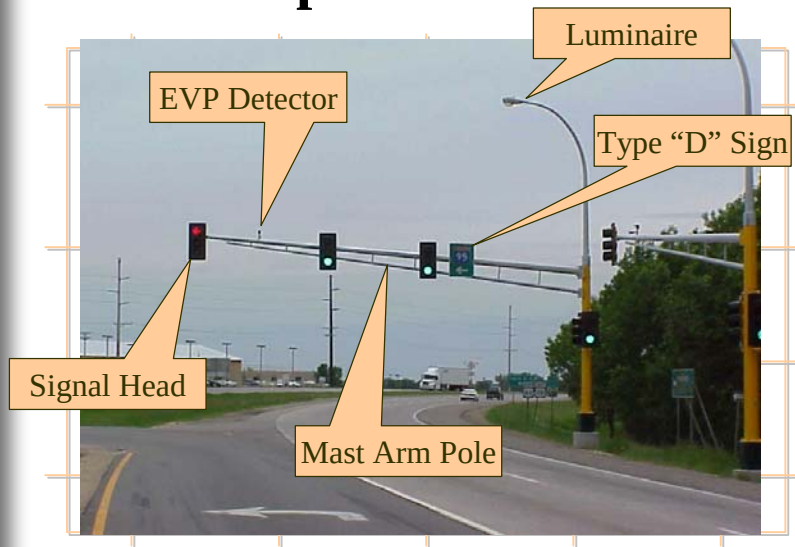
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Field Components



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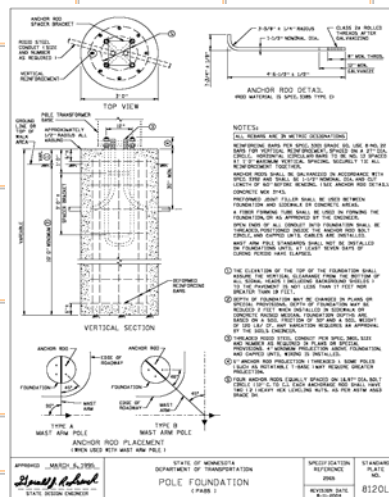
3

This picture identifies a mast arm pole and some of the common components found on it. This includes emergency vehicle preemption (EVP detector), traffic signal heads (protected and permitted), a luminaire for lighting the roadway and a Type "D" guide sign.



Field Components

Foundation Standard Plate



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This is Standard Plate No. 8120L, Pole Foundation. Refer to the Standard Plates for the most current version.



Field Components



Foundation Cage

Anchor Bolt



The pictures in the slide show a steel foundation cage (reinforcing bars) and an anchor bolt. See Standard Plate 8120L for details.

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Field Components



Foundation

This picture shows the foundation at grade level. Notice the anchor rods and bolts where the signal transformer base attaches.

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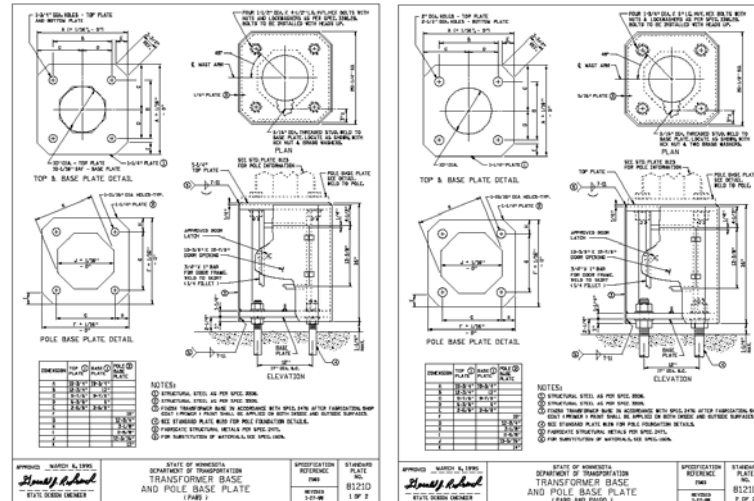
Traffic Signal 101

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Field Components

Transformer Standard Plate



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This is Standard Plate No. 8121D (page 1 and 2), Transformer Base and Pole Base Plate.



Field Components



Pole Base and Transformer

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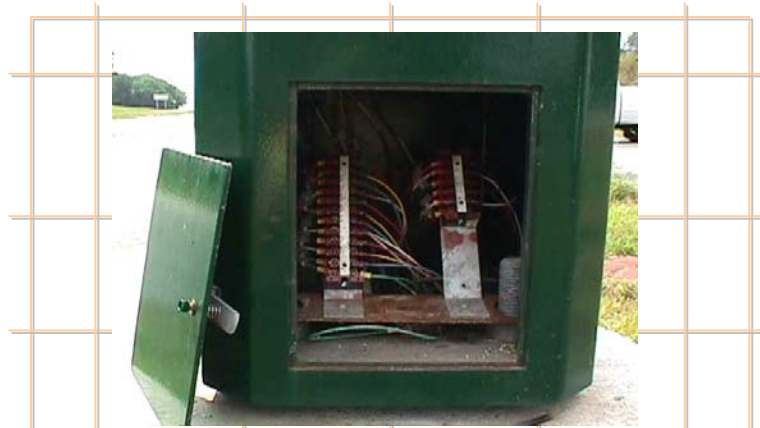
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8

The pictures in the slide show a pole base and transformer. See Standard Plate 8121D for details.



Field Components



Transformer Access Panel

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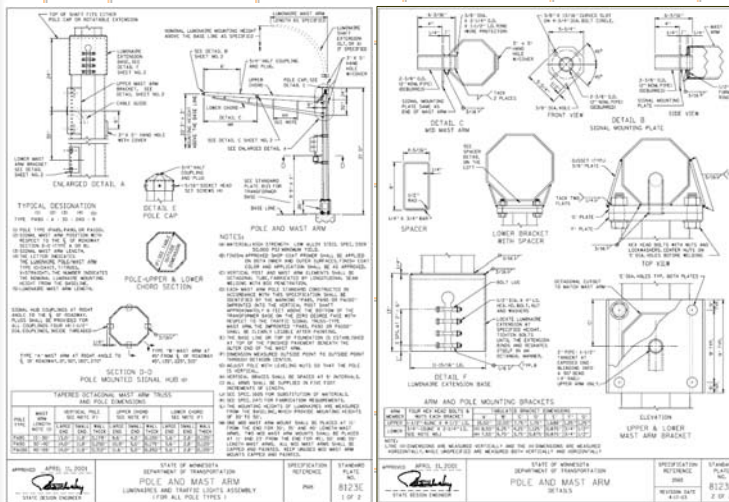
9

This picture shows a transformer base access panel. See Standard Plate 8121D for details.



Field Components

➤ Pole and Mast Arm Standard Plate



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This is Standard Plate No. 8123E (page 1 and 2), Pole and Mast Arm.

Notice that there are 3 types that are used:

- PA85 (15' - 30')
- PA90 (30' - 40')
- PA100 (40'-55')

The length of the arm is specified on the signal layout plan sheets (see topic 4).



Field Components



Stamp



Pole

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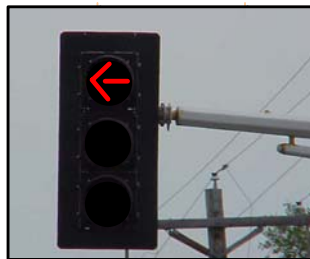
Traffic Signal 101

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This picture shows the vertical pole (yellow post shown in the picture on the left) and a stamp indicating that this is a Pole Type PA100 (right). See Standard Plate 8123E for details.



Field Components



3-section
Protected Left Turn
Signal



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Traffic Signal 101

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This shows a picture of a 3-section protected left turn signal. In a protected left, all three indications are arrow type. Vehicles are only allowed to move during the green indication (no permissive left turn movement is allowed).



Field Components



These pictures show a protected/permissive left turn signal. Left turn vehicles are allowed to operate as a protected movement during the green arrow and as a permissive movement (yield to oncoming traffic) during the green ball. Notice the supplemental 'Left Turn Yield on Green' sign.

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Field Components



This picture shows the horizontal mast arm pole. See Standard Plate 8123E for details. Mast arm poles are supplied in 5' increments from 15' to 55'.

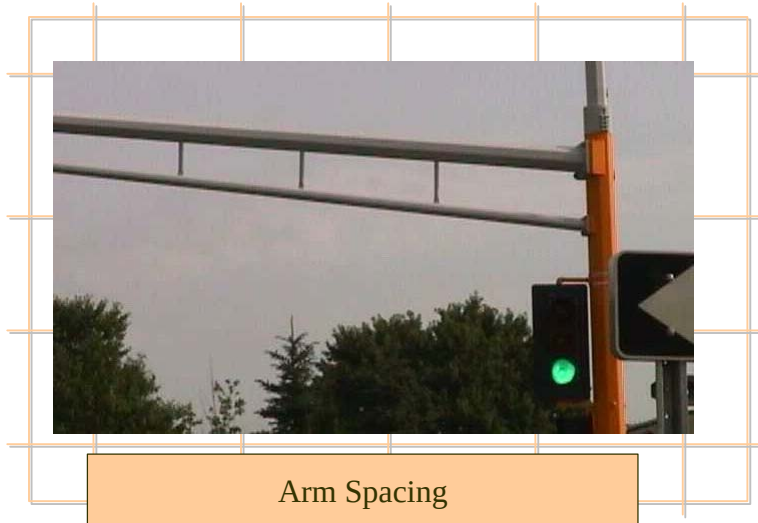
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Field Components



This picture shows the vertical braces on a mast arm pole. The braces are spaced at 5' intervals. See Standard Plate 8123E for details.

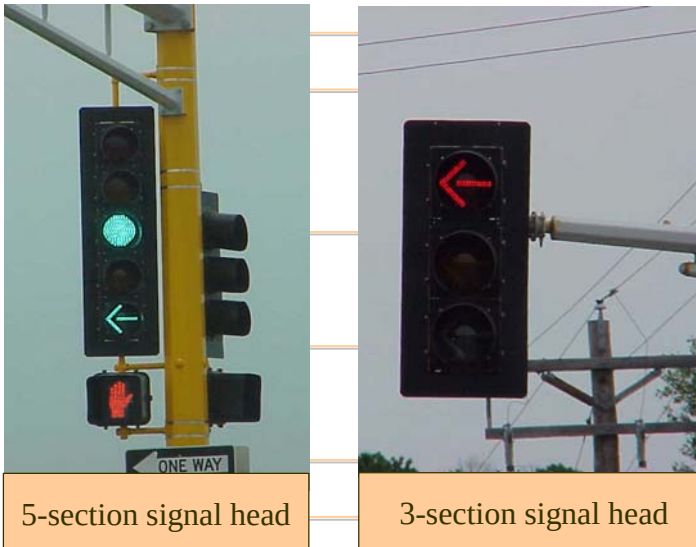
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Field Components



The picture on the left shows a typical 5-section signal head on a vertical pole and the picture on the right is a typical 3-section head mounted on the end of a mast arm.

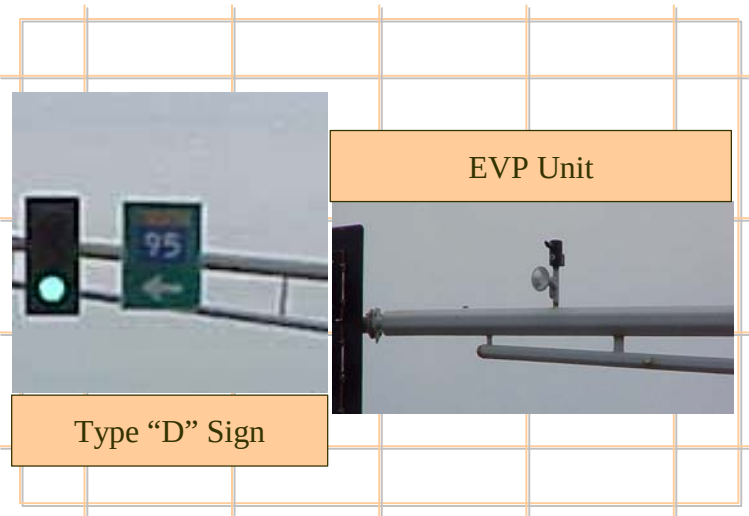
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Field Components



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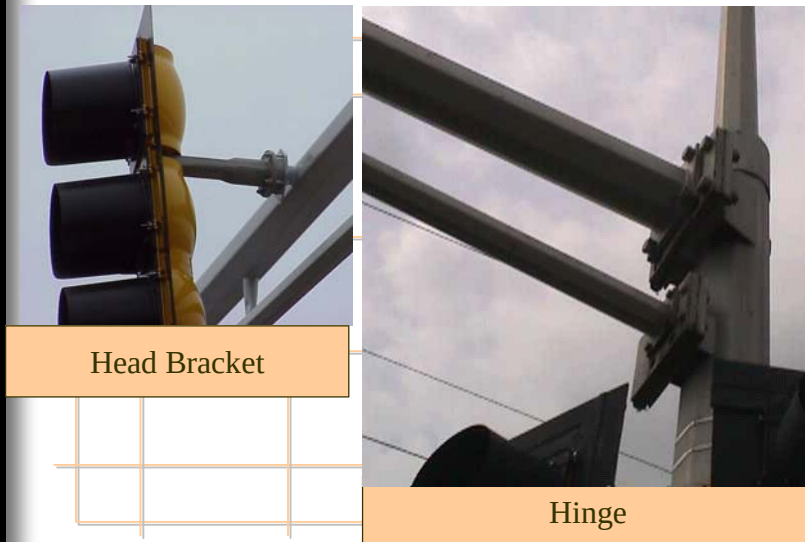
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The picture on the left shows a typical Type "D" guide sign. The picture on the right shows a close up view of an Emergency Vehicle Preemption (EVP) detector and confirmatory light. See topic 12 for more information on EVP.



Field Components



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The picture on the left shows a typical signal head-mounting bracket. The picture on the right shows a hinge where the mast arm is mounted to the pole. The hinge allows the mast arm to be rotated if it is on a house-moving route.



Field Components



Luminaire Extension



Luminaire

The picture on the left shows the luminaire shaft extension. The picture on the right is the luminaire head.

Generally, there are at least two luminaires at an intersection.

The luminaire has a photoelectric cell.

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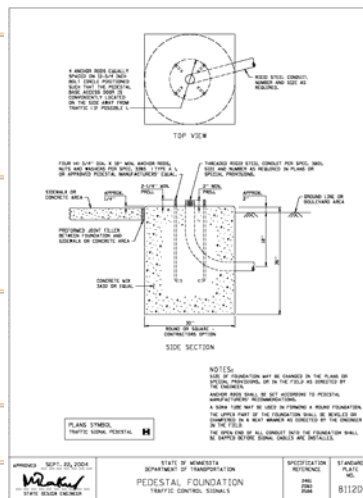
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Field Components

➤ Ped Foundation Standard Plate



This is Standard Plate No. 8112D, Pedestal Foundation. Refer to the Standard Plates for the most current version.

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Field Components



Pedestal Pole



Pedestal Base

The picture on the left shows a 3-section left turn signal mounted on top of a pedestal pole. The picture on the right is a close up of the pedestal pole base and foundation.

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Traffic Signal 101

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Field Components



Pedestal Pole Foundation



Base w/ Windcolar

The picture on the left is the concrete pedestal foundation and the anchor rods. The picture on the right shows the base and windcolar.

See Standard Plate 8112D for details on the pedestal foundation.

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Field Components



Long Pole
w/bracketing

Pedestal Bracket



Pedestal Bracket

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The pictures in the slide show some typical mounting assemblies for traffic signal heads on a pedestal pole.



Field Components



Pedestrian Push Button
Station

Push Button Sign



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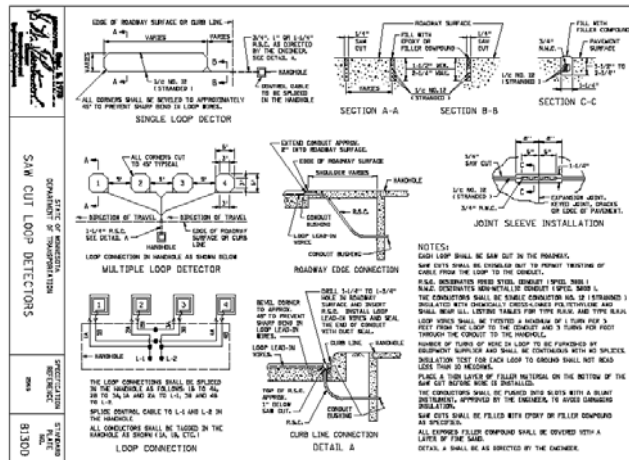
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The picture on the left shows a pedestrian push button station. The picture on the right shows a close-up of a pedestrian push button and push button sign.

Field Components

➤ Sawcut Detail



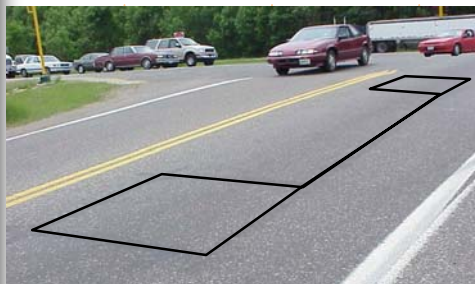
This is Standard Plate No. 8130D, Saw Cut Loop Detectors.

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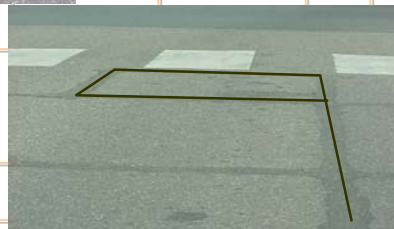
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Field Components



Saw-Cut Loop Detector



These pictures show loop detectors that are placed in the roadway by saw-cut. The detectors have been outlined for these pictures only.

Conductor wire is placed in the saw cuts and covered with epoxy filler. The loops are used to detect vehicles.

See Standard Plate 8130D
for details.

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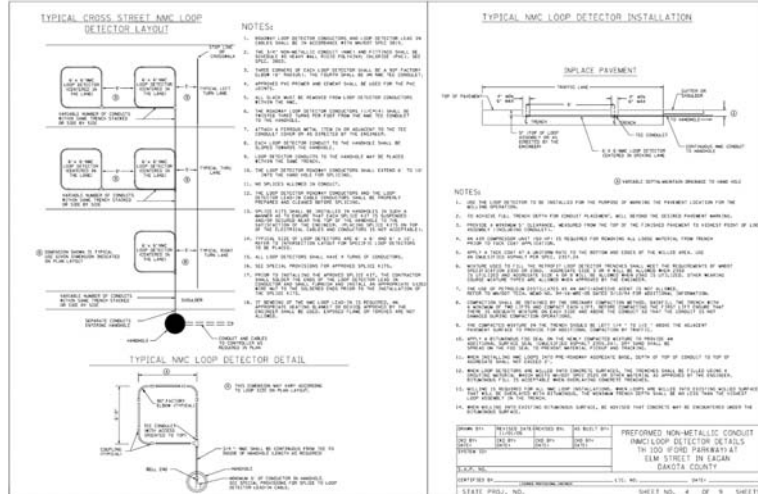
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Field Components

➤ Non-Metallic Loop Detail



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This is a copy of the Non-Metallic Loop detail. A copy of this plan sheet is found at the back of this manual.



Field Components



Non-Metallic Loop (NMC)

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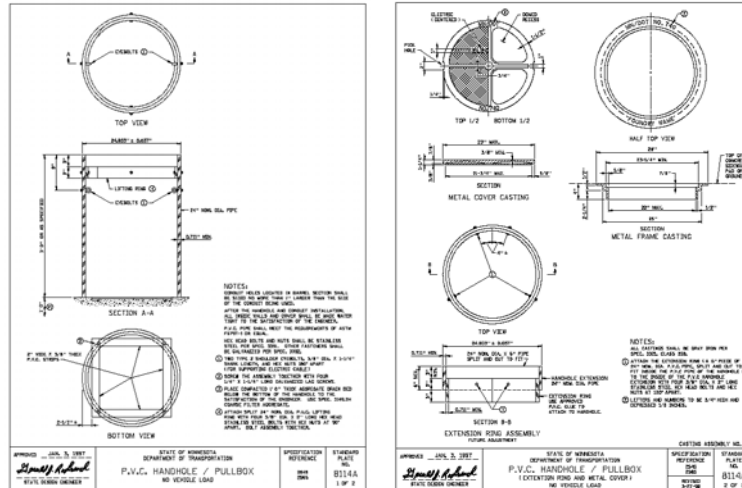
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This is a picture of a NMC loop conduit. Conductor wire is placed in the conduit and the loop assembly is placed in or under the roadway. The NMC loop is used to detect vehicles.



Field Components

Handhole Standard Plate



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This is Standard Plate No. 8114A (page 1 and 2), PVC Handhole / Pullbox. Refer to the Standard Plates for the most current version.



Field Components



Handhole

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The picture on the left shows the handhole barrel prior to installation. The pictures on the right show typical handhole installations.

A handhole is used as an access to conduit and wire. The lid can be removed.

See Standard Plate 8114A for details.



Field Components



Crosswalk



Pedestrian Ramp

The picture on the left shows a typical crosswalk marking. This indicates where pedestrians cross the roadway.

The picture on the right shows a typical pedestrian curb ramp installation.

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Field Components



Signal Cabinet and Pad



Service Cabinet

These pictures show a typical traffic signal cabinet and service cabinet installation. See topic 5 for further details.

