District 1

Traffic Signal Design Guidelines

October 2025

Illinois Department of Transportation

TRAFFIC SIGNAL DESIGN GUIDELINES

Table of Contents

Section **Page**

Chapter 1 Plan Preparation 2

Section 1.01 Design Prequalification 2

Section 1.02 System of Measurement 2

Section 1.03 Plan Preparation Procedures 3

Section 1.03(a) Project Submittals and Review 3

Section 1.03(b) Plan Review 3

Section 1.03(c) Final Plan Submittal 4

Section 1.04 PS&E Formatting / Drafting Guidelines 5

Section 1.04(a) General Requirements 5

Section 1.04(b) Bureau of Traffic Let vs Others 6

Section 1.04(c) Cover Sheet (Only for BOT Let Projects) 6

Section 1.04(d) Index, Standards, and General Notes Sheet (Only BOT Let Projects) 6

Section 1.04(e) Summary of Quantities Sheet/s (Only BOT Let Projects) 7

Section 1.04(f) Traffic Signal District Standards 8

Section 1.04(g) Temporary Traffic Signal Installation and Removal Sheet 8

Section 1.04(h) Temporary Cable Plan and Temporary Phase Diagram Sheet 9

Section 1.04(i) Geometric Plan and Signal Layout Sheet 9

Section 1.04(j) Cable Plan and Phase Diagram Sheet 10

Section 1.04(k) Mast Arm Mounted Street Name Signs and Schedule of Quantities Sheet 10

Section 1.04(l) Temporary Interconnect Plan Sheet 11

Section 1.04(m) Temporary Interconnect Schematic Sheet 11

Section 1.04(n) Proposed Interconnect Plan Sheet 11

Section 1.04(o) Proposed Interconnect Schematic and Interconnect Schedule of Quantities Sheet 12

Section 1.04(p) Special Details 12

Section 1.04(q) Plan Notes 12

Section 1.04(r) Estimate of Cost 13

Section 1.04(s) Estimate of Time 13

Section 1.04(t) Special Provisions 13

Chapter 2 Traffic Signal Operation 14
Section 2.01 Signal Phasing 14
Section 2.02 NEMA Standard Ring and Barrier Diagram 16
Section 2.03 Left Turn Phasing 17
Section 2.03(a) Permissive Only Left Turn Phasing 17
Section 2.03(b) Protected Only Left Turn Phasing 18
Section 2.03(c) Protected-Permissive Left Turn Phasing 19
Section 2.03(d) Split Phase Left Turn Phasing 20
Section 2.03(e) Prohibiting Left Turns 21
Section 2.03(f) Right Turn Overlaps 21
Section 2.03(g) Left Turn Flashing Yellow Arrow 22
Section 2.04 Left Turn Phase Sequence Options 23
Section 2.04(a) Lead-Lead Left Turn Phasing 23
Section 2.04(b) Lag-Lag Left Turn Phasing 24
Section 2.04(c) Lead-Lag Left Turn Phasing 25
Section 2.04(d) Yellow Trap 26
Section 2.05 Pedestrian Phasing 27
Section 2.06 Traffic Signal Preemption and Priority 27
Section 2.06(a) Emergency Vehicle Preemption (EVP) 28
Section 2.06(b) Railroad Preemption 30
Section 2.06(c) Transit Priority Request 30
Section 2.07 Signal Operation and Contract Documents 30
Section 2.07(a) Signal Operation on the Cable Plan 30
Section 2.07(b) Signal Timing Development 32
Section 2.07(c) Signal Ownership, Maintenance and Energy Costs 33
Chapter 3 Signal Design and Equipment 34
Section 3.01 Geometrics and Signal Layout 34
Section 3.02 Traffic Signal Cabinet and Controller 35
Section 3.02(a) Peripheral Devices 37
Section 3.02(b) Adaptive Signal Control 37
Section 3.02(c) Uninterruptible Power Supply Systems 37
Section 3.03 Signal Heads 38
Section 3.03(a) Vehicular Signal Heads 38
Section 3.03(b) Pedestrian Signal Heads 40