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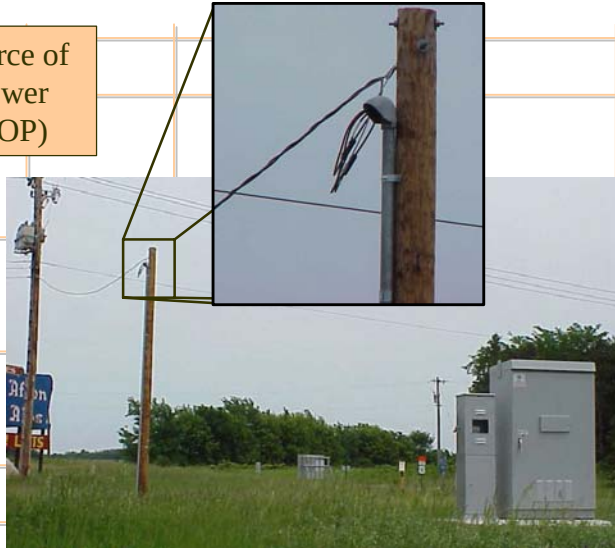
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Field Components

Source of
Power
(SOP)



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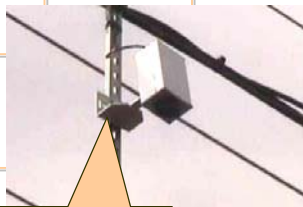
33

These pictures show a typical source of power (SOP).



Field Components

Video Detection



Sonic Detection



Microwave Detection

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When loop detectors are not present, other forms of vehicle detection may be installed. These pictures show some other forms of detection. Typically, these detectors are installed overhead.



Field Components



Signal Ahead Sign

This is a picture of a signal ahead sign. This is installed prior to traffic signals to warn the motorist that a signal is ahead.

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Field Components



Advance Warning Flasher (AWF)

These pictures show a typical Advance Warning Flasher installation. It differs from the signal ahead sign since it has flashers. See topic 10 for further details.

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Field Components



Span Wire Signal

This is a picture of a typical span wire signal. Generally, these are temporary installation, but some may be long term. Generally the traffic signal wires are installed overhead instead of underground.

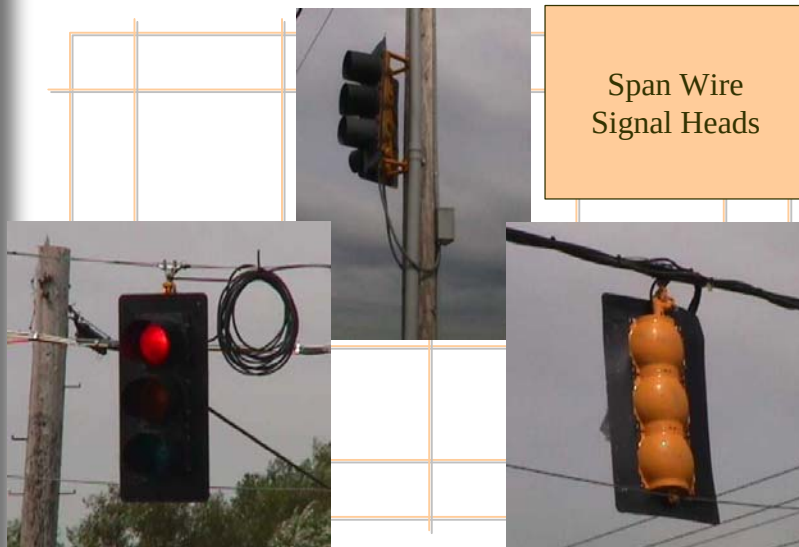
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Field Components



Span Wire
Signal Heads

Close-up pictures of span wire signal heads.

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Handout

Selected Mn/DOT Standard Plates

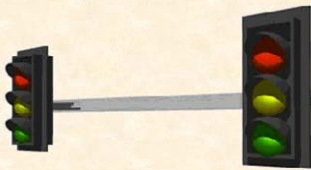
For the latest version of the Standard Plates, please visit:

www.dot.state.mn.us/tecsup/splate/index.html

TOPIC 4: INTRODUCTION TO PLAN



Mn/DOT - Office of Traffic Engineering & ITS



Traffic Signal Plans

Chapter 4

Traffic Signal Plans

In this chapter you will be introduced to a typical traffic signal plan sheet layout and wiring diagram. This will cover the typical items that are found in these plan sets.

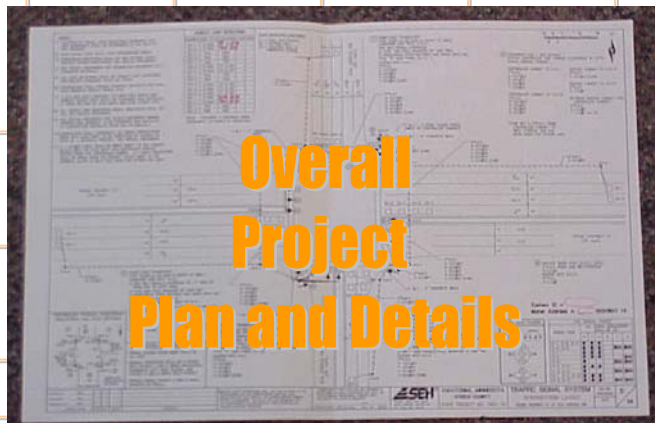
A copy of the plan set is included at the back of this manual.



Mn/DOT - Office of Traffic, Security & Operations (OTSO)

Traffic Signal Plans

➤ **Picture of Signal Plan Set**



Overall
Project
Plan and Details

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Picture of a signal plan set.



What is plan used for?

- Contractors bid
- Building the signal
- Operating/maintaining the signal
- Locates
- Tort claims/Law suits

The purpose of the plan set.

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Traffic Signal 101

3



Traffic Signal Plans

➤ Required Sheets

Sheet	Signal Design
Title Sheet	✓
Estimated Quantities (if not shown on the title sheet)	✓
Details ▪ Equipment Pad Layout ▪ Preformed NMC Loop Detector Detail ▪ Advance Warning Flasher Detail ▪ Signing and Pavement Markings Details ▪ Other(s)	✓

Final signal plans should be prepared on 11" x 17" plan sheets. The scale for the "Intersection Layout" should be 40 scale (1:500 metric), interconnect layouts can be 100 scale (1:1000 metric). Each sheet of the plan must be properly identified in the lower right corner (State Project or State Aid Project Number and Sheet XX of XX).

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Sheet	Signal Design
Intersection Layout Sheet	√
Field Wiring Diagram	√
Interconnect Layouts	√
For Information Only Sheet(s)	√
Utilities	√

1

[illegible]

E

Topic 4: Introduction to Plan



Title Sheet

– Plan Description and Location

MINNESOTA DEPARTMENT OF TRANSPORTATION
CONSTRUCTION PLAN FOR TRAFFIC CONTROL SIGNAL AND INTERCONNECT SYSTEMS
 AT THE INTERSECTIONS OF T.J.L. 795 (KEYVIN PARKWAY) AND DEV STREET WEST AND ON T.J.L. 795 (KEYVIN PARKWAY) FROM MICKEY STREET TO
 MORRIS STREET IN THE CITY OF GOTHAM, FARRAHER COUNTY
 STATE PROJ. NO. 9999-00

– Governing Specs and Index of Sheet

GOVERNING SPECIFICATIONS
 THE 1988 EDITION OF THE MINNESOTA DEPARTMENT OF TRANSPORTATION
 "STANDARD SPECIFICATIONS FOR CONSTRUCTION" AS AMENDED BY THE
 MAY 2, 1994 SUPPLEMENTAL SPECIFICATIONS SHALL GOVERN.

INDEX

- 1 TITLE
- 2 PAD LAYOUT AND TYPE "D" SIGNS
- 3 SERVICE CABINET DETAILS
- 4 NMC LOOP DETECTOR DETAILS
- 5 INTERSECTION LAYOUT
- 6 MATCH LINE LAYOUTS AND PAVEMENT MARKINGS
- 7 FIELD WIRING DIAGRAM
- 8 INTERCONNECT LAYOUT
- 9 UTILITIES LAYOUT

THIS PLAN CONTAINS 9 SHEETS

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The plan description and location defines the type of work being performed and the location of the work.

The governing specifications for the project are defined; the project funding and the index of sheets contained within the plan set are defined on the title sheet.



Title Sheet

– Plan Preparation Certification Note

I HEREBY CERTIFY THAT THE FINAL FIELD REVISIONS, IF ANY, OF THIS PLAN WERE MADE BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

DATE _____ REG. NO. _____

– Signature Block

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

DATE: 3-1-20 REG. NO. 99999 ENGR. ALEXANDRA FARRAHER
 DESIGN SQUAD BATMAN AND ROBIN

APPROVED _____ CITY OF GOTHAM ENGINEER DATE: _____
 APPROVED _____ DATE: _____
 RECOMMENDED FOR APPROVAL _____ METRO DIVISION TRANSPORTATION ENGINEER DATE: _____
 RECOMMENDED FOR APPROVAL _____ METRO DIVISION TRAFFIC ENGINEER DATE: _____
 RECOMMENDED FOR APPROVAL _____ STATE PRE-LETTING ENGINEER DATE: _____
 OFFICE OF LAND MANAGEMENT APPROVAL _____ DIRECTOR, LAND MANAGEMENT DATE: _____
 APPROVED _____ STATE DESIGN ENGINEER DATE: _____

March 2006

Traffic Signal 101

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The plan preparation certification note identifies:

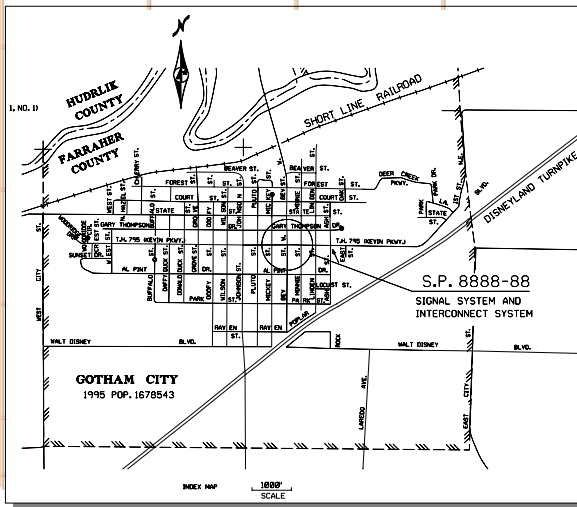
- who the plan set was developed by (or under the direct supervision of)
- that individual's state registration information.

The signature block is contained on the title sheet and varies depending on the type of project.



Title Sheet

Index Map



March 2006

Traffic Signal 101

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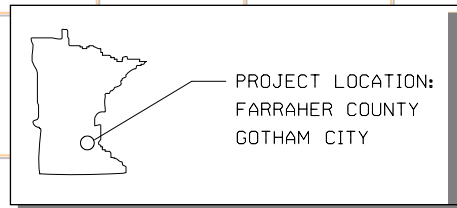
The index map is used to identify the location of the project(s).

The project numbers and sheet numbers are shown in the lower right hand corner of the title sheet and on all other sheets. For revisions to the plan made after project advertisement, an "R" shall be used after the sheet number.



Title Sheet

Signal Location



Plan Revisions Block

PLAN REVISIONS		
DATE	SHEET NO.	APPROVED BY

March 2006

Traffic Signal 101

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The generalized location (county and office) is shown on the title page.

The plan revisions block is included so that future plan revisions can be documented.



Title Sheet

STATEMENT OF ESTIMATED QUANTITIES				
ITEM NO.	DESCRIPTION	UNIT	EST. QTY.	FINAL QTY.
2565,511	FULL TACT CONTROL SIGNAL SYSTEM	SIG SYS	1	
2565,601	TRAFFIC CONTROL INTERCONNECTION	LUMP SUM	1	

STANDARD PLATES - SIGNAL SYSTEMS	
THE FOLLOWING STANDARD PLATES, APPROVED BY THE FEDERAL HIGHWAY ADMINISTRATION, SHALL APPLY ON THIS PROJECT.	
PLATE NO.	DESCRIPTION
7036D	PEDESTRIAN CURB RAMP
8110D	TRAFFIC SIGNAL BRACKETING (POLE MOUNTED)
8111C	TRAFFIC SIGNAL BRACKETING (PEDESTAL MOUNTED)
8112C	PEDESTAL FOUNDATION (TRAFFIC CONTROL SIGNALS)
8114A	P.V.C. HANDHOLE/PULLBOX (NO VEHICLE LOAD)
8115D	PEDESTRIAN PUSH BUTTON INSTALLATION
8118C	SERVICE EQUIPMENT AND POLE (TRAFFIC CONTROL SIGNALS)
8119C	GROUND MOUNTED CABINET FOUNDATION
8120K	POLE FOUNDATION (PAB5)
8121D	TRANSFORMER BASE AND POLE BASE PLATE (PAB5, PAB6 AND PA100)
8122C	PEDESTAL AND PEDESTAL BASE (TRAFFIC CONTROL SIGNALS)
8123D	POLE AND MAST ARM (LUMINAIRE AND TRAFFIC LIGHTS ASSEMBLY)
8124E	MAST ARM SIGNAL HEAD MOUNTS (ONE-WAY MOUNTS)
8125F	POLE FOUNDATION (PAB6 AND PA100)
8127B	LIGHT BASE-DESIGN E (40 FT. POLE OR LESS)
8128B	LIGHT BASE-DESIGN H (49 FT. POLE)
8130D	SAW CUT LOOP DETECTORS
8140B	ROADWAY LIGHTING SERVICE CABINET

STANDARD PLATES APPLICABLE TO THIS PROJECT

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Traffic Signal 101

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A list of applicable Standards Plates for the project is included in the plan set.

The estimated quantities may be included on a separate sheet or shown on the title sheet (if there is room). Traffic control interconnection, emergency vehicle preemption system, and other items such as conduit and handholes for a future signal system may be itemized separately from the signal system due to cost participation.

The appropriate specification item numbers, item descriptions, and units using the state's computerized pay item list shall be included.



Page 2 of the plan

Equipment Pad Details



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The equipment pad layout sheet shows the details for the equipment pad. The concrete pad in the picture is the equipment pad for the traffic signal controller and service cabinet.



Page 3 of the plan

➤ Advance Warning Flasher Details



This is the detail sheet for the advance warning flasher. The pictures show some typical AWF installations. Also see topic 10 for more information on AWF.

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Traffic Signal 101

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Page 4 of the plan

➤ NMC Loop Detail



The detail sheets show the standard details that are applicable to the project. They may include the following:

- Service equipment detail
- Equipment pad layout
- Loop detector details
- Advance warning flasher details
- Pavement markings detail
- Type "D" and/or Type "C" sign details
- Wood pole and span wire mounting
- Any other details specific to the signal system

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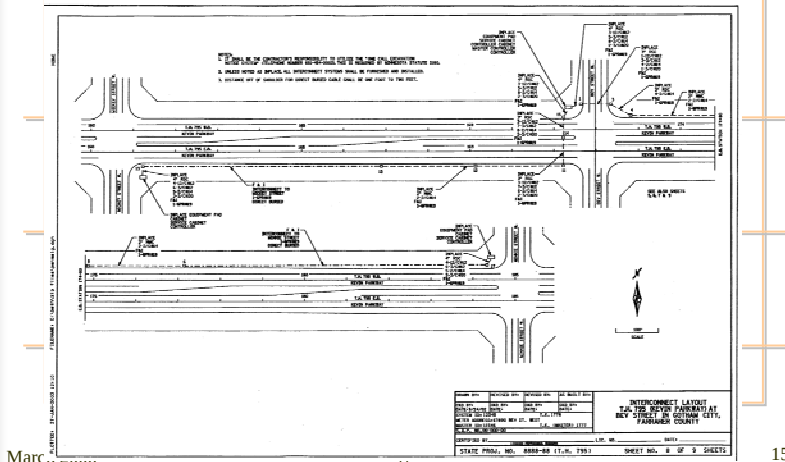
Traffic Signal 101

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Page 8 of the plan

- **Interconnect plan sheet**
 - Interconnect sheets use 100 scale

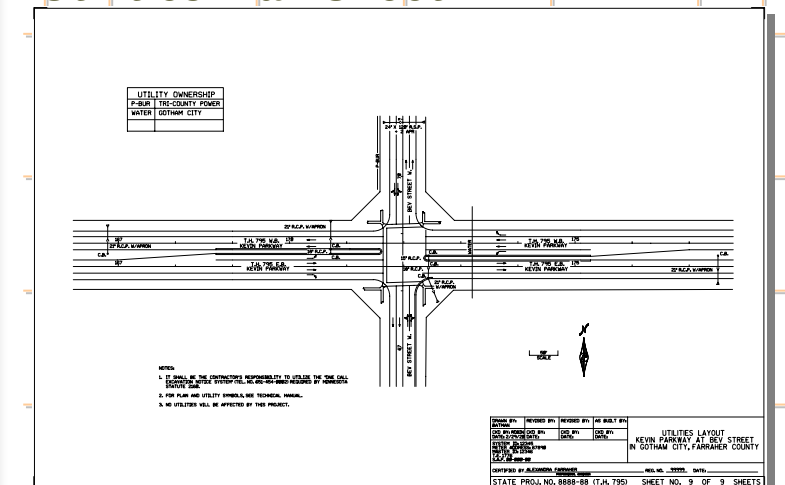


This plan sheet shows interconnect for the project. Interconnect is a means of remotely controlling some or all of the functions of a traffic signal. It also allows the master controller to communicate with any local controllers in the system.



Page 9 of the plan

- **Utilities Plan Sheet**



This is a plan sheet view of the public utilities.



Introduction to Plan



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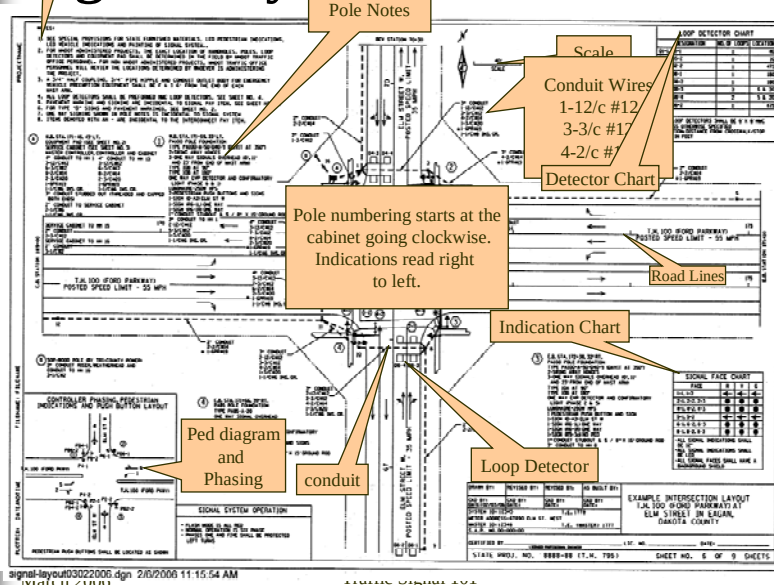
Traffic Signal 101

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Picture of Intersection at
Trunk Highway 61 at
Trunk Highway 95.

Construction
Notes

Signal Layout-PAGE 5

signal-layout03022006.dgn 2/6/2006 11:15:54 AM
vidit 2006

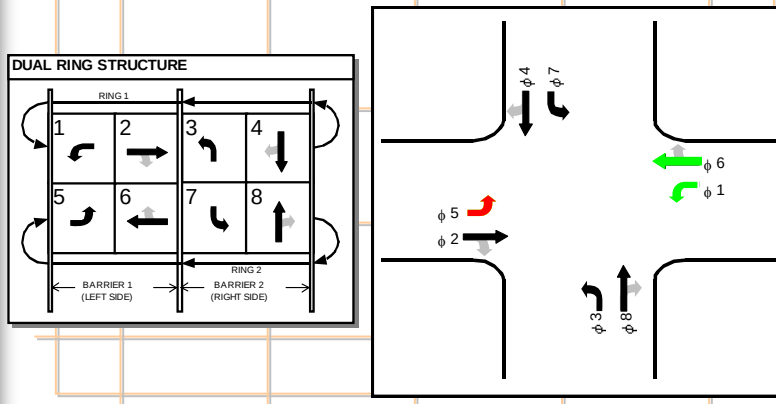
20

This is a typical plan sheet
signal layout. A copy of
this layout is found in the
Appendix.



Controller Operations

– Dual-ring and Concurrent group Controllers



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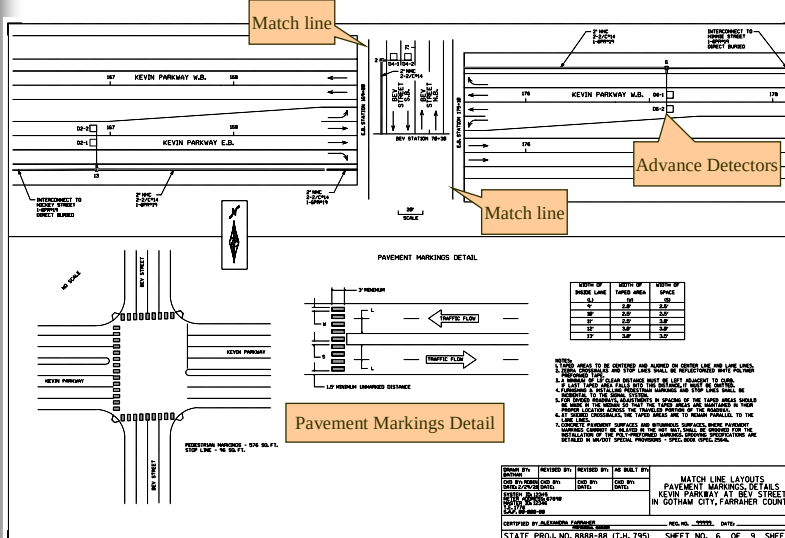
Traffic Signal 101

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Dual ring and concurrent group controllers. Refer to Chapter 7 for additional details.



Signal Layout



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This is the match line sheet of the signal layout. This sheet shows the advance detectors along with the pavement marking detail.

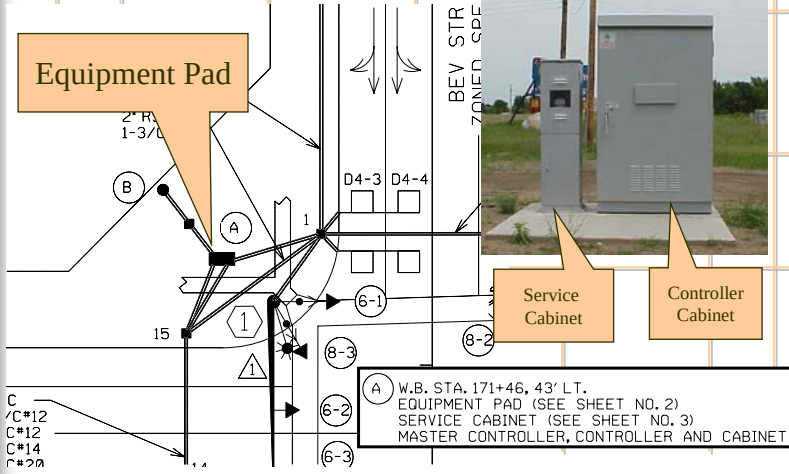
The intersection layout sheet includes the following (at a minimum):

- Intersection geometrics
- All graphics depicting signal system components
- Controller phasing diagram
- Signal system operation notes
- Signal faces table
- Loop detectors table
- Signal pole notes
- Equipment pad notes
- Source of power notes
- Construction notes
- Signal system ID, meter address and TE number
- A scale
- A north arrow
- Speed limits
- Street names
- Metric logo
- DO NOT show utilities on the layout sheet, include additional sheet(s) for utilities.



Signal Layout

Intersection Layout



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Traffic Signal 101

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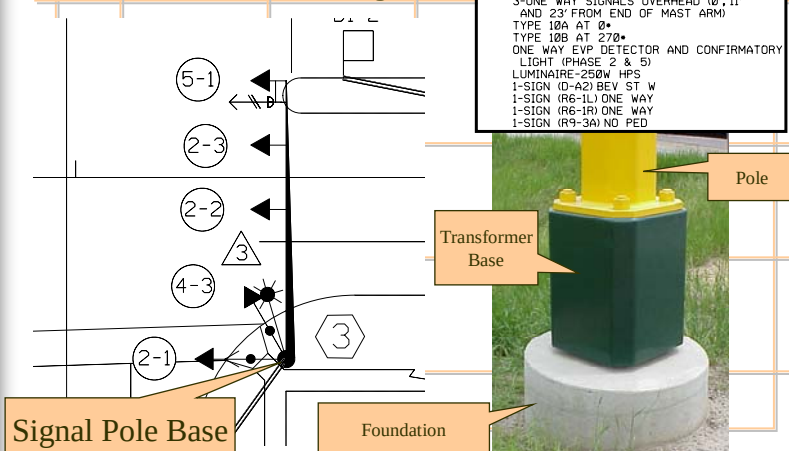
The equipment pad note is shown as a circled "A".

A solid (filled) symbol identifies new equipment and an open symbol identifies in-place equipment.



Signal Layout

Intersection Layout



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Traffic Signal 101

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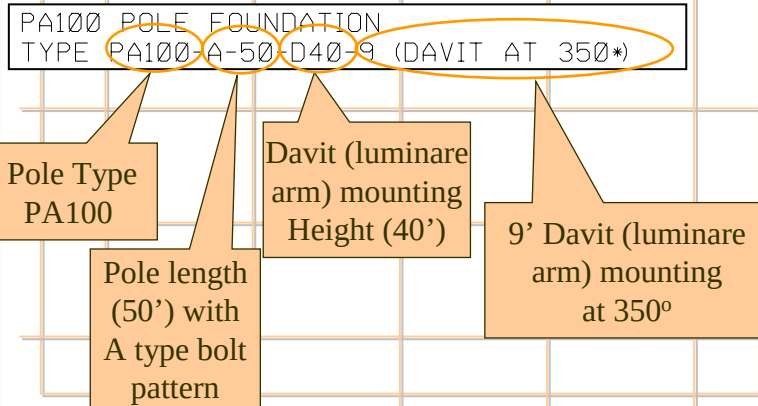
The signal bases and pole notes are shown in a hexagon. The signal bases are labeled clockwise around the intersection with Number 1 being adjacent to or near the controller cabinet.

A solid filled symbol identifies new equipment and an open symbol identifies in-place equipment.



Signal Layout

Intersection Layout



March 2006

Traffic Signal 101

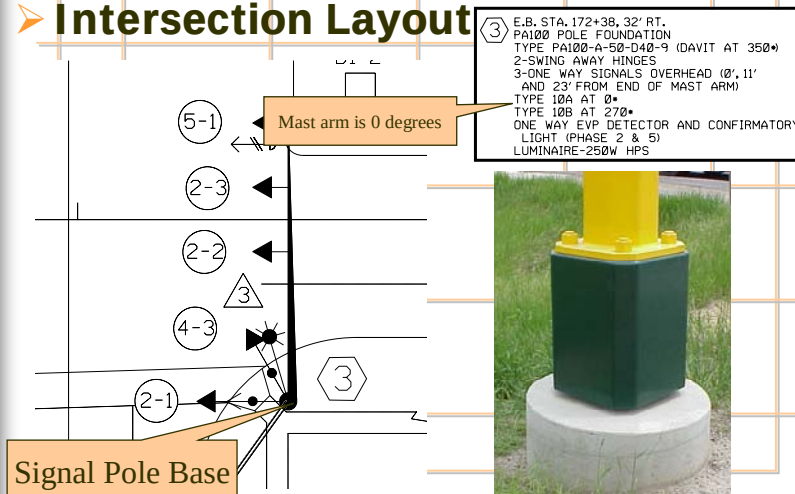
25

This defines the items shown in the pole note.



Signal Layout

Intersection Layout



March 2006

Traffic Signal 101

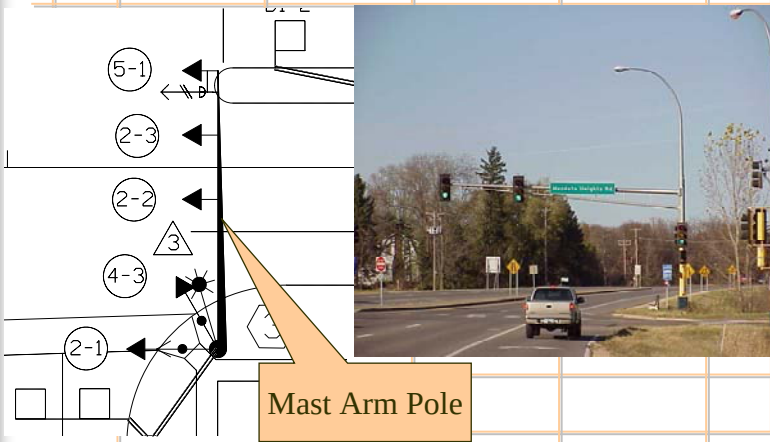
26

These are the signal pole notes. The mast-arm is at 0 degrees. Items referenced with angles are in relation to the mast arm pole in the clockwise direction.



Signal Layout

Intersection Layout



The mast arm pole as shown on the plans and in the field.

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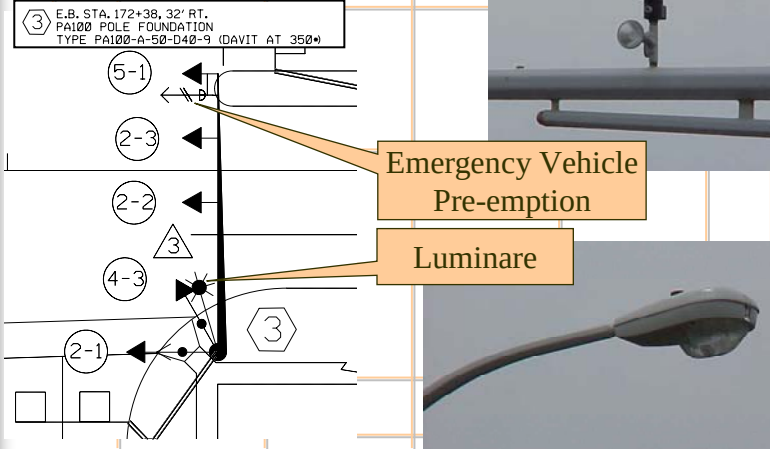
Traffic Signal 101

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Signal Layout

Intersection Layout



Emergency Vehicle Pre-emption (EVP) unit is shown with the arrow and two lines. The half circle indicates the confirmatory light.

Luminaires are shown as identified on the sample plan at the left and are labeled with a triangle.

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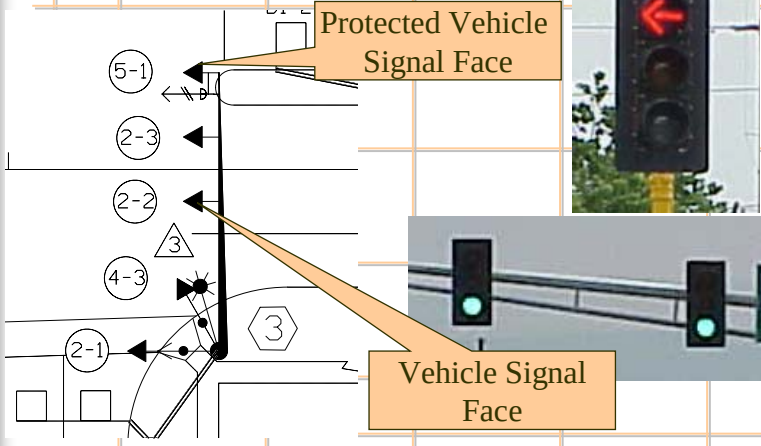
Traffic Signal 101

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Signal Layout

Intersection Layout



The vehicle signal face is identified with the filled triangle (proposed). The faces are labeled from right to left as you approach the intersection.

Signal faces are numbered with the controller phase first, followed by the face number (for example 2-1, 2-2, etc.).

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Signal Layout

Intersection Layout

LED SIGNAL INDICATIONS			
FACE	R	Y	G
1-1, 1-2	←	←	←
2-1, 2-2, 2-3	●	●	●
4-1, 4-2, 4-3	●	●	●
5-1, 5-2	←	←	←
6-1, 6-2, 6-3	●	●	●
8-1, 8-2, 8-3	●	●	●

-ALL VEHICLE SIGNAL INDICATIONS SHALL BE 12"
-EACH SIGNAL FACE SHALL HAVE A BACKGROUND SHIELD



The signal indications table identifies the face configuration for the signals shown on the plan sheet. The Face identification number refers to the signal face identifier number (circled number such as 2-1) shown on the plan sheet.

R = Red indication

Y = Yellow indication

G = Green indication

LED = Light Emitting Diode indication

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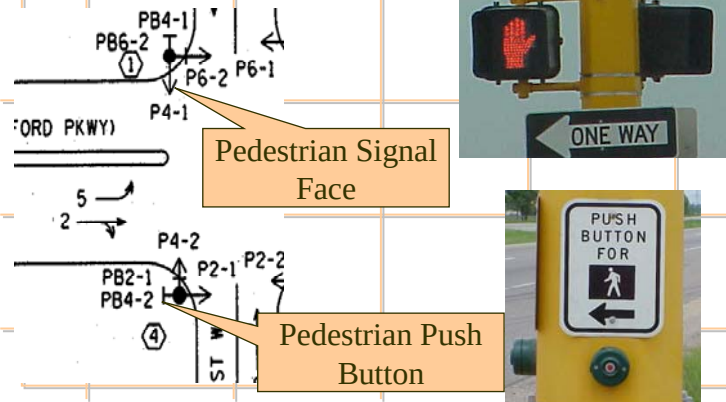
Traffic Signal 101

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Signal Layout - Peds

Intersection Layout



The pedestrian signal face is illustrated with an arrow. The face is numbered as you approach the intersection with Number 1 being the first on the right and Numbers 2, 3, and 4 as you proceed through the intersection. The labels are preceded by a P with the controller phase number (for example P4-3, P4-4, etc.).

The pedestrian push button is labeled with a PB and the controller phase number.

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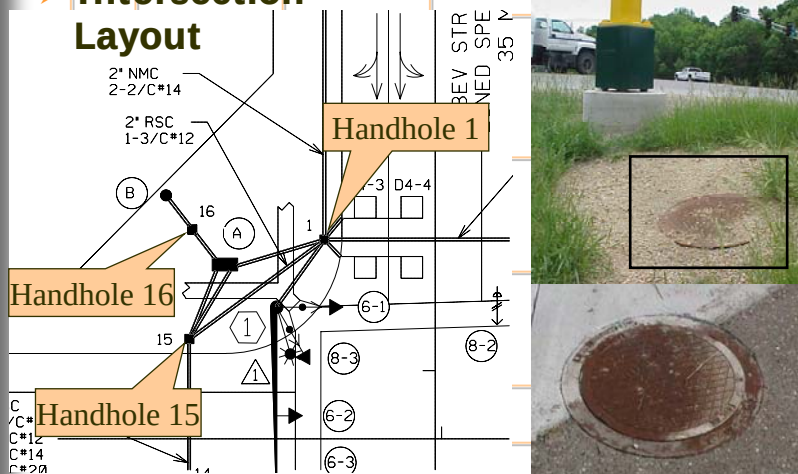
Traffic Signal 101

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Signal Layout

Intersection Layout



The handholes are shown as the solid black square (v) on the plan sheet.

March 2006

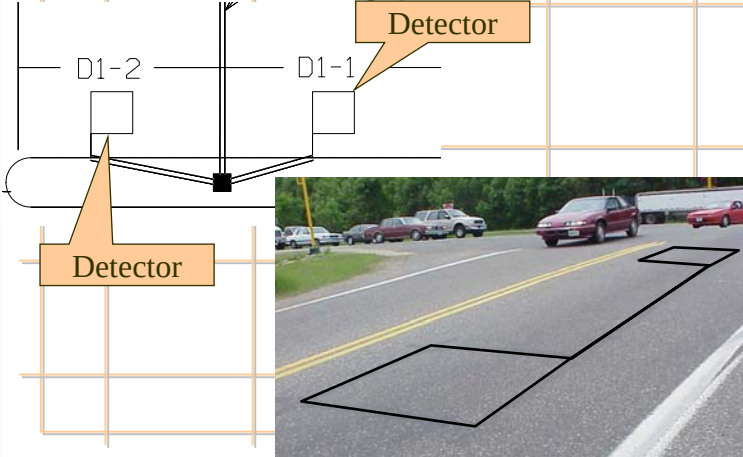
Traffic Signal 101

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Signal Layout

➤ Intersection Layout



Loop detectors are shown with a square or rectangle. The detectors are normally labeled as you approach the intersection and from right to left with Number 1 usually a detector back from the stop line and Number 2 to the left. These numbers are preceded by a D and the controller phase number (for example D8-1, D8-2, etc.).

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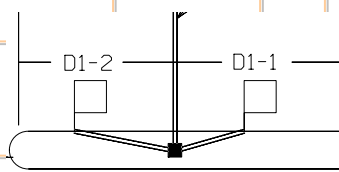


Signal Layout

➤ Intersection Layout

NMC LOOP DETECTORS		
DESIGNATION	NO. OF LOOPS	LOCATION
D1-1, D5-1	1	40
D1-2, D5-2	1	10
D2-1, D2-2	1	475
D4-1, D8-1	1	180
D4-2, D8-2	1	180
D4-3, D8-3	2	5 & 20
D4-4, D8-4	2	5 & 20
D6-1, D6-2	1	475

-ALL LOOP DETECTORS SHALL BE 6' X 6'
UNLESS OTHERWISE SPECIFIED
-LOCATION: DISTANCE FROM CROSSWALK/STOP
LINE IN FEET



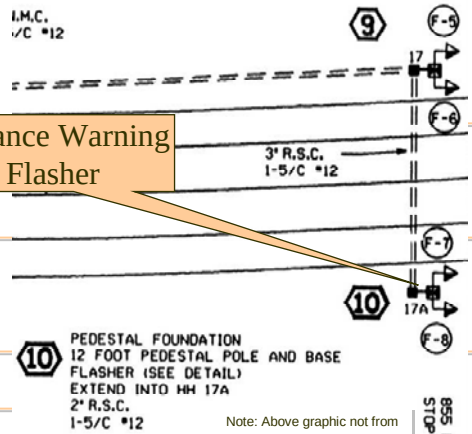
The loop detector table identifies the size, number and location of the detector shown on the plan sheet. The detector number refers to the detector shown on the intersection plan sheet. The location shows the distance from the stop line to the detector.

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Advance Warning Flasher

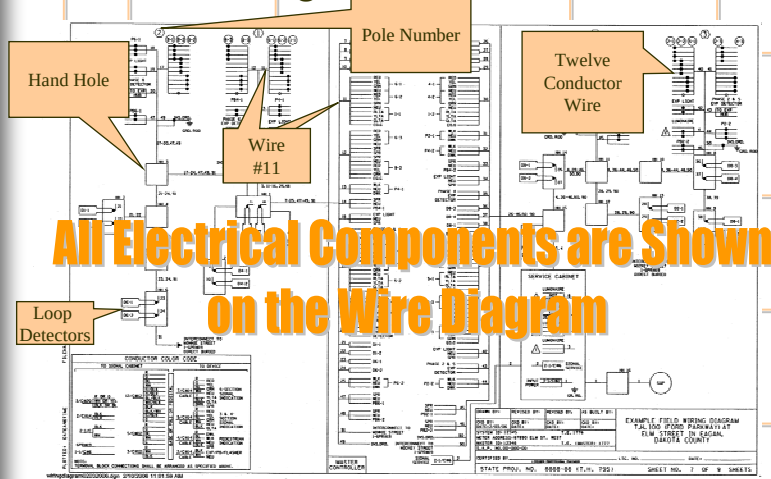


Note: Above graphic not from sample signal plan

Traffic Signal 101

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Field Wiring - Page 7 of 9

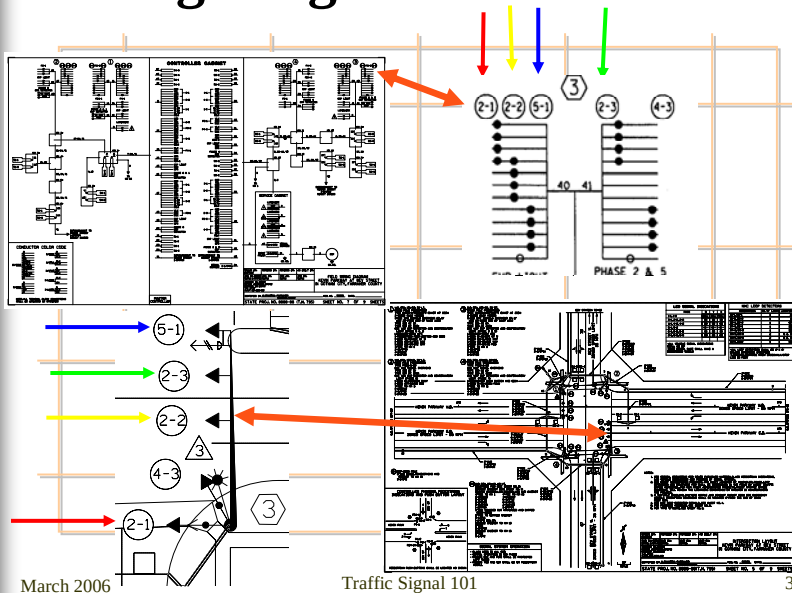


Traffic Signal 101

The Field Wiring diagram.



Wiring Diagram

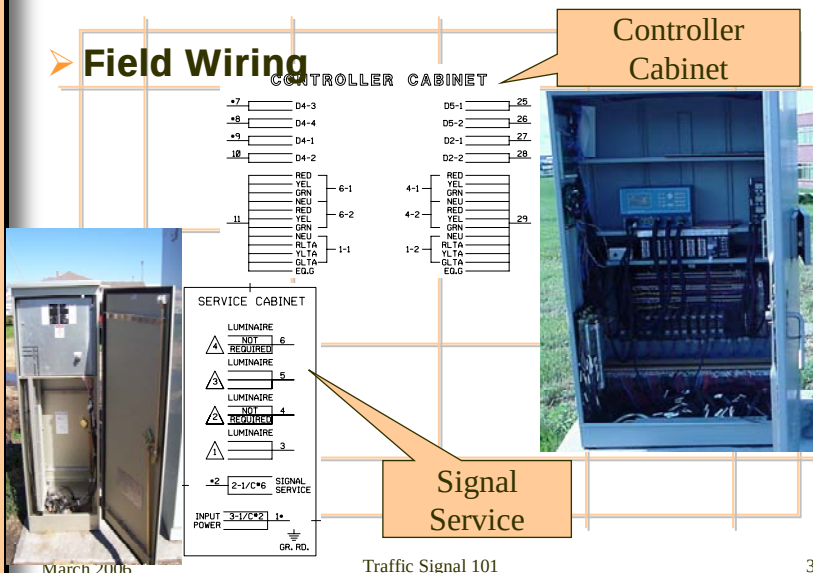


Pole #3 wire diagram to layout sheet.