Section 3.03(c) Bicycle Signal Heads 40
Section 3.03(d) Flashing Yellow Arrow....41
Section 3.04 Signal Support Structures 42
Section 3.04(a) Mast Arm Assembly and Poles 42
Section 3.04(b) Signal Posts....43
Section 3.04(c) Span Wire Installation 43
Section 3.05 Detection....44
Section 3.05(a) Pedestrian Detection – Push Button....44
Section 3.05(b) Bicycle Detection 46
Section 3.05(c) Vehicle Detection and Detector Loop Replacement 46
Section 3.06 Underground Facilities 48
Section 3.06(a) Handholes....48
Section 3.06(b) Conduit 49
Section 3.06(c) Electric Cable....52
Section 3.06(d) Foundations 56
Section 3.07 Electric Service....58
Section 3.08 Emergency Vehicle Preemption 59
Section 3.09 Traffic Signal Priority 60
Section 3.10 Traffic Signal System Interconnect....60
Section 3.10(a) Telephone Service 60
Section 3.10(b) Local System Communication Requirements....60
Section 3.10(c) Centralized Systems 61
Section 3.11 Railroad Interconnect....61
Section 3.12 Temporary Traffic Signal Installation....61
Section 3.12(a) Temporary Pole and Signal Head Placement....62
Section 3.12(b) Temporary Interconnect 62
Section 3.12(c) Temporary Preemption 63
Section 3.12(d) Construction Staging....63
Section 3.12(e) Temporary Pedestrian Signals 64
Section 3.12(f) Temporary Vehicle Detection 64
Section 3.12(g) Temporary Traffic Signals for Single Lane Staging 64
Section 3.12(h) Temporary Electric Service 64

Chapter 4 Other Devices and Policies....65
Section 4.01 Red Light Running Camera (RLRC) 65
Section 4.02 License Plate Readers (LPR) 66
Section 4.03 High Intensity Activated Crosswalk Beacon (HAWK), also known as Pedestrian Hybrid Beacons (PHB)....67
Section 4.04 Rectangular Rapid Flashing Beacon (RRFB) 67
Section 4.05 Leading Pedestrian Interval (LPI) 68
Chapter 5 Signing....69
Section 5.01 Street Name Signs....69
Section 5.01(a) Aluminum Street Name Signs 69
Section 5.01(b) LED Internally Illuminated Street Name Signs....71
Chapter 6 Lighting at Signalized Intersections 73
Section 6.01 Intersection Combination Lighting 73
Section 6.02 Intersection Transition Lighting....73
Section 6.03 Requirements 73
Chapter 7 Miscellaneous 74
Section 7.01 Supplemental Local Requirements....74
Section 7.02 Special Waste Coordination 74
Section 7.03 SUE Survey Request....74

LIST OF FIGURES

Figure 1.1 List of IDOT Highway Standards Related to Traffic Signal Projects 7

Figure 2.1 Sample Intersection Phase Diagram – Major Roadway East-West 14

Figure 2.2 Sample Intersection Phase Diagram – Major Roadway North-South 15

Figure 2.3 Sample Intersection Ring and Barrier Diagram 16

Figure 2.4 Permissive Only Left Turn Operation Ring and Barrier Diagram 17

Figure 2.5 Protected Only Left Turn Phasing Ring and Barrier Diagram 18

Figure 2.6 Protected-Permissive Left Turn Phasing Ring and Barrier Diagram 19

Figure 2.7 Ring and Barrier Diagram with Split Phase Left Turn Phasing on the Minor Street 20

Figure 2.8 Ring and Barrier Diagram with Right Turn Overlap on Minor Road 21

Figure 2.9 Ring and Barrier Diagram for Protected Only Lead-Lead Left Turn Phasing 23

Figure 2.10 Ring and Barrier Diagram for Protected Only Lag-Lag Left Turn Phasing on the Major Street 24

Figure 2.11 Ring and Barrier Diagram for Protected Only Lead-Lag Left Turn Phasing on the Major Street 25

Figure 2.12 Yellow Trap with Lead-Lag Left Turn Phasing 26

Figure 2.13 EVP Phase Diagram - Protected-Permissive or Permissive Left Turn Phasing on both Major and Minor Roadway 28