Wiring Diagram

Field Wiring



The field wiring diagram is used to describe how the actual field wiring shall be placed.

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MTA/MDOT - Office of Traffic, Security & Operations (OTSO)



Mn/DOT - Signal Courses

➤ Training Schedule

- Signals 101....March 23rd, 2006
- Signal Design.....March 1st-3rd, 2006
- Signal Timing & Coordination...Spring, 2007
- Roadway Lighting Design...Spring, 2006
- Advanced Traffic Controller...Summer 2006
- www.dot.state.mn.us/trafficeng.html

Mn/DOT Office of Traffic, Security & Operations offers a variety of classes. Check the web for the latest scheduled offering of classes.

Handout

Mn/DOT Signal Cell Library

For the latest version, please visit:

www.dot.state.mn.us/caes/cadd/

TOPIC 5: CABINET



Office of Traffic, Security & Operations (OTSO)



Traffic Signals 101

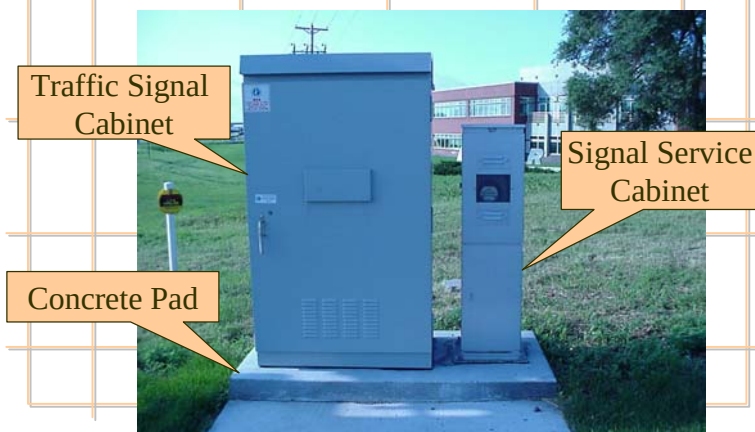
Topic 5 Cabinets



Office of Traffic, Security & Operations (OTSO)

Cabinets

➤ Traffic Signal Cabinet and Signal Service Cabinet



March 2006

Traffic Signal 101

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Traffic Signal Cabinet and Signal Service Cabinet

A typical installation of a Traffic Signal Cabinet and Signal Service Cabinet on a concrete pad.

Both cabinets meet Underwriters Laboratories (UL) standards.

Located adjacent to a signalized intersection.

Houses the controller which detects all vehicle and pedestrian activity and activates signals accordingly.



Cabinets

➤ Traffic Signal Cabinet and Signal Service Cabinets



Close-up of Signal Service Cabinet

Traffic Signal Cabinet and Signal Service Cabinets

Numerous Circuit Breakers, Switches, Cables, etc.

Furnishes power, and control to virtually all devices in, or adjacent to the intersection.

- Vehicle and Pedestrian indications
- Control equipment
- Convenience light and GFCI receptacle
- Street lighting

March 2006

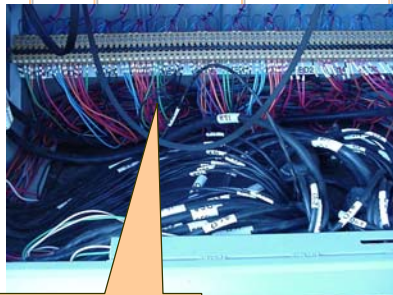
Traffic Signal 101

3

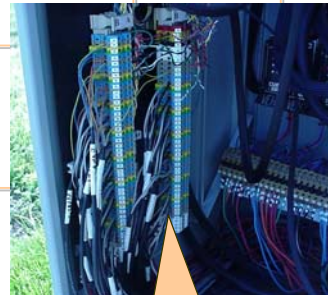


Cabinets

➤ Field Wiring in Traffic Signal Cabinet



Indication Hook-ups



Loop/PPB Hook-ups



Indication returns and grounds

Field Wiring in Traffic Signal Cabinet

All vehicle, pedestrian, and miscellaneous indications are connected to fuses and returned to neutral and ground busses.

All detector loops, and any other detection devices, are connected to Loop/Pedestrian Push-Button (PPB's) hook-up panel.

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Traffic Signal 101

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Cabinets

➤ Typical Traffic Signal Cabinets



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Traffic Signal 101

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Typical Traffic Signal Cabinets

Both sizes sit on the same bolt pattern.

Both current generation cabinets have identical panels and are wired identically.

The "P" size cabinet (60") has room enough only for basic control equipment.

Well-sized for business/downtown areas.

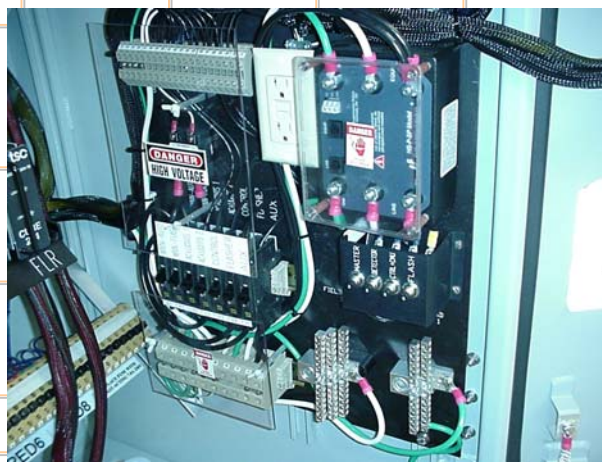
The "R" size cabinet (77") has room enough to add equipment for special equipment and operations.

- Autoscope
- Sonic Emergency Vehicle Preemption



Cabinets

➤ Power Panel



March 2006

Traffic Signal 101

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Power Panel

Electrical service from "Signal Service Cabinet" is connected here. (120VAC, single-phase, 60Hz)

Power Line protection is provided to help prevent damage from electrical overloading.

- Lightning
- Surges
- Nearby power-lines

Many neutral and ground wires connected here.

Provision for connecting test/maintenance equipment by furnishing a GFCI outlet.

- Drills
- Meters
- Power Line Monitors

NOTE: Some areas covered by plexi-glass to help prevent electrical shock.



Cabinets

➤ Cabinet Fans/Convenience Light Panel



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Traffic Signal 101

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Cabinet fans/Convenience Light Panel

Convenience light for cabinet maintenance.

1 of 2 ventilation fans.

Thermostat for control of ventilation fans.



Cabinets

➤ Detector Interface Panel



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Traffic Signal 101

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Detector Interface Panel

Wiring for ALL outputs of detection devices.

- 32 detector outputs in current cabinet configuration

Wiring for inputs to controller.

- 24 inputs in basic configuration for latest model

Wiring for inputs to, and outputs of controller to permit special functions.

- Detector reset
- Controller Reds & Greens
- Emergency Vehicle Preemption functions

Other special connections.

NOTE: Most special functions are currently accomplished via controller programming. In earlier controllers, these functions were accomplished with additional wiring.



Cabinets

➤ Detector Amplifier Rack



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Detector Amplifier Rack

Provides physical housing for “plug-in type, rack-mountable” detector amplifier units.

Detector rack distributes AC and DC power to all detector units as needed.

All outputs are wired to the Detector Interface Panel.

All detector inputs are wired from the Loop/Pedestrian Push-Button hook-up panel.

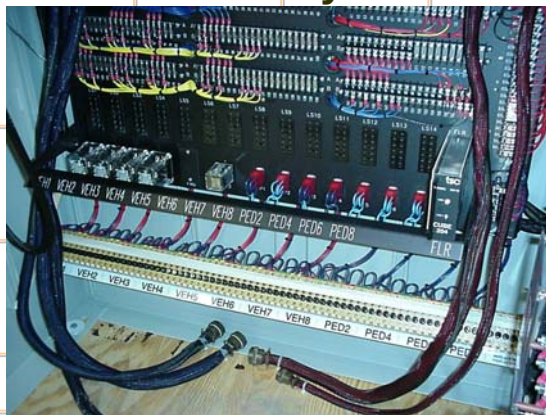
Various other inputs/outputs to accomplish proper, or enhanced detector operation.

Detector Power Supply (shown furthest left in picture) supplies DC power to Detector Rack.



Cabinets

➤ Controller Interface / Load-Switch / Flash Transfer Relay Panel



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Controller Interface/Load-Switch/Flash Transfer Relay Panel

Controller Interface Panel

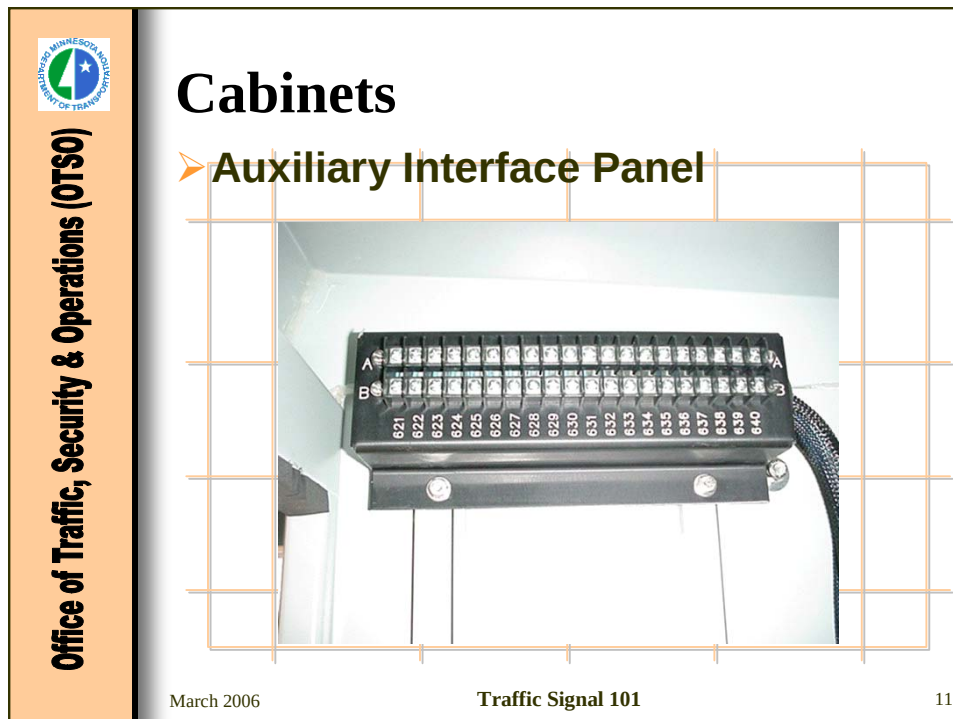
- ALL of the wires of the 3 NEMA controller connectors are terminated on the Controller Interface Panel. (177 connections)
- Many of the Conflict Monitor Unit (CMU) wires (approx. 49 of 81) are also terminated here.
- This is where signals input & output the controller. Most other assemblies and equipment are directly, or indirectly connected here.

Load-Switch Panel

- Load-switches are devices that convert the low-voltage D.C. outputs of the controller to High-voltage A.C. that power the indications in the intersection.
 - Opto-isolators in each load-switch help to protect the controller from high currents entering the controller.
 - Lightning
 - Over-voltage
 - Power-lines
- A Flasher is also located on the Load-Switch Panel. The flasher supplies power to the indications when the intersection is in the “Flash” mode.
 - Similar in basic operation to the Load-Switch
 - 2 alternating outputs, each 1 Hz, 50% duty cycle
- Flash Transfer Relays (FTR’s) are also located on the Load-Switch Panel. These FTR’s transfer indications between the load-switches and flasher.
 - FTR’s usually control only the RED indications
 - Flash color (amber or red) determined by “Flash Plugs”

Weidmueller Fuse Panel

- All field indications are connected to these 80 indicating fuses.
 - These provide a relatively easy way of connecting field indications
 - Usually one wire for each individual indication
 - Neon lamp on each fuse location indicates if fuse is “blown”



Auxiliary Interface Panel

Provides terminations for making additional electrical connections.

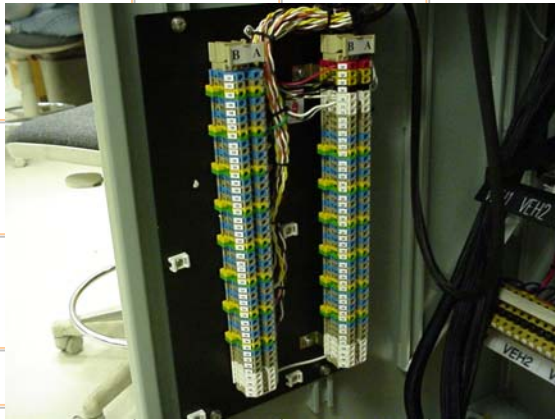
- Emergency Vehicle Preemption (EVP)
- Auxiliary detection
- Interlock functions





Cabinets

➤ Loop/Pedestrian Push-Button Hook-up Panel



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Traffic Signal 101

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Loop/Pedestrian Push-Button hook-up Panel

Provides terminations for virtually ALL detection field wires.

- Vehicle detection types.
 - Loop
 - Microwave
 - Ultrasonic
 - Magnetometer
 - Autoscope
- Pedestrian detection devices
 - Push-buttons
 - Optical sensors
- Emergency Vehicle Preemption
 - Optical
 - Sonic
- Railroad Preemption



Cabinets

➤ Auxiliary panel



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Traffic Signal 101

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Auxiliary panel

Control and Test switches

- Control Equipment Power switch
- Detector Power switch
- Master Controller Power switch
- Cabinet Lamp Power switch
- "Stop-Timing Override" switch
- Vehicle Test switches



Cabinets

– Police panel



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Traffic Signal 101

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Police Panel

AUTOMATIC - Normal “Stop-and-Go” and “Walk/Don’t Walk” operation.

SIGNALS OFF – All traffic signal indications go dark.

FLASH – Normally flashes Red/Red, pedestrian heads are off.

Note: If intersection has gone to flash due to automatic fault detection, it cannot be “reset” using this switch. If it’s necessary to put the signal to “SIGNALS OFF” or “FLASH”, it can be returned to “AUTOMATIC” operation. The operation will resume at the point at which the switch was moved from AUTOMATIC operation.



Cabinets

➤ At the back of your workbook under Tab 15, you will find a typical “Cabinet Print”

March 2006

Traffic Signal 101

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TOPIC 6: CONTROLLER OPERATIONS



Office of Traffic, Security & Operations (OTSO)



In this topic you will be introduced to traffic signal controller operations.

Traffic Signals 101

Topic 6 Controller Operations



Office of Traffic, Security & Operations (OTSO)

Controller Operations

— Econolite Controllers

KMC8000

ASC8000



KMC8000

1. Oldest of the three controllers displayed here.
2. The most rugged of the three.
3. The most difficult to install.
4. Least capable of the three without extensive external wiring/equipment.

- More external connections.
- More complicated wiring.

B. ASC8000

1. Newer, and less rugged as the previous controller mentioned.
2. Less wiring with less difficulty.
3. Capabilities increased greatly.

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Traffic Signal 101

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Controller Operations

— Econolite Controllers



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Traffic Signal 101

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C. ASC2

1. Newest, with great capability.
2. Greatest capability with least external connections.

D. ASC2S

1. Same as ASC2 except for surface mount technology.
2. Surface mount technology results in small-size, light-weight. ($\approx 7 \times 9 \times 15$ inches/ $\approx 8\frac{1}{2}$ lbs.)



Controller Operations

— Econolite Controllers



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E. ASC2M & KMC10,000



Controller Operations

– NEMA Controllers

- **Standardization of Connectors**
- **Operating Limits Standardized**
- **Standardization of Timed Intervals**

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Traffic Signal 101

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NEMA Controllers (National Electrical Manufacturers Association)

A. NEMA's involvement in controller design helped greatly to simplify installations.

1. Standardization of A, B, C (1, 2, 3) connectors.

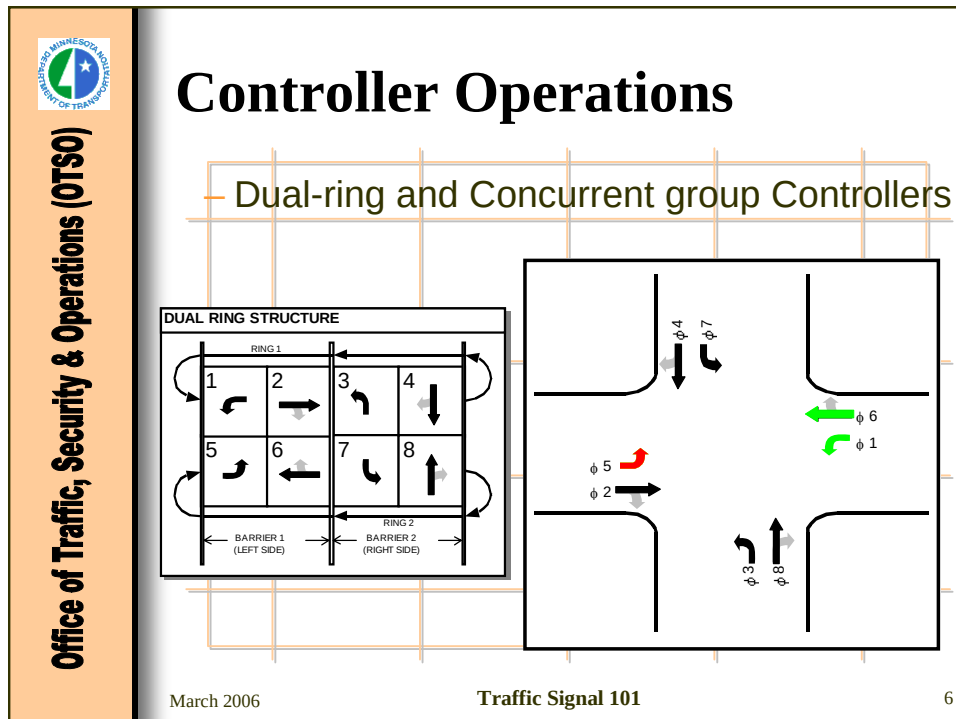
- Standard "pin-outs".
- Standard Input/Output (I/O) names.
- Connectors physical identical/interchangeable.

2. Operating limits standardized.

- Operating temperature range. -30°F to 165°F.
- Humidity range. >95% @40°F to 110°F.
- Operating voltage. 89 to 135 VAC.
- The above three specifications are but a few of many. Many other parameters have contributed to a better product.

3. Standardization of timed intervals.

- Passage time.
- Maximum green time.
- Gap reduction.
- Walk & Ped Clearance.
- Many more intervals with proper operation dictated by NEMA.



Dual-ring and concurrent group controllers.

A. A dual-ring controller operates similar to TWO separate controllers.

- Ring 1 contains phases Ø1, Ø2, Ø3, Ø4.
- Ring 2 contains phases Ø5, Ø6, Ø7, Ø8.
- No more than one phase from either ring can time at any given time.

B. An 8Ø (eight-phase) usually has two CONCURRENT groups.

- Concurrent Group 1 contains phases Ø1, Ø2, Ø5, Ø6.
- Concurrent Group 2 contains phases Ø3, Ø4, Ø7, Ø8.
- Phases from one group cannot time with phases of the other group.

C. Combining two rings with two concurrent gives the following:

- Ø1 or Ø2 allowed to time with Ø5 or Ø6 and vice-versa.
- Ø3 or Ø4 allowed to time with Ø7 or Ø8 and vice-versa.

D. Barriers.

- Phase(s) must terminate their timing and cross the “BARRIERS” together.

E. Exceptions.

- The model of the current discussion has been about a “dual-ring, two concurrent group, eight-phase controller configuration.
- IT CAN ALL BE CHANGED, within limits, TO PERFORM SPECIAL OPERATIONS.



Controller Operations

– Conflict Monitor Unit (CMU)



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Conflict Monitor Unit. (CMU)

- A. When the CMU recognizes a “fault”, it will put the intersection to FLASH.
- B. Not an integral part of the controller.
- C. Monitors condition of the controller.
 - Internal controller voltages monitored.
 - Certain controller programming monitored.

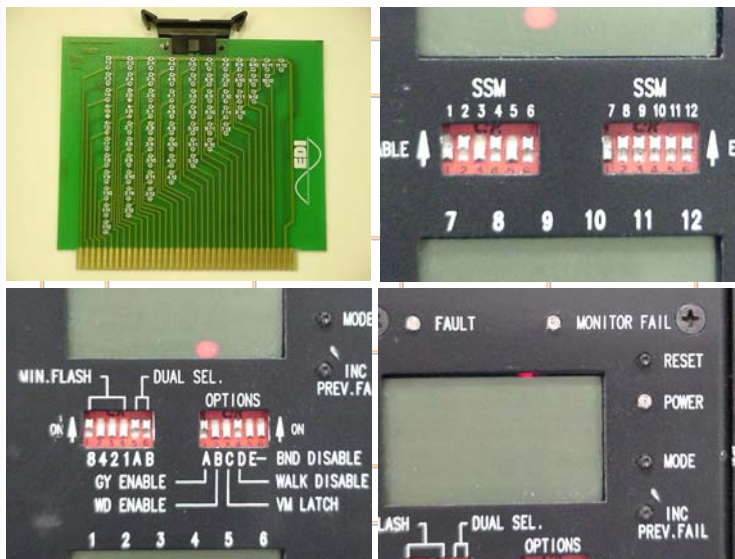
- D. Monitors field indications AT THE POINT THE CIRCUITS LEAVE THE CABINET.

Checks for:

- Conflicts.
- Red failure.
- Dual indication.



Controller Operations



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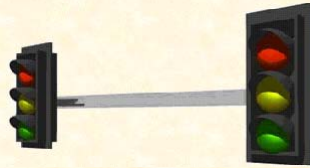
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TOPIC 7: FIELD OPERATIONS



Office of Traffic, Security & Operations (OTSO)



Traffic Signals 101

Topic 7 Field Operations

In this topic, you will be introduced to the operation of signals in the field. This includes controller elements such as cycle length and phases; pedestrian timing requirements; pre-timed and actuated signal control; and system control.

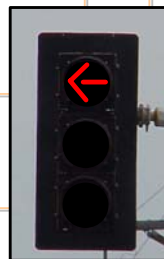


Office of Traffic, Security & Operations (OTSO)

Field Operations

➤ Controller Timing

- A traffic signal controls traffic by assigning right-of-way to one traffic movement or several non-conflicting traffic movements at a time
- Right-of-way is assigned by turning on a **green** signal for a certain length of time or an interval
- Right-of-way is ended by a **yellow** change interval during which a yellow signal is displayed, followed by the display of a **red** signal



The objective of traffic signal timing is to assign the right-of-way to alternating traffic movements in such a manner to minimize the average delay to any group of vehicles or pedestrians and reduce the probability of accident producing conflicts.

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Field Operations

➤ Cycle Length

- The cycle length is the total time to complete one sequence of signalization around an intersection
- In an actuated controller unit, a complete cycle is dependent on the presence of calls on all phases
- In a pre-timed controller unit it is a complete sequence of signal indications
- In a fully actuated signal (defined later), the cycle length varies
- The cycle length is fixed in a coordinated or pre-timed signal

Short cycle lengths typically yield the best performance in terms of providing the lowest overall average delay provided the capacity of the cycle to pass vehicles is not exceeded. **The cycle length, however, must allow adequate time for vehicular and pedestrian movements.** Longer cycles are used during peak periods to provide more green time for the major street, to permit larger platoons in the peak direction, and/or to reduce the number of starting delays.

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Field Operations

➤ Phase Change Interval

- The phase change interval timing (Yellow) advises drivers that their phase has expired and they should:
 - come to a safe stop prior to the stop line, or;
 - proceed through the intersection if they are too near the intersection to stop
- Intersection Clearance Interval (All-Red)
 - The Intersection Clearance Interval will provide a vehicle enough time at the end of yellow to clear before the next green is displayed

The MN MUTCD states that the exclusive function of the steady yellow interval shall be to warn traffic of an impending change of right-of-way assignment. The yellow vehicle change interval should have a range of approximately 3 to 6 seconds. Generally the longer intervals are appropriate to higher approach speeds. The yellow vehicle change interval should be followed by a short all-way red clearance interval, of sufficient duration to permit the intersection to clear before cross traffic is released.

Minnesota Traffic Laws state that vehicular traffic facing a yellow indication are warned that the related green movement is being terminated or that the red indication will be exhibited immediately thereafter when vehicular traffic shall not enter the intersection.

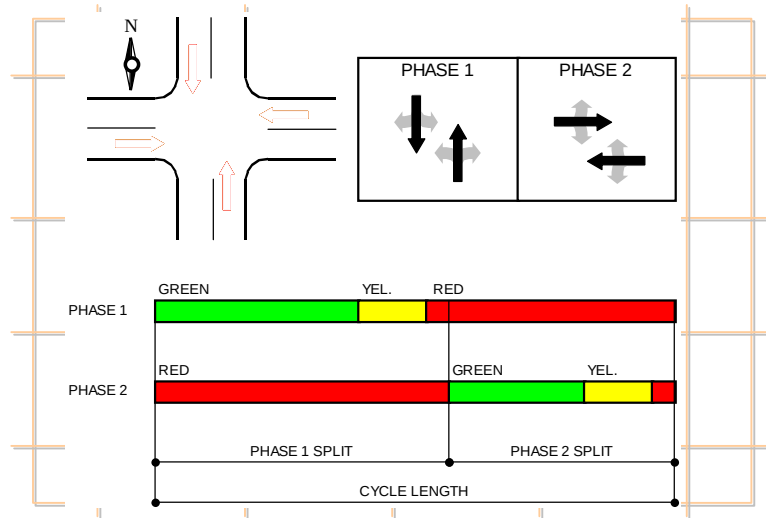
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Field Operations



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The figure at the left shows the timing operation for a basic two-phase or two-traffic movement pre-timed controller. Note that at the end of phase 1 and phase 2 yellow, there is a short all-red clearance interval.



Field Operations

➤ Pedestrian Timing

– Walk

- The MN MUTCD states, "the WALK interval should be at least 4 to 7 seconds in length so that pedestrians will have adequate opportunity to leave the curb before the clearance interval is shown"
- If pedestrian volumes and characteristics do not require a 7-second walk interval, walk intervals as short as 4 seconds may be used.

– Flashing Don't Walk

- $\text{flashing DON'T WALK} = D/R$



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The *flashing* DON'T WALK interval is determined by the following formula:

$$\text{flashing DON'T WALK} = D/R$$

D = Distance from the near curb or shoulder to at least the center of the farthest traveled lane.

R = Walking rate of 4 ft/sec (1.2 m/sec). Assumed walking rate unless special conditions (school kids, elderly or handicapped) require a slower walking rate.

See topic 9 on pedestrians for further details.



Field Operations

➤ *Pre-timed signal control*

- Under these conditions, the signal assigns right-of-way at an intersection according to a predetermined schedule
- The sequence of right-of-way (phases), and the length of the time interval for each signal indication in the cycle is fixed, based on historic traffic patterns

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No recognition is given to the current traffic demand on the intersection approaches unless detectors are used. The major elements of pre-timed control are (1) fixed cycle length, (2) fixed phase length, and (3) number and sequence of phases.

Advantages to pre-timed control include:

- Simplicity of equipment provides relatively easy servicing and maintenance.
- Can be coordinated to provide continuous flow of traffic at a given speed along a particular route, thus providing positive speed control.
- Timing is easily adjusted in the field.
- Under certain conditions can be programmed to handle peak conditions.

Disadvantages to pre-timed control include:

- Do not recognize or accommodate short-term fluctuations in traffic.
- Can cause excessive delay to vehicles and pedestrians during off-peak periods.



Field Operations

➤ ***Traffic-actuated signal control***

- Traffic-actuated control of isolated intersections attempts to adjust green time continuously, and, in some cases, the sequence of phasing
- These adjustments occur in accordance with real-time measures of traffic demand obtained from vehicle detectors placed on one or more of the approaches to the intersection

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The full range of actuated control capabilities depends on the type of equipment employed and the operational requirements.

Advantages to actuated signals include:

- Usually reduce delay (if properly timed).
- Adaptable to short-term fluctuations in traffic flow.
- Usually increase capacity (by continually reapportioning green time).
- Provide continuous operation under low volume conditions as an added safety feature, when pre-timed signals may be put on flashing operation to prevent excessive delay.
- Especially effective at multiple phase intersections.

Disadvantages to actuated control include:

- The cost of an actuated installation is substantially higher than the cost of a pre-timed installation.
- Actuated controllers and detectors are much more complicated than pre-timed signal controllers, increasing maintenance and inspection skill requirements and costs.
- Detectors are costly to install and require careful inspection and maintenance to ensure proper operations.



Field Operations

➤ Traffic-actuated control

– Full Actuated Control.

In full actuated control, all signal phases are actuated and all signalized movements require detection

Many Mn/DOT applications require full-actuated density operation (refer to the Traffic Signal Timing and Coordination Manual)

Traffic actuated signal control can further be broken into the following categories:

- Semi-Actuated
- Full Actuated Control

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Field Operations

➤ Traffic Signal Phasing

– A traffic **signal phase**, or **split**, is the part of the cycle given to an individual movement, or combination of non-conflicting movements during one or more intervals

– An **interval** is a portion of the cycle during which the signal indications do not change

The predetermined order of phases is the sequence of operation. This order is fixed in a pre-timed controller, and under certain circumstances, may be variable with an actuated controller.

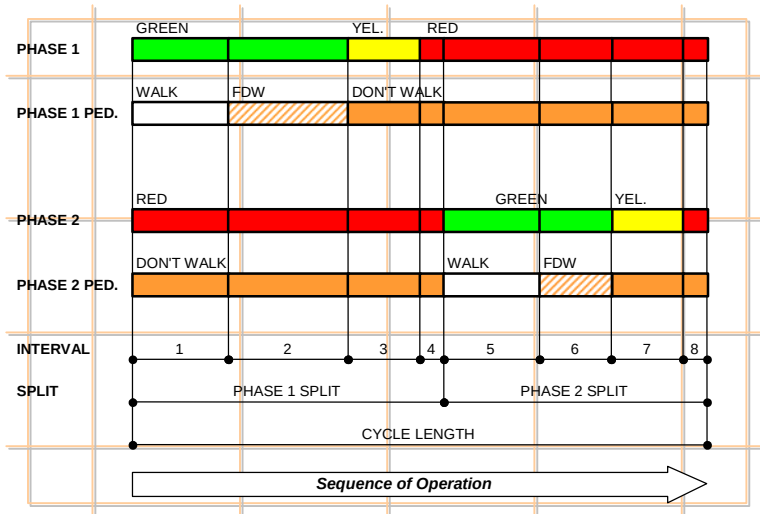
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Field Operations



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For the figure to the left, there are eight intervals where the signal indications do not change. Notice that intervals 4 and 8 are all red periods (interval 4 is the phase 1 all red and interval 8 is the phase 2 all red). The phase 1 split is made up of intervals 1 through 4 and the phase 2 split is made up of intervals 5 through 8. The sum of split 1 and 2 is the cycle length.



Field Operations

➤ Actuated Controller Phase Operations

- **Minimum Green** Interval is the shortest green time of a phase
- A minimum green time setting will accommodate the lowest expected number of vehicles that arrive per cycle
- It also allows approaching vehicles a chance to reach detectors

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Definition of the **minimum green** interval for an actuated controller.

There must be a minimum green time so that stopped vehicles have enough time to get started and partially cross the intersection before the clearance interval appears.



Field Operations

- **Passage Time** (vehicle extension or gap time) is the time that the green phase will be extended for each actuation

Passage time (vehicle extension or gap time) is typically set as the time it takes to travel from the vehicle detector to the stop line at the travel speed of the roadway for pulse loops or the average acceptable headway between vehicles for presence loops located close to the stop line.

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Field Operations

- **Maximum Green** establishes the maximum limit to which the green interval can be extended on a phase in the present of a serviceable demand on a conflicting phase

Most controllers used by Mn/DOT can have two or more maximum green times programmed. The second maximum time can put into effect by time clock.

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Field Operations

– Recall

- *Recall to Minimum:* When active and in the absence of a vehicle call on the phase, a temporary call to service the minimum initial time will be placed on the phase
- *Recall to Maximum:* With the maximum vehicle recall active a constant vehicle call will be placed on the phase
- *Recall to Pedestrian:* This feature provides vehicle green and pedestrian walk and clearance intervals

In the absence of an actuation, a controller unit will normally rest on the current phase being serviced. A recall will force the controller to return to a particular phase's green interval, even with no demand.

An actuation is the operative response of any type of detector (call).

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Field Operations

➤ Vehicle Detection



One of the advantages to actuated control is the ability to adjust timing parameters based on actual vehicle or pedestrian demand. Since this vehicle or pedestrian demand varies at different times of the day, a detector is placed in the path of approaching vehicles or at a convenient location for the use of pedestrians.

The actual operation of the signal is highly dependent on the operation of these detectors.

The pictures at the left show typical detector units in the controller cabinet. The detectors used in the field will be discussed in the following slides.

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Field Operations

– Presence detection

- Call & Extend
 - Vehicles put call into the controller at any time
- Call-only
 - Vehicles put call into the controller only during Red
- Delay Call
 - Vehicles put call into the controller only after a programmed delay-time
- Delay Call-immediate extend
 - Vehicles place a call to the controller only after a programmed delay-time EXCEPT when the phase that calls the detector is Green, then the call goes in immediately

A presence detector has the ability to sense that a vehicle, whether moving or stopped, has appeared in its zone of detection.

A call is a registration of a demand for the right-of-way by traffic at a controller unit.

An extension detector is one that is arranged to register an actuation at the controller unit only during the green interval for that approach so as to extend the green time of the actuating vehicles.

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Field Operations

– Pulse-type detection

- Extend only
 - Vehicles put call into the controller only during Green
- Sampling
 - Vehicles put call into the controller anytime, but not for traffic control, for counting vehicles only

Pulse mode detection is a mode of operation where the detector produces a short output pulse when detection occurs.

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Field Operations

- Emergency Vehicle Preemption (EVP)
Detection
 - Optical
 - Strobe light pulsing at very specific frequency
 - Can have digital information encoded on the pulsing light
 - Sonic
 - Actually “hears” sirens approaching using directional microphones
 - NOTE!!! about EVP
 - EVP has priority over normal traffic operation

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An EVP detector is a device that preempts a traffic signal controller. See topic 12 for further details.



Field Operations

- Types of Detectors
 - Loop
 - Micro-loops
 - Magnetometer
 - Microwave
 - Ultrasonic
 - Video

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A loop detector is the most common detector type. It is a loop of wire imbedded in the pavement carrying a small electrical current. When a large mass of metal passes over the loop, it senses a change in inductance of its inductive loop sensor by the passage or presence of a vehicle near the sensor.

A magnetometer measures the difference in the level of the earth's magnetic forces caused by the passage or presence of a vehicle near its sensor.

A microwave radar detector is a detector that is capable of sensing the passage of a vehicle through its field of emitted microwave energy.

An ultrasonic detector is capable of sensing the passage or presence of a vehicle through its field of emitted ultrasonic energy.

A video detector responds the video image or changes in the video image of a vehicle.



Field Operations

➤ Coordinated Systems

- A coordinated system is a series of signalized intersections that are designed to interact as a system. Reasons for coordinating include:
 - To move traffic through a series of intersections
 - To reduce delay
 - Move vehicles in a grid system
 - To help reduce gridlock for closely spaced intersections

The system concept as related to traffic signal control includes the methods, equipment, and techniques required coordinating traffic flow along an arterial or throughout an area.

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Field Operations

– System Objective

- The major objective of a traffic control system is to permit continuous movement and/or minimize delay along an arterial or throughout a network of major streets
- In the system, a timing plan is defined by a combination of control parameters for one or more intersections based upon an analysis of demand

The major objective of a traffic control system is to permit continuous movement and/or minimize delay along an arterial or throughout a network of major streets. This involves the selection, implementation, and monitoring of the most appropriate operational plan. Basically, a traffic signal system provides the appropriate and necessary timing plans for each intersection in terms of individual needs as well as the combined needs of a series of intersections.

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Field Operations

– Timing plans for a system consists of:

- **A System Cycle.** A specific cycle length is imposed throughout the system covered by the timing plan
- **Split.** Each movement in the intersection has a defined split
- **Offset.** The offset is the relationship of the beginning of the main street green at this intersection to a master system base time
- Offset should be expressed in seconds
- The difference in offset between intersections along a street defines the speed at which traffic can travel without stopping

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Field Operations

– Types of Traffic Signal Control Systems

- **Time of Day (TOD) Time Based System.**
 - **Non-interconnected System.** The offset relationship is maintained by relying on the clocks in the local controllers
 - **Interconnected System.** Local intersections are physically interconnected to ensure coordinated operation
- **Traffic Responsive System.** Volume levels determine which of a number of available cycle lengths is selected, and volume differential determines offset (i.e., inbound, outbound, or average)

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Handout

Excerpts from the Traffic Signal Timing and Coordination Manual

For the latest version of this manual, please visit:

www.dot.state.mn.us/trafficeng/otepubl/index.html

TOPIC 8: HEAD AND LOOP PLACEMENT



Office of Traffic, Security & Operations (OTSO)



In this topic you will be introduced to traffic signal head placement and vehicle loop detector placement. A series of detector and head placement charts are included at the back of this topic. These are found in the Signal Design Manual.

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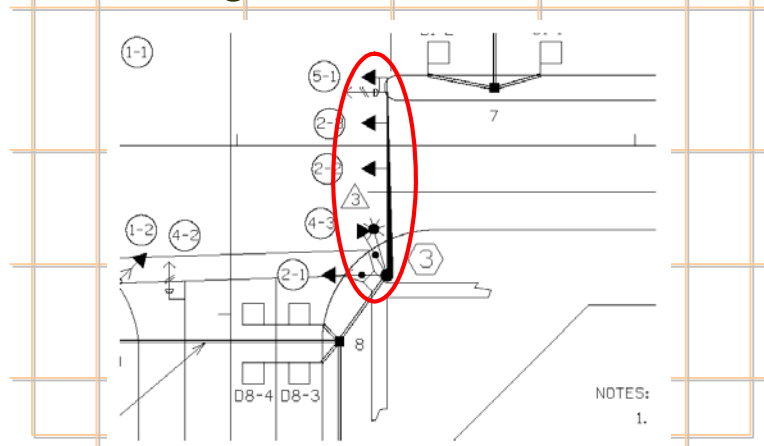
Topic 8 Head/Loop Placement



Office of Traffic, Security & Operations (OTSO)

Head Placement

➤ Traffic Signal Head Placement



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When placing signal heads:

- Consider signal operations
- Review noted information from field observations checklist (signal design)

Then refer to:

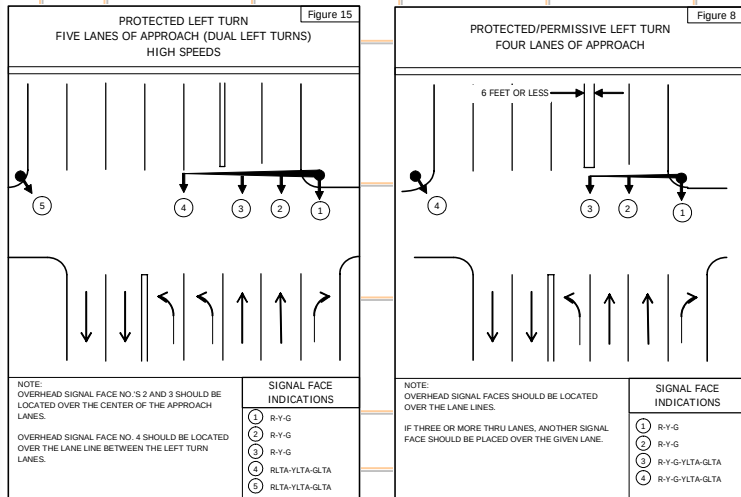
- Signal face layouts in the Signal Design Manual
- Standard plates and technical manual for symbols and,
- Uniform traffic signal plan labeling format (Signal Design Manual)

A filled in triangle indicates a new signal head, an open triangle indicates an existing signal head.



Head Placement

Traffic Signal Layout



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Sample signal head placement charts. Refer to the handouts at the back of this topic (from the Signal Design Manual).

These charts show the minimum number of signal heads.

There has to be more than one signal head.

These layouts are not definitive, and should be considered the minimum arrangements. These figures do not cover every possible condition; they may need to be adapted to fit the situation.



Loop Placement

Loop Detector Placement Design

- **Guaranteed Green**
- **Safety**
- **Failsafe**
- **Maintenance**
- **Operation**

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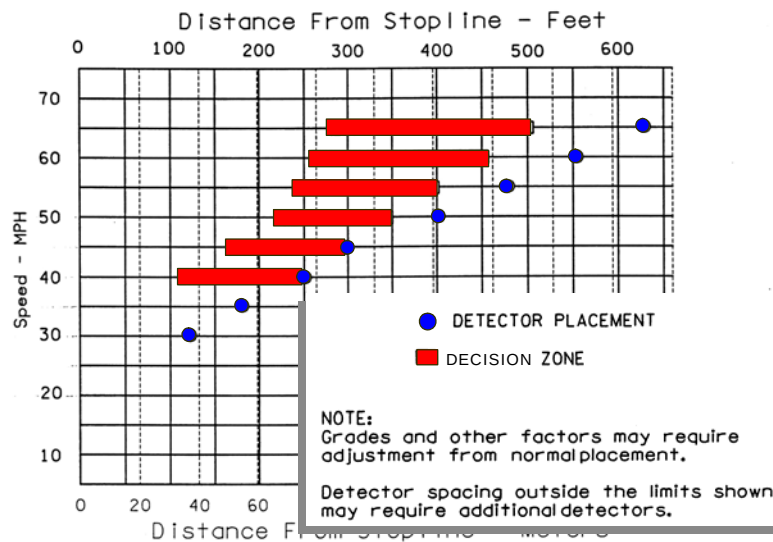
Guaranteed Green. All vehicles except right turn on red (RTOR) vehicles will be guaranteed service of a green light within a cycle.

Safety. Consideration must be given to winter as well as summer conditions

Failsafe. Alternatives must be provided for when a primary detector fails so that non-mainline phases don't have to be placed on recall.

Maintenance. Detectors should be located in a good roadbed, if the surface is in a very poor condition it should be replaced.

Operation. Detectors should provide operation that is logical to the driving public.