Figure 2.14 EVP Phase Diagram - Protected Only Left Turn Phasing on Major Roadway and Protected-Permissive Left Turn Phasing on Minor Roadway 29

Figure 2.15 EVP Phase Diagram - Protected Only Left Turn Phasing on both Major and Minor Roadway 29

Figure 2.16 Example Controller Phase Diagram 31

Figure 3.1 Various Signal Indications (Source – MUTCD 11th Edition Chapter 4E & 4F) 39

Figure 3.2 Pedestrian Signal Head With Countdown Timer 16” X 18” 40

Figure 3.3 Typical Signal Head configuration and Position for Flashing Yellow Arrow Operation 41

Figure 3.4 Required Signal Post Heights 43

Figure 3.5 Conduit Fill Calculation Table 50

Figure 3.6 Conduit Size Based on Fill Table 51

Figure 3.7 Minimum Conduit Size Table 51
Figure 3.8 Required Vertical Cable Length..... 52
Figure 3.9 Required Cable Slack Length..... 53
Figure 3.10 Traffic Signal Electric Service Requirements..... 54
Figure 3.11 Electric Service Cable Size 55
Figure 3.12 Mast Arm Assembly Foundation Depths 56
Figure 3.13 Foundations on Sloped Surfaces 57
Figure 4.1 Controller Phase Diagram with Leading Pedestrian Interval..... 68
Figure 5.1 Mast Arm Mounted Street Name Sign Abbreviations (length in inches)..... 70
Figure 5.2 LED Street Name Sign Examples 71

LIST OF ABBREVIATIONS

Abbreviation	Represents
AADT	Annual Average Daily Traffic
ADT	Average Daily Traffic
APS	Accessible Pedestrian Signal
ATC	Advanced Traffic Controller
ATMS	Advanced Traffic Management System
BLRS	Bureau of Local Roads & Streets
BOD	Bureau of Design
BOT	Bureau of Traffic
CADD	Computer Aided Drafting and Design
CMS	Central Management System
CNC	Coilable Nonmetallic Conduit
CTA	Chicago Transit Authority
DDI	Diverging Diamond Interchange
EMC	Electrical Maintenance Contract
ESU	Environmental Studies Unit
EVP	Emergency Vehicle Preemption
FHWA	Federal Highway Administration
FY	Flashing Yellow
HARGIS	Historic and Architectural Resources Geographic Information System
HAWK	High Intensity Activated Crosswalk Beacon
HDPE	High-Density Polyethylene
ICC	Illinois Commerce Commission
IDOT	Illinois Department of Transportation
IDS	Intersection Design Study
IES	Illuminating Engineering Society
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
LED	Light-Emitting Diode
LPI	Leading Pedestrian Interval
LPR	License Plate Reader

Abbreviation	Represents
MASH	Manual for Assessing Safety Hardware
MOT	Maintenance of Traffic
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
PCC	Portland Cement Concrete
PESA	Preliminary Environmental Site Assessment
PHB	Pedestrian Hybrid Beacon
PROWAG	Public Rights-of-Way Accessibility Guidelines
PTZ	Pan, Tilt, Zoom
RLR	Red Light Running
RLRC	Red Light Running Camera
ROW	Right-of-Way
RRFB	Rectangular Rapid Flashing Beacon
SCAT	Signal Coordination and Timing
SM	Single Mode
SPUI	Single Point Urban Interchange
SRA	Strategic Regional Arterial
SUE	Subsurface Utilities Engineering
SY	Steady Yellow
TSP	Transit Signal Priority
UPS	Uninterruptible Power Supply

APPENDICES

Appendix A Signal Layout & Phase Diagram Examples

Example A-1: Protected-Permissive Left Turn Phasing for Both Roadways

Example A-2: Protected-Permissive Left Turn Phasing for Both Roadways with Pedestrians on All Approaches

Example A-3: Protected Only Left Turn Phasing for Major Roadway and Protected-Permissive Left Turn Phasing for Minor Roadway