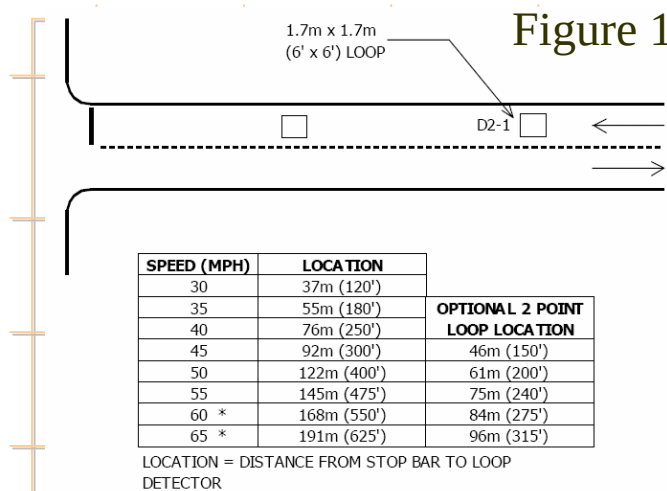


The horizontal bar indicates a range of distance out from the intersection, within which some drivers will, and some will not, stop for a yellow light. Detector placement allows the signal to change to yellow when this area near the intersection is empty of cars.

The decision zone is 2 to 4-1/2 seconds away from the stop bar.



Loop Placement

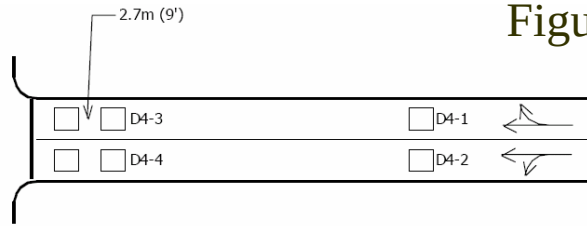


This is a typical detector placement for a loop on the major approach. There is no stop-line detector and the phase is placed on recall (the green is returned to this movement after servicing the conflicting movements).



Loop Placement

Figure 2



LOCATION = DISTANCE FROM STOP BAR TO
LOOP DETECTOR

LOOP DETECTOR FUNCTIONS

- 1 = CALL AND EXTEND
- 3 = EXTEND ONLY
- 7 = DELAY CALL - IMMEDIATE EXTEND

SPEED (MPH)	FRONT LOOP LOCATION	BACK LOOP LOCATION
30	1.5m (5')	37m (120')
35	1.5m (5')	55m (180')
40	1.5m (5')	76m (250')
45	1.5m (5')	92m (300')
50	1.5m (5')	122m (400')
55	1.5m (5')	145m (475')

NUMBER	FUNCTION	SIZE
D4-1	3	1.7 x 1.7m (6' X 6')
D4-2	1	1.7 x 1.7m (6' X 6')
D4-3	7	2 - 1.7 x 1.7m (6' X 6')
D4-4	1	2 - 1.7 x 1.7m (6' X 6')

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Where the minor approach is low volume and low speed, the back detectors (D4-1 and 2) are sometimes omitted.

Handout

Excerpts from the Signal Design Manual, Chapter 3 and 4

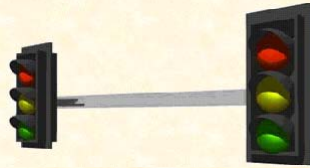
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www.dot.state.mn.us/trafficeng/otepubl/index.html

TOPIC 9: PEDESTRIAN



Office of Traffic, Security & Operations (OTSO)



Traffic Signals 101

Topic 9 Pedestrian

In this topic you will be introduced to the movement of pedestrians at signalized intersections.



Office of Traffic, Security & Operations (OTSO)

Pedestrian

➤ Need for Pedestrian Control

- Safety
 - The primary need for pedestrian control is to reduce the number and severity of traffic accidents involving pedestrians
- Traffic Flow
 - Where pedestrian flow is heavy, special controls may be necessary to prevent reduction in capacity

Safety. Pedestrians are slow and fragile as compared to motor vehicles; a collision between a vehicle and a pedestrian almost always results in at least an injury, often a fatality. The pedestrian population includes many people who are not familiar with traffic laws (one does not need to pass an examination to become a pedestrian).

Traffic Flow. At unsignalized intersections a steady stream of pedestrians preempting crosswalks may reduce vehicular capacity considerably. At signalized intersections lacking special pedestrian signals, conflicts between vehicular movements and pedestrians may cause congestion.

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Pedestrian

➤ Pedestrian Timing Requirements

- The pedestrian timing requirements include:
 - The Walk Interval
 - Flashing Don't Walk Interval

Pedestrian timing includes the Walk time (defined on slide 4 below) and the Flashing Don't Walk time (defined on slide 5 on the next page).

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Pedestrian

– Pedestrian Timing Requirements

- *Walk:* The walk interval is typically 4 to 7 seconds. This allows pedestrians adequate time to leave the curb and begin crossing. Under special circumstances, such as at a school crossing with numerous pedestrians, walk times may need to exceed 7 seconds.

The Walk interval is the time given to allow the pedestrian to leave the curb and begin crossing the street.

Mn/DOT typically uses 7 seconds.

The MN MUTCD, Chapter 4E guidance is to use 7 seconds. The MN MUTCD indicates this option:

“If pedestrian volumes and characteristics do not require a 7-second walk interval, walk intervals as short as 4 seconds may be used.”

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Pedestrian

– Pedestrian Timing Requirements

- *Flashing Don't Walk (FDW)*: FDW (pedestrian clearance) is provided to allow a pedestrian who has just left the curb to travel to **at least** the center of the farthest traveled lane before opposing vehicles receive a green. The calculation of the flashing don't walk (pedestrian clearance) is:

$$FDW = D / R$$

The Flashing Don't Walk calculated as the amount of time required to cross the street. This should allow pedestrians adequate time to cross the roadway safely. It is based on the Distance to cross (D) and the rate at which a pedestrian walks (R).

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Pedestrian

– Ped Timing **Recommended** Practice

- For a single roadway or a divided roadway with a median island less than 6 feet wide, the pedestrian is provided time to cross the entire intersection, without stopping in the middle.
- WALK = 7 seconds (this may be reduced to 4 seconds if it is necessary to minimize pedestrian timing considering the other factors)

More details on Mn/DOT's recommended timing practice can be found in the Traffic Signal Timing and Coordination Manual.

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Pedestrian

- $FDW = (D/R)$
- (time should not be less than WALK time and the time may be reduced by the yellow interval **IF** it is necessary to minimize pedestrian timing considering other factors)

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Signal controllers used by Mn/DOT do not time the yellow vehicle indication concurrent with the flashing don't walk. Because of this, the yellow interval may be included in the pedestrian clearance time (i.e., the pedestrian clearance time is equal to flashing don't walk interval plus the yellow interval).

D is the distance across, from curb to the center of the farthest travel lane.

R is the walking rate in feet per second. Usually 4 feet/second (2.7 mph) is used, but speeds as slow as 2.5 feet/second (1.7 mph) may be used in special circumstances.



Pedestrian

- *Divided Roadways*
 - Option 1 - Cross to Median Only (for divided roadways with median islands over 6 feet wide with pedestrian indications and button in the median)
 - Option 2 - Cross Completely

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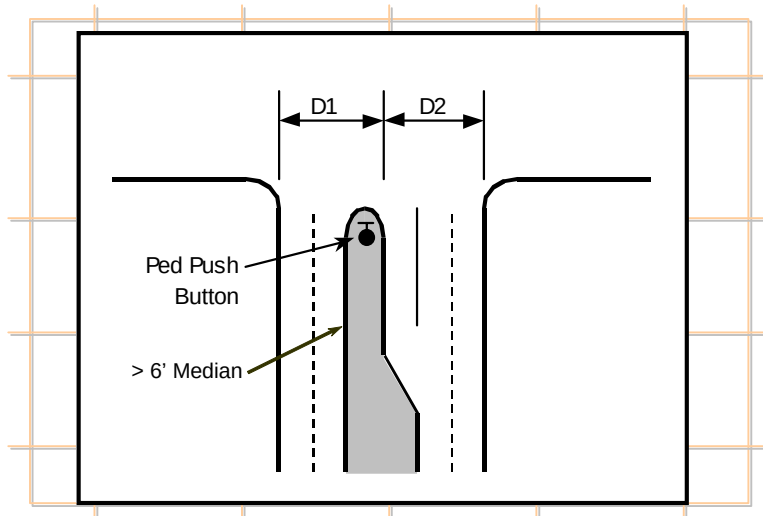
For Option 1, the crossing distance should be determined by using the longest distance from one side to the median.

For Option 2, the timing is sufficient to allow a pedestrian who starts to cross on the beginning of Walk, to cross the entire roadway. A pedestrian, who begins to cross later, may have to stop in the median, press the ped button, and wait for the next Walk.

- $Walk = D1/R$
- Flashing DON'T Walk = $(D2/R)$



Pedestrian



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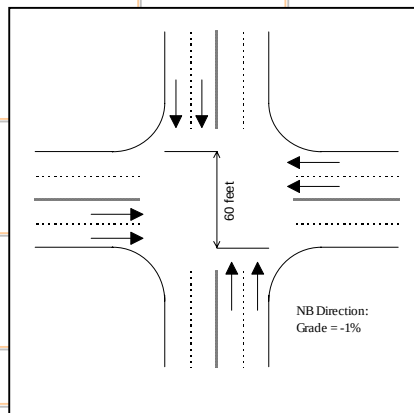
9

This graphic shows the measurements of D1 and D2.



Pedestrian

➤ Pedestrian Timing Requirements Example



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Pedestrian timing requirement example. For this example a pedestrian is required to cross in the north-south direction (60 feet). In this example, the distance D is used as 60 feet.



Pedestrian

➤ Pedestrian Timing Requirements Example

- Assume a walking speed of 4 feet per second with no special pedestrian requirements.
- The flashing don't walk would then be:
 - $FDW = 60 \text{ feet} / 4 \text{ feet per second} = 15 \text{ seconds}$

In this example the pedestrian would typically be given a 7 second Walk proceeding the Don't Walk.

For normal conditions, 4 feet per seconds is typically used as the crossing speed. This speed may need to be reduced under special circumstances.

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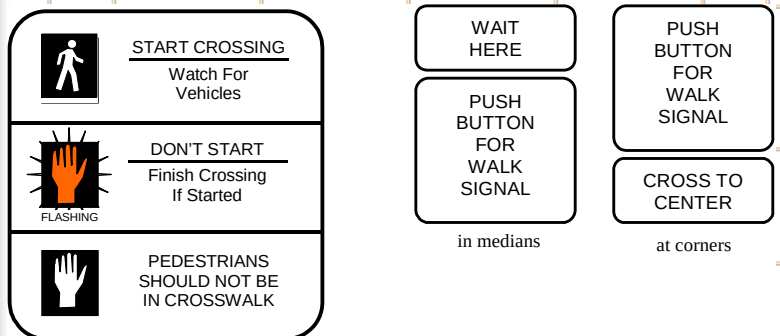
Traffic Signal 101

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Pedestrian

– Pedestrian Information Sign



Sign Specifications: 6 x 6 inches
Black legend on white background,
Except the DON'T WALK is orange.

Pedestrian Information Sign

- To provide pedestrians with more information at the traffic signal
- The pedestrian informational sign shall be used on all traffic signal installations that have pedestrian indications.

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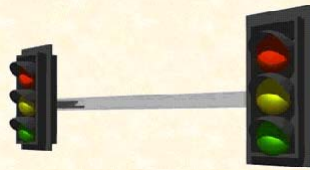
Traffic Signal 101

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TOPIC 10: ADVANCED WARNING FLASHER



Office of Traffic, Security & Operations (OTSO)



Traffic Signals 101

Topic 10 Advanced Warning

In this chapter you will be introduced to Advanced Warning Flashers (AWF).

The information presented in this section is from the MUTCD Section 4M and the Traffic Signal Timing and Coordination Manual. A copy of the relevant sections from these documents is included at the end of this topic.



Office of Traffic, Security & Operations (OTSO)

Advanced Warning

— Advanced Warning Flasher (AWF)



Picture of an Advanced Warning Flasher.

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Advanced Warning

Advanced Warning Flasher



March 2006

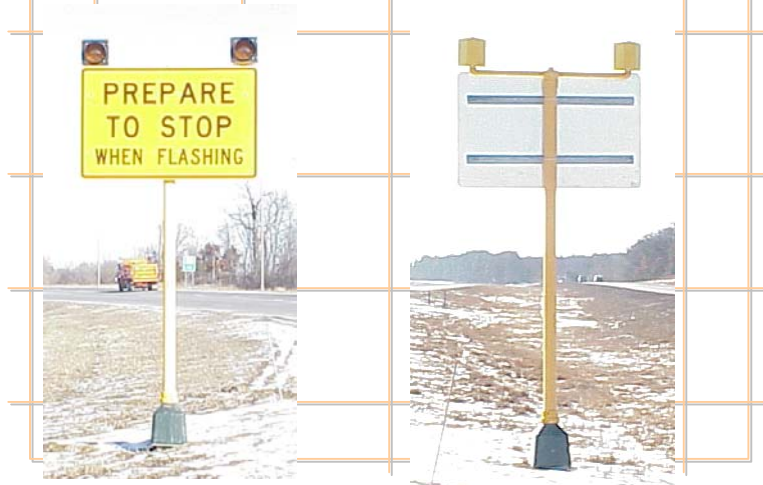
Traffic Signal 101

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Advanced Warning

Advanced Warning Flasher



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Traffic Signal 101

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Front and rear view of AWF.



Advanced Warning

➤ Advanced Warning Flasher

- The Advanced Warning Flasher (AWF) is a device which, at certain high speed locations, has been found to provide additional information to the motorist describing the operation of the traffic signal
- Advance Warning Flasher can assist the driver in making safer and more efficient driving decisions

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The purpose of the Advanced Warning Flasher.



Advanced Warning

➤ Advanced Warning Flasher

- The additional information includes a sign/flasher combination to get the driver's attention and a specific notice that the driver must prepare to stop

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The Minnesota AWF system consists of a flasher and a sign located on main street approaches to a high speed signalized intersection. It is connected to the traffic signal in such a way that when the main street green is about to change to yellow, the flasher is turned on to warn the approaching drivers of the impending change. Basically, the purpose of an optimally designed combination of traffic signal and AWF system is twofold: 1) to inform the driver in advance of a required drive decision (prepare to stop) and 2) to minimize the number of drivers that will be required to make that decision.

Pictures of the Advanced Warning Flasher (AWF) are shown on slides 2, 3 and 4.



Advanced Warning

➤ Advanced Warning Flasher Consideration

- Isolated or unexpected signalized intersection
- Limited sight distance
- Dilemma Zone
- Accidents
- Heavy Truck Volume
- Engineering Judgment

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Traffic Signal 101

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The guidelines in the Traffic Signal Timing and Coordination Manual indicate when the installation of advanced warning flashers (AWF) for signal change interval should be considered. Due to the complex nature of traffic flow characteristics, these guidelines should be applied along with engineering judgement. Guidelines should be reviewed for each prospective installation.



Advanced Warning

➤ Guidelines for Installation (MUTCD 4M.2)

- Advanced Warning Flasher
- Advanced Warning Flasher Sign Placement
- Leading Flash
- Detector Placement

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The AWF shall flash yellow in a wig-wag fashion manner prior to the termination of the green, and during yellow and red periods of the signal.

The flasher shall be set back from the intersection as shown on the next slide.

The leading flash is the amount of time, prior to the signal turning yellow, that the AWF flashes.

The detection of the intersection shall be determined without regard to the AWF.



Advanced Warning

Posted Speeds (mph)	AWF Placement		Leading Flash (seconds)
	meters	feet	
40	170	560	8.0
45	170	560	7.0
50	215	700	8.0
55	215	700	7.0
60	260	850	8.0
65	260	850	7.5

The AWF set back location based on the posted speed (mph). This table can be found in the MN MUTCD.

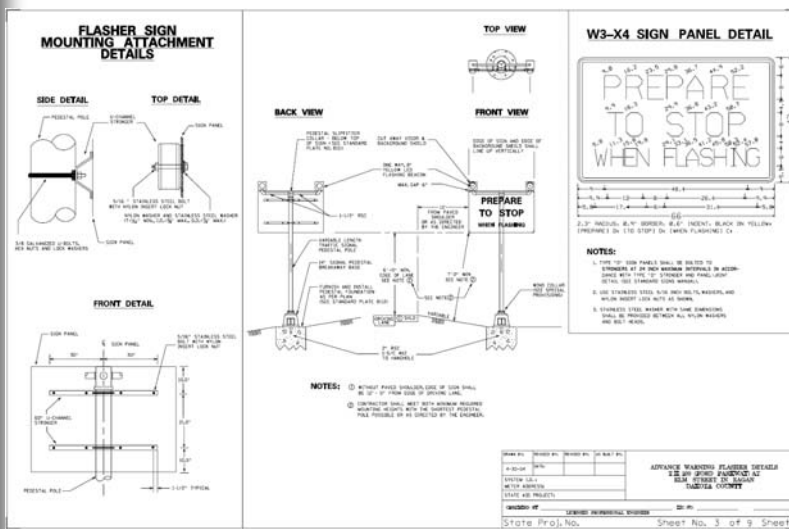
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Advanced Warning



The figure to the left is an Advanced Warning Flasher Detail. A copy of the most current version of this can be downloaded from the website.

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Handout

**Excerpts from the Traffic Signal Timing and Coordination Manual,
and the Minnesota Manual on Uniform Traffic Control Devices (MN
MUTCD), Chapter 4**

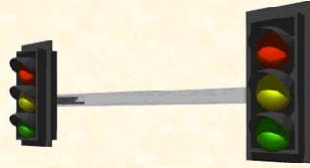
For the latest version, please visit:

www.dot.state.mn.us/trafficeng/otepubl/index.html

TOPIC 11: EMERGENCY VEHICLE PREEMPTION (EVP) AND RAILROAD PREEMPTION (RR)



Office of Traffic, Security & Operations (OTSO)



Traffic Signals 101

Topic 11

Emergency Vehicle Preemption (EVP) and Railroad (RR) Preemption

The transfer of signal control to a special signal operation is called preemption.

There are three common types of preemption, based on different reasons:

- Emergency Vehicle
- Railroad
- Transit Vehicle

This topic will cover emergency vehicle and railroad preemption. A handout is included at the back of this topic on these topics.



Office of Traffic, Security & Operations (OTSO)

EVP and RR

➤ Emergency Vehicle Preemption (EVP)

- Emergency vehicle preemption (EVP) is a system installed on authorized emergency vehicles and at traffic signals which allows the authorized emergency vehicles to travel through signalized intersections in a safe and timely manner

This is the EVP definition.

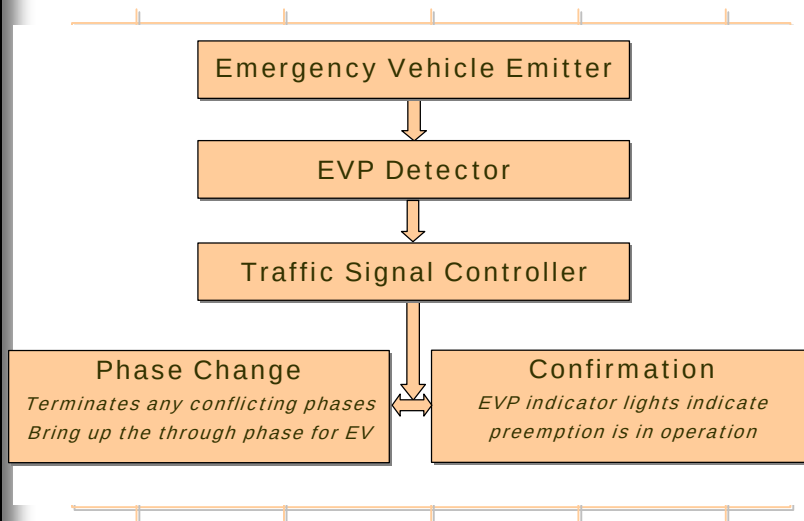
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EVP and RR



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The system works as follows:
An authorized emergency vehicle approaching a signalized intersection en-route to a call has an activated emitter (a strobe light oscillating at a specified frequency). The oscillations are detected by an EVP detector mounted on the signal mast arm. The detector may be located elsewhere to increase the range. The signal controller terminates any conflicting phases to bring up the through phase for the authorized emergency vehicle. Indicator lights mounted on the mast arm indicate that preemption is in operation.



EVP and RR

➤ Guidelines for Construction

- Within the State of Minnesota, EVP detection systems shall respond to emitted frequencies:
 - High Priority - $14.035 \text{ Hz} \pm 0.05 \text{ Hz}$
 - Low Priority - $9.639 \text{ Hz} \pm 0.03 \text{ Hz}$

All newly constructed signals shall be wired for EVP. This includes running the necessary electrical conductors to the base of each pole or terminating in the mast arm as appropriate.

Traffic signals with EVP shall use confirmatory white indicator lights. The confirmatory light shall only be used during signal preemption. Railroad preemption shall have priority over all other types of preemption, including authorized emergency vehicles.

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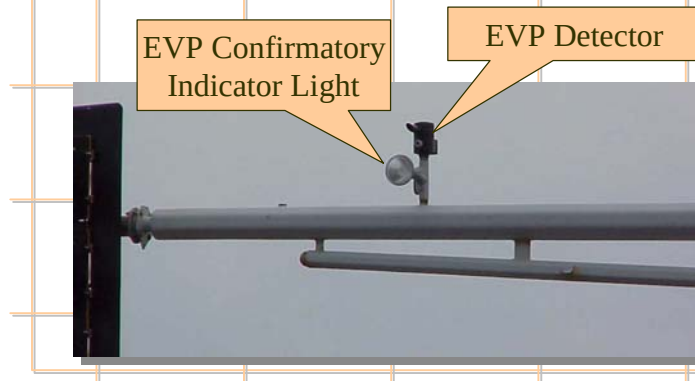
4



EVP and RR

➤ Guidelines for Operation

– EVP Confirmatory Indicator Light



The white/clear confirmatory indicator light shall be mounted, in most cases, on the signal mast arm, one indication light facing each direction of approach. The EVP confirmatory light shall remain dark (off) when the EVP Operation is not active. When the EVP is in operation, the indicator light shall flash or be steady under conditions defined below.

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EVP and RR

– Purpose of the Confirmatory Indicator Light

- Verify to the authorized emergency vehicle driver that the signal controller has received the call
- Verify to the authorized emergency vehicle drivers approaching from different directions which direction of approach would receive preemption

Note: The indications do not assign any right of way at the intersection.

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EVP and RR

– Meaning of the Confirmatory Indicator Light

- Steady EVP Confirmatory Indicator Light facing an approach means that the authorized emergency vehicle preemption has been received by the signal controller for that approach
- Flashing EVP Confirmatory Indicator Light facing an approach means that the signal controller has received a call for preemption from an authorized emergency vehicle on a conflicting approach, and is responding to that call

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This defines the meaning of the confirmatory light.



EVP and RR

➤ Operation of the Confirmatory Light

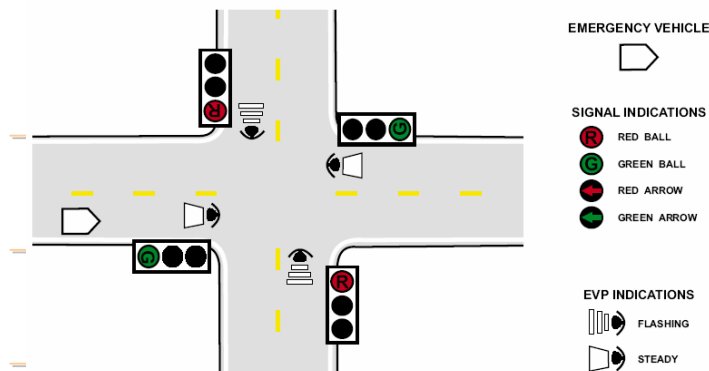


Figure 4D-1. Emergency Vehicle Preemption (EVP) Two-Phase Operation

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The approach that is preempted will receive a steady confirmatory light along with the opposing approach. The controller will cycle through to bring up the circular green indications. The conflicting approaches will receive flashing confirmatory lights and circular red indications.



EVP and RR

Operation of the Confirmatory Light

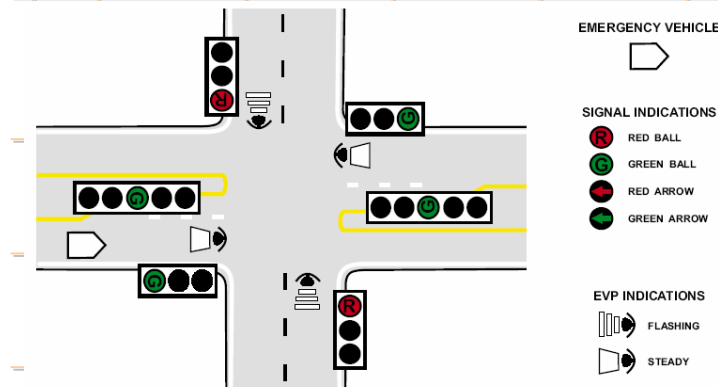


Figure 4D-2. Emergency Vehicle Preemption (EVP) Protected/Permissive Operation

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The approach that is preempted will receive a steady confirmatory indication light along with the opposing approach. The controller will cycle through to bring up the circular green signal indication. The left turn green arrow is not given on the preempted approach since a permissive green ball for the opposing flow would have to be terminated first. An opposing left turner, seeing the signal go to yellow, might mistakenly assume that the preempted approach was also yellow, and turn into the oncoming traffic proceeding on a green. This is referred to as a "left turn trap." To avoid this, the left turn green arrow is not given to any approach.

The operation of this intersection, under preemption, is similar to that of a two-phase intersection. Conflicting approaches will receive flashing confirmatory indication lights and circular red signal indications.



EVP and RR

Operation of the Confirmatory Light

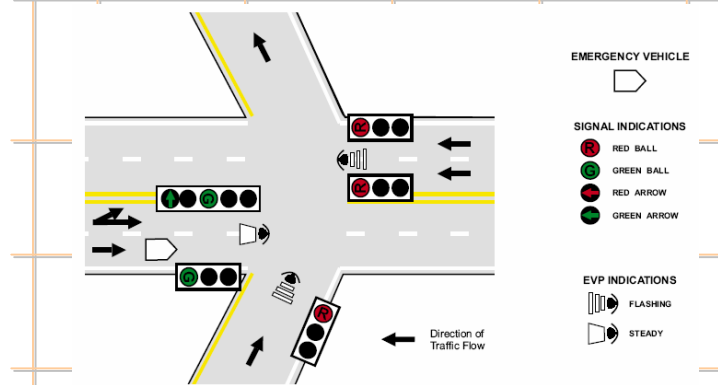


Figure 4D-3. Emergency Vehicle Preemption (EVP) Ramp/One-Way/T-Intersection Protected/Permissive Operation

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The approach that is preempted will receive a steady confirmatory indicator light, a protected left turn green arrow, and a circular green. The opposing and conflicting approaches will receive flashing confirmatory indicator lights and red indications.



EVP and RR

➤ Operation of the Confirmatory Light

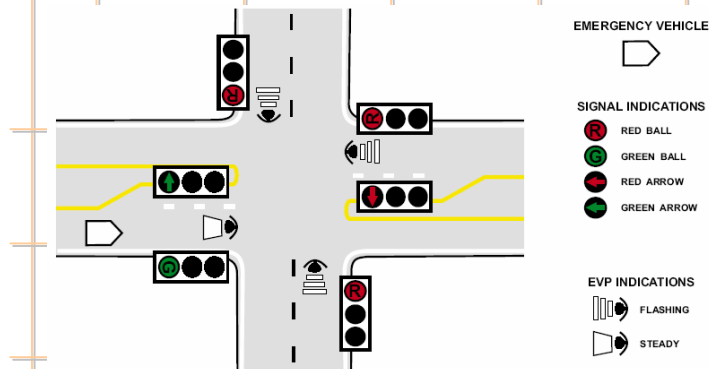


Figure 4D-4. Emergency Vehicle Preemption (EVP) Protected Operation

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The approach that is preempted will receive a steady confirmatory indicator light, a protected left turn green arrow, and a circular green. The opposing and conflicting approaches will receive flashing confirmatory indicator lights and red indications.

If roadway geometry, signal operation, or preemption recognition distance is insufficient to clear left turning vehicles ahead of the authorized emergency vehicle, the engineer may bring up concurrent circular green through signal indications and leave all other movements red, including the protected left turn movements.

This alternative is permitted in low speed applications where clearing the left-turn bay is a problem. In this operation the confirmatory indications would operate similar to the two phase operation.



EVP and RR

➤ Railroad Preemption

- Railroad preemption is a system installed on traffic signals which allows trains or Light Rail Transit (LRT) vehicles to preempt the signal and travel through the intersection in a safe and timely manner

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This is the railroad preemption definition.



EVP and RR

➤ Guidelines for Preemption

- If either of the following conditions are present, consideration should be given to interconnect the traffic signal and railroad grade crossing:
- Highway traffic queues that have the potential for extending across a nearby rail crossing
- Traffic queued from a downstream railroad grade crossing that have the potential to interfere with an upstream signalized intersection

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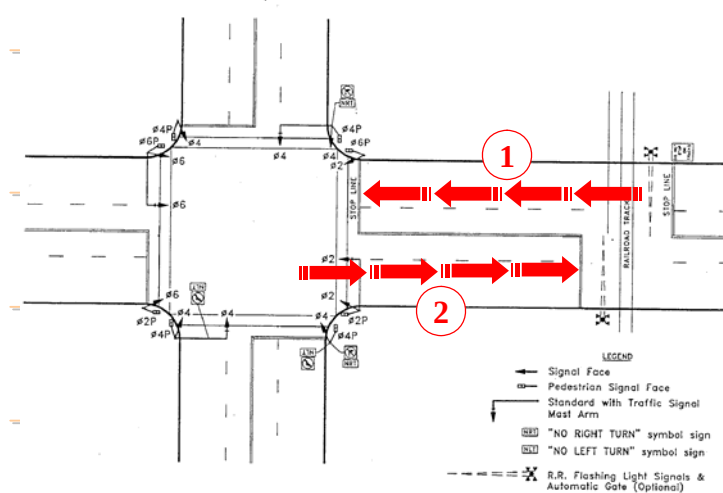
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The preemption conditions are described below (next slide).



EVP and RR

Typical 2-Phase Signal Operation



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Condition 1: Highway traffic queues behind the intersection stop line, and has the potential to block the railroad tracks.

Condition 2: Highway traffic queues behind the railroad grade crossing stop line, and has the potential to interfere with the signalized intersection. (Some vehicles stacked in the middle of the intersection).



EVP and RR

➤ Guidelines for Design

- When the determination has been made to preempt the traffic signal for a train, many items need to be considered
- Some are listed here:
 - distance between the traffic signal and the grade crossing
 - intersection geometry
 - track orientation
 - approach speed of train
 - etc.

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Things to consider for preemption.



EVP and RR

➤ Guidelines for Operation

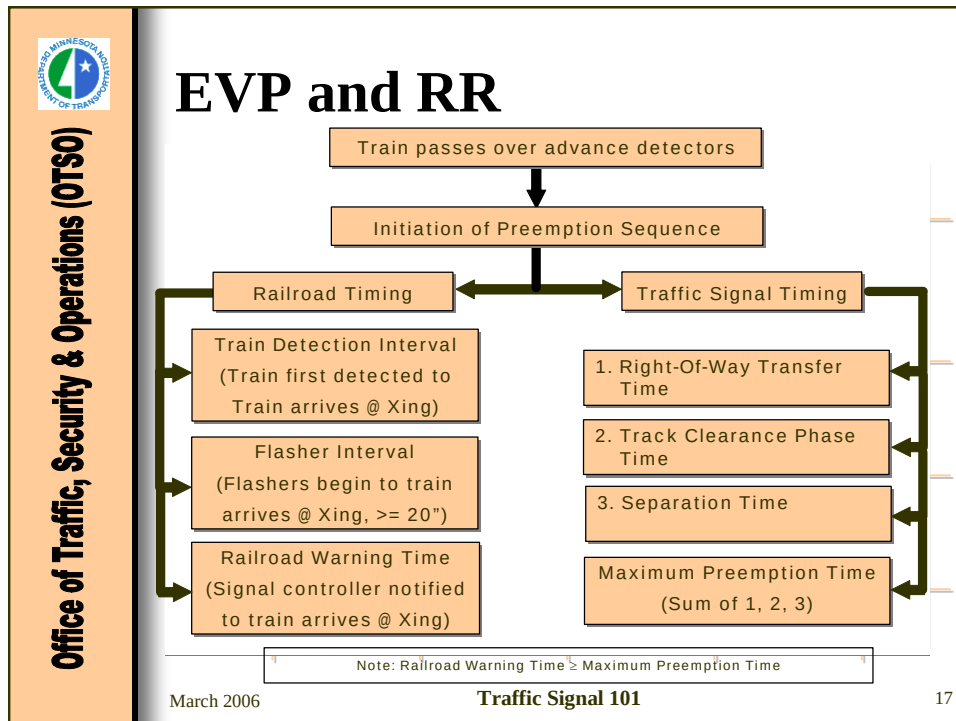
- Goal 1: Permit traffic to clear the tracks before the train reaches the crossing.
- Goal 2: Clear the traffic at the intersection.

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Guidelines for operation; goals.



GUIDELINES FOR OPERATION

The MMUTCD (Section 8C-6) requires that “The preemption sequence initiated when the train first enters the approach circuit, shall at once bring into effect a highway signal display which will permit traffic to clear the tracks before the train reaches the crossing. The preemption shall not cause any short vehicular clearances and all necessary vehicular clearances shall be provided. However, because of the relative hazards involved, pedestrian clearances may be abbreviated in order to provide the track clearance display as early as possible. After the track clearance phase, the highway intersection traffic control signals should be operated to permit vehicle movements that do not cross the tracks, but shall not provide a through circular green or arrow indication for movements over the tracks”.

If the traffic signal is equipped with emergency vehicle preemption, the confirmation lights shall flash for all approaches during the preempt sequence.

TRAFFIC SIGNAL TIMING

Maximum Preemption Time

The Maximum Preemption Time is the amount of time needed following initiation of the preemption sequence for the highway traffic signals to complete the entire sequence to clear the crossing within the minimum track clearance distance, of any vehicles prior to the arrival of the train at the crossing. This is the total of the Right-of-Way Transfer Time, Track Clearance Phase Time and Separation Time. A tabulation of the calculation appears below.

Right-Of-Way Transfer Time

Equipment Response	_____ seconds
Pedestrian Clearance Time	_____ seconds
Minimum Green on Conflicting Phase	_____ seconds
Leading Flash Time of AWF (if present)	_____ seconds

Critical Phase Movement

(Longer of Pedestrian Clearance or Min Green or

Leading Flash Time of AWF)

_____ seconds

Yellow Change Interval*

_____ seconds

Red Clearance*

_____ seconds

Right-of-Way Transfer Time (Subtotal)

_____ seconds

*if not included in the Pedestrian Clearance Time

Track Clearance Phase Time

Dissipation of queued vehicles, per lane

_____ seconds

Queue Clearance Time

_____ seconds

Track Clearance Phase Time (Dissipation or Clearance Time)

_____ seconds

Separation Time (typically 4-8 seconds)

_____ seconds

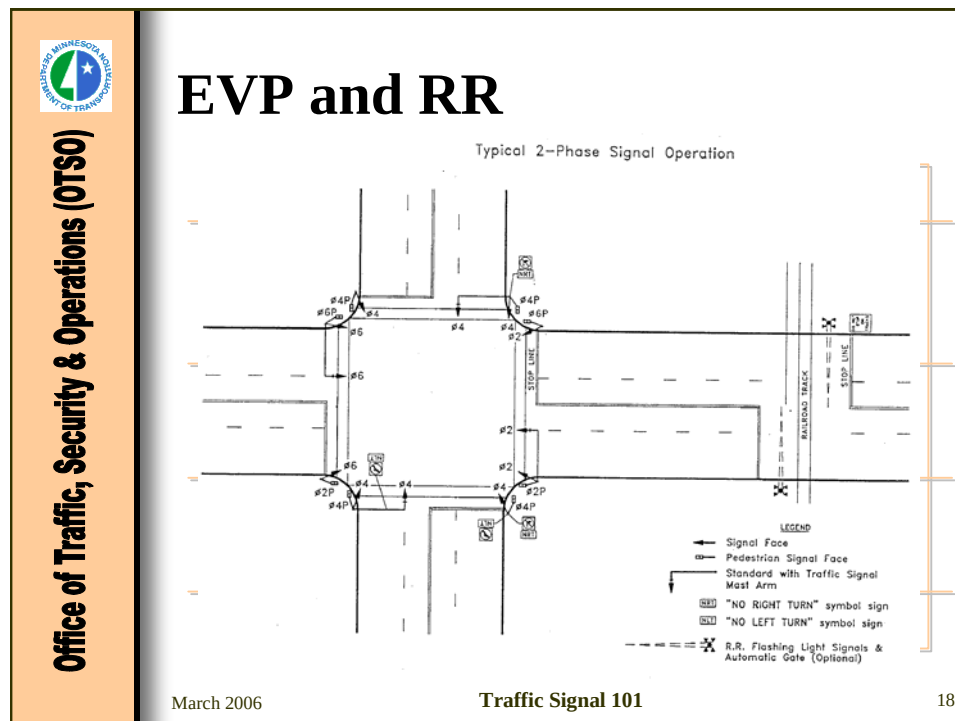
Maximum Preemption Time

_____ seconds

(Sum of the Right-of-Way Transfer Time, Track Clearance Phase Time and Separation Time)

RAILROAD TIMING

Railroad timing has to make sure that the Railroad Warning Time must be greater than or at least equal to the Maximum Preemption Time of traffic signal. At some locations, the Railroad Warning Time, the Train Detection Interval, and the Flasher Interval may all be the same.



This is the operation explanation diagram.



EVP and RR

– Railroad Crossing



This is a field picture of railroad preemption.

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EVP and RR

– Railroad Cabinet



This is a field picture of a railroad cabinet.

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Handouts

EVP handout from MN MUTCD (Page 4D-9 to 4D-14)

**Railroad Preemption handout from the Traffic Signal Timing and
Coordination Manual**

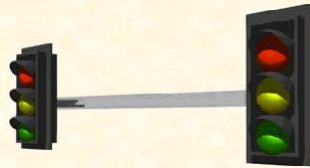
For the latest version, please visit:

www.dot.state.mn.us/trafficeng/otepubl/index.html

TOPIC 12: SPECIAL PROVISIONS



Office of Traffic, Security & Operations



Traffic Signals 101

Topic 12 Special Provisions

This topic will cover the Standard Specifications for Construction Book (Spec Book), the Contract Proposal and Supplemental Agreements.

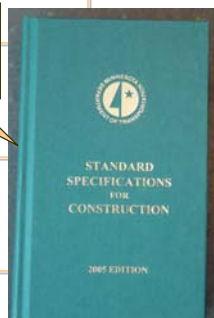


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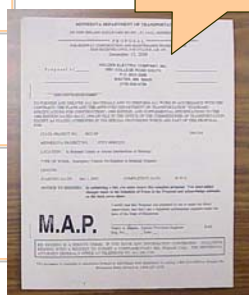
Special Provisions

- Mn/DOT 2005 Standard Specifications for Construction Book (Spec Book) and Mn/DOT Proposal

SPEC Book



Proposal



The "Spec Book" contains standard specifications to be used and referred to in the design of traffic signal plans and in the preparing of traffic signal Special Provisions. Plan designers need to be aware of the specifications contained in the Spec Book that may apply to their individual project.

Each individual project will have a Contract Proposal. The Contract Proposal contains many important documents, including the Special Provisions for the Project.

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Special Provisions

THE 2005 SPEC BOOK:

CONTAINS BOTH "METRIC AND "NON-METRIC CONVERSION

CONTAINS MODIFICATIONS TO THE 2000 SPEC BOOK

The 2005 Spec Book includes both "metric" and "non-metric" conversions. The 2005 Spec Book also includes numerous modifications to the former 200 Spec Book.

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Special Provisions

➤ "Spec. Book" Format

– Three Divisions

- Division I: General Requirements and Covenants
- Division II: Construction Details
- Division III: Material

Division I Specifications are labeled as 1000 series (1101 thru 1911).

Division II specifications are labeled as 2000 series (2021 thru 2581).

Division III specifications are labeled as 3000 series (3101 thru 3985).

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Special Provisions

➤ Division I - General Requirements & Covenants

MN/DOT 1504 - COORDINATION OF PLANS & SPECIFICATIONS

IN CASE OF DISCREPANCIES:

SUPPLEMENTAL SPECIFICATIONS:

Govern Over ...

Standard Specifications

PLANS:

Govern Over ...

Supplemental Specifications, and Standard Specifications

SPECIAL PROVISIONS:

Govern Over ...

~~Plans, Supplemental Specifications, and Standard Specifications~~

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“These Standard Specifications, the Plans, Special Provisions, supplemental Specifications, and all supplementary documents are essential parts of the Contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work.

In case of discrepancy, calculated dimensions will govern over scaled dimensions; Special Provisions will govern over Standard and supplemental Specifications and Plans; Plans will govern over Standard and supplemental Specifications; supplemental Specifications will govern over Standard Specifications.

The Engineer will decide all issues concerning errors and omissions that are not otherwise resolved by logical conclusion or Contract modification. Both parties to the Contract shall inform each other as to any discrepancies they uncover, and neither the Contractor nor the Engineer shall take advantage of any error or omission.

In the interest of avoiding repetitious wording in the Specifications, certain words and phrases have been omitted where reference is clearly related by expressions of authority or intention. Where certain words and terms appear, they are to be construed with reference to the definitions, abbreviations, heading, titles, item names, and other pertinent provisions of the Contract documents, as may be implied.”

Office of Traffic, Security & Operations



Special Provisions

➤ Division II - Construction Details

MISCELLANEOUS CONSTRUCTION SECTION

2565 - Traffic Control Signals

Format:

- Description
- Materials
- Construction Requirements
- Method of Measurement
- Basis of Payment

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Division II contains Mn/DOT 2565 (Traffic Control Signals).

The format of Mn/DOT 2565 is as follows:

Description:

- has a General information section.
- has a Definitions section.

Materials:

- has a General information section.
- specifies various materials, including references to Division III of the Spec Book.

Construction Requirements:

- has a General information section
- specifies the requirements for actually constructing a traffic control signal system.

Method of Measurement:

- traffic control signal systems are measured as an integral unit complete in place and operating with the complete installation at *one intersection* being considered one unit.

Basis of Payment:

- There is a payment schedule listed in this section that shows the Item No., Item, and Unit. There is only one item used for traffic control signal systems in the Spec Book, however, signal system projects do use other “individual” pay items. These pay items are written as part of the Special Provisions.



Special Provisions

➤ Division III - Materials

Electrical Materials Section

- Conduit (3801 thru 3803)
- Lighting Luminaires (3810)
- Photoelectric Controls (3812)
- EVP Equipment (3814)
- Electric Cables and Conductors (3815)
- Mast Arm Pole Standards (3831)
- Traffic Signal Pedestals (3832)
- Pedestrian Push Buttons and Signs (3833)
- Pedestrian Signal Faces (3835)
- Electrical Service Equipment (3837)
- Electrical Junction Boxes (3838)

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Division III includes a section entitled "Electrical Materials" which contains various material specifications for traffic control signal systems. Many of these material specifications are referred to by Mn/DOT 2565. The format of these material specifications are divided into: Scope, Requirements, and Inspection and Testing.



Special Provisions

➤ OTHER NATIONAL AND LOCAL STANDARDS SPECIFIED IN THE BOOK

- AASHTO
- ITE
- NEC
- RUS
- ASTM
- ICEA
- NEMA
- UL

All electrical equipment to be furnished by a Contractor shall conform to other regulations, standards, and Codes as specified in the "Spec Book"

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AASHTO, American Association of State Highway and Transportation Officials

ASTM, American Society of Testing and Materials

ITE, Institute of Transportation Engineers

ICEA, Insulated Cable Engineers Association

NEC, National Electrical Code

NEMA, National Electrical Manufacturers Association

RUS, Rural Utilities Service

UL, Underwriter Laboratories, Inc.



Special Provisions

SUPPLEMENTAL SPECIFICATIONS

- Additions and revisions to the standard specifications that are approved after the Spec Book has been printed and distributed
- The plan and the proposal need to state if supplemental specifications apply to your specific project

Supplemental specifications are additions and revisions to the standard specifications that are approved after the standard specification book has been printed and distributed. They are published separately (usually in paperback booklet form) until the next updated Spec Book is published and released. The Plan and Proposal for each specific project will state if there are supplemental specifications that apply.

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Special Provisions

THE PROPOSAL

- Addendums
- Notice to Bidder
- Special Provisions by Division (2565)
- Attachments
- Contract Schedule (Bid Prices)

Each Mn/DOT project has a proposal.

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Special Provisions

Contract Proposal

- Contain special “provisions” by Division
- Division “SS” covers signal systems
- Division “SS” may be formatted into more than two “SS” sections

Each Proposal contains Special Provisions by Division, for example:

Division S – General Requirements

Division SL – Electric Street Lighting

Division SS – Traffic Control Signals

Division ST – Traffic Signs and Devices

Division SZ – Freeway Traffic Management Systems

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Special Provisions

SPECIAL PROVISIONS

- Special Provisions are “additions and revisions” to the Standard and Supplemental
- Specifications covering conditions peculiar to an individual project

Special Provisions are just that: **“SPECIAL”** provisions. If an item(s) is adequately addressed or specified in the Spec Book, Standard Plates, Plan, or other Contract documents, then that item(s) should not be duplicated within the Special Provisions.

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Special Provisions

Division SS (Traffic Control Signals)

- SS-1 Qualification of Workers
- SS-2 Traffic Control Signals
- SS-3 Emergency Vehicle Preemption (EVP) System
- SS-4 Traffic Control Interconnection

All signal system Special Provisions that are part of Mn/DOT projects or have State Aid money involved will have a SS-1 "Qualification of Workers" specification.

SS-3 EVP could be incidental to the traffic signal system and therefore be part of SS-2 "Traffic Control Signals".

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Special Provisions

SPECIAL PROVISIONS FORMAT

Traffic Control Signals:

- Description
- General
- Materials
- Construction Requirements
- Measurement and Payment

A typical set of Special Provisions for a signal system is formatted similar to the Spec Book; however, the actual format of the Special Provisions may vary somewhat when compared to the Spec Book format.

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Special Provisions may also include detail drawings that are pertinent to the specific project.

The following is a closer look at a typical set of Special Provisions for a signal system:

Qualification of Workers

This section requires Signal and Lighting Certification for all Contractors' Supervisors and Foreman involved in the field installation of traffic signal and lighting system projects. This language is required in the Special Provisions for any project that involves Mn/DOT and State Aid projects.

Traffic Control Signals

Signal system Special Provisions will have a description paragraph of the work: what work is involved, location of project; and what documents the project shall be in accordance with.

Traffic Control Signals:

General Section:

This section will usually include a list of Department furnished materials being supplied to the Contractor and language specifying where the Contractor is to pick-up the Department furnished materials. This section may also include any Plan changes, notes to bidders, specifying whether or not an agreement will apply to the project, etc.

Materials Section:

This section will cover any material items that are not covered in other Contract documents, or language in other documents that needs to be modified for this specific project.

Construction Requirements:

This section contains language dealing with the actual construction of the signal system. Like the materials section, it will include language that modifies items in the Spec Book, Plan, or other Contract documents.

Measurement and Payment:

This section will specify exactly how the signal system will be measured and paid for. The pay items in this section need to match the pay item(s) listed on the estimated quantity sheet in the Plan.

The following is a "sample" pay item for a signal system set of Special Provisions:

Removing and salvaging the existing traffic control signal system; furnishing and installing materials and electrical equipment; and installing Department furnished materials as specified herein, all to provide a complete operating new full-traffic-actuated traffic control signal system at the intersection of _____ and _____ in _____, _____ County as contained in these Special Provisions and in the Plans will be measured as an integral unit and paid for as specified in Mn/DOT 2565.4 and Mn/DOT 2565.5 respectively for Item No. 2565.511 (TRAFFIC CONTROL SIGNAL SYSTEM).

The majority of signal system Special Provisions are written by the Mn/DOT Office of Traffic Engineering for State let projects. Consultants, however, usually prepare the Special Provisions for consultant designed Mn/DOT projects.



Special Provisions

ADDENDUMS

- Additional information, corrections, or deletions to Special Provisions, Plans, or the Spec Book after project has been put on sale, but before the actual letting
- Addendums are sent out to those who have purchased Contract documents for the specific project
- The addendums are included in the front portion of the "final" proposal for the project

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At times it may become necessary to provide additional information, corrections, additions, or deletions to the Special Provisions, Plans, and/or Spec Book after the Project is put on sale, but before the actual letting of the Project. This information is provided to bidders by creating an "Addendum". These addendums are then sent out to Contractors, suppliers, etc. that have purchased the Contract documents for the specific project. These addendums are sent out with enough lead time to allow bidders the opportunity to consider the addendum in preparing their bid. *All addendums will be located in the front portion of the Mn/DOT final project proposal.*



Special Provisions

SUPPLEMENTAL AGREEMENTS

- Written after Contract underway
- Negotiated between Contractor and project Engineer
- Keep to minimum

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It is important that Plans and Special Provisions are clear, accurate, and adequately indicate the work that the Contractor is required to perform. However, when that does not happen, or if some item(s) is inadvertently omitted from the project documents, Mn/DOT will negotiate a supplemental agreement with the Contractor to rectify the situation. There are occasions when supplemental agreements are necessary due to field conditions that were not apparent at the time of the project design. It is, however, in the best interest of everyone to try and keep supplemental agreements to a minimum.

Handout

Sample Special Provisions

For the most current sample, please visit:

www.dot.state.mn.us/trafficeng/designtools/index.html

Use the Traffic Signals pull-down menu and select “Special Provisions for Signals”

TOPIC 13: MAINTENANCE



Office of Traffic, Security & Operations (OTSO)



Traffic Signals 101

Topic 13 Maintenance

In this topic you will be introduced to:

- Maintenance Responsibilities
- Definitions of Responsibilities
- The Signal Responsibility List
- System Types
- Actions



Office of Traffic, Security & Operations (OTSO)

Maintenance

➤ Maintenance Responsibilities

- The Maintenance responsibilities are spelled out in the MINNESOTA DEPARTMENT OF TRANSPORTATION TRAFFIC CONTROL SIGNAL AGREEMENT
- Refer to Topic 2 regarding agreements

The agreement will have a number upon which other documents may refer to. The number will be in effect until another agreement is written, in which it will state that the new number super cedes and terminates the old agreement number.

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Maintenance

➤ Maintenance Responsibilities

- The maintenance responsibilities will be outlined in this agreement
- The maintenance will be defined as to the entity responsible for the following:
 - Provide power to the traffic signal and streetlights
 - Maintain and keep in repair traffic control signal and streetlights

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A quick and easy reference is the **signal responsibility list**, which is a report in the facility management system. This list can be generated by the District Traffic Offices, or requested by the Electrical Services Section (ESS) and they will generate a list.

The list contains an index that shows the responsibility types, the system types with abbreviations and has a format that makes the responsibility easily recognizable.

The handout at the back of this topic shows a sample agreement and a sample responsibility list.



Maintenance

➤ Maintenance Responsibilities

- Relamp the traffic control signal and streetlights
- Clean and paint the traffic control signal, cabinet and luminaire mast arm extensions
- Maintain signing
- Signal Interconnect
- Timing of traffic control signals.

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The slide to the left is a continuation of the maintenance responsibility.



Maintenance

➤ Further definitions of the responsibilities

- Provide power to traffic control signal and streetlights
- Maintain and keep in repair traffic control signal and streetlights

Provide power to traffic control signal and streetlights means which entity shall provide necessary electrical power at its expense.

Maintain and keep in repair traffic control signal and streetlights means repair/replace all hardware and associated equipment to operate the signal system. This includes the cabinet and equipment within, the wiring to the equipment in the field, the signal heads, standards and luminaires, the loops, pedestrian push buttons, and all devices needed to operate the signal system.

Relamp the traffic control signal and streetlights means to replace any burnt out lamp or replace the lamps at given intervals.

Clean and paint means to paint the cabinet, the signal heads and standards, and the luminaire mast arm extensions on an as needed basis.

Maintain signing means to repair/replace any missing signing, due to vandalizing or weather and insure the signs are legible at all times.

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Maintenance

➤ Further definitions of the responsibilities

- Relamp the traffic control signal and streetlights
- Clean and paint
- Maintain signing

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Maintenance

➤ Further definitions of the responsibilities

- Maintain signal interconnect
- Timing of traffic control devices

Maintain signal

interconnect means to keep the needed wiring and associated equipment in operation at all times.

Timing of traffic control

devices means to establish the timing scheme for the operation of the signal control system.

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Maintenance

➤ THE SIGNAL RESPONSIBILITY LIST HAS THE FOLLOWING HEADINGS:

- **TH** = Trunk Highway ID number, the highway the signal is located on
- **Location** = The cross street the signal is located on
- **System** = System ID number Each signal system is assigned an ID number

The handout is a sample Statewide Signal Responsibility List.

The items on the slide to the left show the headings listed on Statewide Signal Responsibility List.

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Maintenance

- **Type** = System Type outlined below
- **Pr** = Maint. Priority Established to set the level in which a signal needs responding, A-B-C-D
- **D** = District in which the signal is located or is responsible for its maintenance
- **City** = City the signal is located in or is responsible for its maintenance

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The slide to the left is a continuation of the headings shown in the Statewide Signal Responsibility List.



Maintenance

- **County** = County the signal is located
- **Xformer address** = The address the power company has for the location
 - This is important when reporting a power outage
- **PWR C** = Power company which supplies power to the signal

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The slide to the left is a continuation of the headings shown in the Statewide Signal Responsibility List.



Maintenance

Cabinet	EVP	Hardware	LED maint.	Luminaire	Relamping (Reimburse #)
SM	NA	CM	PC	MM	RM

- **Cabinet** --- All equipment within and including cabinet
- **EVP** --- Emergency vehicle pre-emption
All associated equipment both in the cabinet and in the field

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The slide to the left is a continuation of the headings shown in the Statewide Signal Responsibility List.



Maintenance

Cabinet	EVP	Hardware	LED maint.	Luminaire	Relamping (Reimburse #)
SM	NA	CM	PC	MM	RM

- **Hardware** --- Any equipment in the field including the underground
- **LED maint.** --- This is in order to encourage other entities to use light emitting diode signal heads, the State agreed to honor the factory warranty and replace any failed units for a specified time
- Any new installations will not be on the list. In time this heading will disappear

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The slide to the left is a continuation of the headings shown in the Statewide Signal Responsibility List.



Maintenance

Cabinet	EVP	Hardware	LED maint.	Luminaire	Relamping (Reimburse #)
SM	NA	CM	PC	MM	RM

- **Luminaire** --- The luminaires (street lights) over the traffic signals
- **Relamping** --- (Reimburse number)
Replacing of the lamps in the signal heads
 - The reimbursable number is the number used to bill another entity for the work which was the responsibility of the entity

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The slide to the left is a continuation of the headings shown in the Statewide Signal Responsibility List.

When LED lamps are not being utilized, the following incandescent lamps shall be used:

The traffic signal lamps shall be nominal 130-volt clear traffic signal lamps with an average life of a minimum 6000 hours.

A 150-watt lamp shall be used for all 300-millimeter (12") circular red, circular green signal indications.

A 116 watt lamp shall be used for all 200-millimeter (8") circular red, circular green indications.

A 69-watt lamp shall be used for all 200-millimeter (8") and 300-millimeter (12") yellow signal indications.

A 116-watt lamp shall be used on 300-millimeter (12") pedestrian indications.

A 69-watt lamp shall be used on 230-millimeter (9") pedestrian indications.



Maintenance

Cabinet	EVP	Hardware	LED maint.	Luminaire	Relamping (Reimburse #)
SM	NA	CM	PC	MM	RM

- **SM**= State Maintenance
- **NA**= Not applicable meaning there isn't EVP in this intersection
- **CM**= County Maintenance

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The slide to the left is a continuation of the headings shown in the Statewide Signal Responsibility List.



Maintenance

Cabinet	EVP	Hardware	LED maint.	Luminaire	Relamping (Reimburse #)
SM	NA	CM	PC	MM	RM

- **PC**= Pay County State pays County for any maintenance performed
- **MM**= Municipal maintenance
- **RM**= Reimbursable maintenance means State is reimbursed for any maintenance

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The slide to the left is a continuation of the headings shown in the Statewide Signal Responsibility List.



Maintenance

➤ System Types

- **ISO** = Free Running Isolated Traffic Signal
 - This would be a signal that operates independently of any other signal or system
- **DU** = Traffic Signal with Dial Up Capability
 - A signal would be capable of being monitored with a computer and phone line from a remote location

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The slide to the left identifies the headings for the various system types shown in the Statewide Signal Responsibility List.



Maintenance

➤ System Types

- **TEL** = Coordinated signal system using Telemetry type communication
 - This would be a signal operating within a system of other signals
 - There would be a series of intersections which would allow the passage of traffic with minimal stoppage
 - The signals have hardwire (interconnect) between them.

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The slide to the left is a continuation of the headings shown for the various system types shown in the Statewide Signal Responsibility List.



Maintenance

➤ System Types

- **AFL** = Advanced Warning Flasher
 - This is the flashers located ahead of the signal which warns motorists to prepare to stop
- **OFL** = Overhead Flashing Beacon
 - A single or double signal head which flashes either yellow or red and is mounted overhead

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The slide to the left is a continuation of the headings shown for the various system types shown in the Statewide Signal Responsibility List.



Maintenance

➤ System Types

- **UNK** = A System which is not Owned or Maintained by the State
- There are many other system types, which are indexed under that heading, the above are the most common

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The slide to the left is a continuation of the headings shown for the various system types shown in the Statewide Signal Responsibility List.



Maintenance

➤ Actions

- Upon notification of a signal malfunction, use the Signal responsibility list to establish which agency is responsible to repair the problem

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The Statewide Signal Responsibility List identifies who is responsible to act on a signal malfunction.

If the problem is identified as another agency ie: lamp out, contact that agency.

If the problem is the State responsibility, either respond to the reported problem or notify the proper Maintenance personnel to make the repairs.



Maintenance

➤ Actions

- If a system is reported black, try to confirm that the signal is in fact all black, not just a black head, caused by a lamp burnout

When established, call the Power Company supplying the power, using the **Xformer** address and report the outage.

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Maintenance

➤ Actions

- **If the Power Company acknowledges that a general power outage is in the area, try to get a estimated length of the outage**

If the power company gives a time in which the outage is over two hours, call to have temporary stop signs put up. **Another step is to have the signal put to a flash operation** using the switch in the police panel door. This is important so when the power is established the signal will flash, rather than go into operation with the stop signs in place, giving conflicting directions. **When the signal is taken out of police panel flash**, make sure the stop signs are removed, or turned so the motorists cannot see them.

If power will be out for more than 2 hours, the stops signs are required.

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Maintenance

➤ Actions

– Signal knockdowns

- When a signal is knocked down notify the responsible agency to make the repairs

If you can check it out and give any information to the agency it saves time for the repairs to be made. Also if there is not at least one signal head functioning in the phase of the knockdown, the intersection should be put to flash and stop signs should immediately be put up. If at least one signal head is visible, leave signal operating. Place a traffic cone over the wires.

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Maintenance

➤ Actions

- When a signal is to be taken out of flash, due to a malfunction that had been repaired, make sure the traffic is at a level that it can be done safely

If you cannot get a break in traffic, you may have to call for assistance. This can be the local police, or someone trained in flagging traffic.

If an advanced warning flasher is out of service, cover the sign or turn the sign so it cannot be seen.

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Maintenance

➤ Actions

- When a new signal is placed into operation, a log book should be put into the cabinet, along with field intersection layouts and cabinet prints

In this log book should be all entries of any maintenance performed and the date and time of arrival and departure. Also the persons name and agency. It is important this be legible as often this is accessed for accident investigations.

Also other people need to know what maintenance has taken place, especially when troubleshooting a persistent problem.

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Maintenance

➤ Actions

- In the spring and fall of the year a system check should be done on all signal intersections

A system check is the maintenance and inventory of the system.

This consists of replacing the filter in the door, checking loop operations, checking timing of the controller and an overall look at the hardware in the field. This would be the pedestrian push buttons, the signal heads, pedestrian heads and signing. Check the alignment of the signal heads and any burned out bulbs. Notify the proper maintenance personnel of rodent damage or other items needing attention.

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Handout

Sample Agreement and Sample Statewide Responsibility List

SAMPLE AGREEMENT

MINNESOTA TRANSPORTATION DEPARTMENT

TRAFFIC CONTROL SIGNAL

AGREEMENT NO. 73845

BETWEEN

THE STATE OF MINNESOTA, DEPARTMENT OF TRANSPORTATION

AND

THE COUNTY OF ANOKA

AND

THE CITY OF LINO LAKES

TO

Install a new Traffic Control Signal with Street Lights, Emergency Vehicle Pre-emption and Signing on Trunk Highway No. 49 (Hodgson Road) - County State Aid Highway No. 10 (North Road) at Trunk Highway No. 49 (Lake Drive) - County State Aid Highway No. 23 (Lake Drive) in Lino Lakes, Anoka County, Minnesota.

S.P. 0204-12

S.A.P. 02-610-09 and 02-623-07

Prepared by Traffic Engineering

ESTIMATED AMOUNT RECEIVABLE

Anoka County	\$5,000.00
City of Lino Lakes	\$5,000.00

AMOUNT ENCUMBERED

	<u>\$68,580.00</u>
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SAMPLE STATEWIDE RESPONSIBILITY LIST

STATEWIDE SIGNAL RESPONSIBILITY LIST

Responsibility Types

SM = State Maintenance
 CM = County Maintenance
 NA = Not Applicable
 CU = Contractor Maintenance
 RC = County Reimbursement
 RM = Municipal Reimbursement
 OT = Other does Maintenance
 PC = State pays the County
 PM = State Pays Municipality
 RO = Other Reimbursement

System Types

AFL = Advanced Warning Flasher
 DU = Traffic Signal with Dial Up Capability
 HCV = HCV Lane Control
 ISU = Free Running Isolated Traffic Signal
 MCM = Master Controller in a separate Cabinet
 MFL = Miscellaneous Flasher
 MSC = Master Controller in a Local Signal Cabinet
 OFL = Overhead Flashing Beacon
 PAY = A system which the State pays another Agency to maintain
 PFL = Flashing Beacon at pedestrian or School Crossing
 QND = Coordinated Traffic Signal using Quadair for Communication
 RLY = Coordinated Traffic Signal using Relay type Communication
 SFL = Overhead Flashing Beacon with Standby operation
 TEL = Coordinated Traffic Signal using Telemetry type Communication
 TOD = Traffic Signal using Time of Day Coordination
 UNK = A System which is not Owned or Maintained by the State
 WFL = Flashing Beacon Mounted with a type 'W' Sign
 MOH = Equipment associated with a Naigh Station

The List has the Following Format:

TH = Trunk Highway ID = System ID Number Type = System Type (See Above) Pr = Maintenance Priority D = District

TH Location ID Type Pr D Ar City County Xformer Address PWR C

Cabinet EVP Hardware LED Maint Luminaire Relamping (REIMBURSE #)
 SM NA MM MM

TH Location ID Type Pr D Ar City County Xformer Address PWR C

36 WASHINGTON AV 20642 TEL A ME M2 Stillwater WASHINGTON 13550 60TH ST. N. NSP
 Cabinet EVP Hardware LED Maint Luminaire Relamping (REIMBURSE #) REDS ARE LED-STATE MAINTAINS UNTIL 11/13/2003
 SM SM MM MM MM A99469