Example A-4: Protected Only Left Turn Phasing for Both Roadways – Single Through Lane on Minor Roadway

Example A-5: Protected Only Left Turn Phasing for Both Roadways – Dual Left Turn Lanes on Three Approaches and One Approach with Single Left Turn Lane and Adjacent Lane Hatched – Right Turn Lanes on All Approaches

Example A-6: T-Intersection – No Pedestrians

Example A-7: T-Intersection – With Pedestrians

Example A-8: T-Intersection – One Approach with Single Lane and No Right Turn Lane – No Pedestrians

Example A-9 Split Phasing on Minor Roadway

Appendix B Typical Detection Placement

Example B-1: Left Turn Lane – Protected-Permissive Left Turn Phasing

Example B-2: Left Turn Lane – Protected Only Left Turn Phasing

Example B-3: Up-Tight Detection with Protected-Permissive Left Turn Phasing

Example B-4: Far Back Detector Loops With Right Turn Lane Taper

Example B-5: Far Back Detector Loops Next to Shoulder

Example B-6: Far Back Detection on Major Roadway and Up-Tight Detection on Minor Roadway – Protected-Permissive Left Turn Phasing for Both Roadways

Example B-7: Far Back Detection on Both Roadways – Protected Only Left Turn Phasing for Major Roadway and Protected-Permissive Left Turn Phasing for Minor Roadway

Example B-8: Private Entrance with Video Detection

Documents Available from the District 1 Office Upon Written Request

- District 1 Traffic Signal Special Provisions
- Latest Traffic Signal Equipment Pay Items List
- Traffic Signal District Standards
- Existing Traffic Signal Plans (Record Drawings)
- Example Traffic Signal Plans
- District 1 Railroad Traffic Signal Design Guidelines

The designer can send an email to DOT.D1.TRF.PlanReviews@illinois.gov to request a copy of specific documents and what their purpose is. This should be addressed to IDOT District 1, Traffic Signal Design Engineer. Most up to date documents can be found at:

https://apps1.dot.illinois.gov - /eplan/desenv/standards/District 1/

Other IDOT Documents

For information on traffic control device material specifications, design, and application criteria, review the applicable publications listed in Chapter 57 Section 1.02 of the IDOT Bureau of Design and Environment (BDE) Manual.

IDOT BDE Manual

Additional information, including standard specifications, IDOT Highway Standards and various IDOT forms can be downloaded from IDOT's website at www.dot.state.il.us under "Resources" tab.

For traffic signals at or near railroad crossings refer to *IDOT District 1 Railroad Traffic Signal Design Guidelines* document found at the following link:

D1 Traffic Design

Chapter 1 Plan Preparation

The following chapter outlines general information on plan preparation procedures and requirements for design consultants.

Section 1.01 Design Prequalification

The firm supplying plans to IDOT District 1 (District) must be prequalified with the Illinois Department of Transportation (Department) in Traffic Signal Design and its signal design staff shall be familiar with the latest traffic signal design procedures used for the District.

If the project involves complex designs or if the firm has not prepared traffic signal plans for the District within the past 12 months, the firm's designer shall schedule a preliminary meeting with the Traffic Signal Design Engineer to discuss project specific issues and any new design requirements. If requested by the District, the designer shall provide copies of their most recent traffic signal installation design and/or modification projects completed for projects in the District.

Interaction between a traffic signal design firm and the District must be on a shared benefit basis. If, in the opinion of the District, the firm is attempting to design plans beyond the level of competence of its staff, the District shall refuse further review until qualified assistance is acquired and approved. The District does not intend to be a teaching agency.

The designer is expected to provide interpretive assistance and corrections to their work up to and through the construction phase of the project. Article 2.26 of the IDOT Standard Agreement Provisions for Consultant Services shall be strictly adhered to.

Section 1.02 System of Measurement

This design guide is written using the United States Customary System.

Section 1.03 Plan Preparation Procedures

Section 1.03(a) Project Submittals and Review

Signal design work shall be performed in a comprehensive manner. Traffic signal design plans shall be developed in sufficient detail to allow for a comprehensive review by the District. If in the opinion of the District, the plans do not include sufficient information to allow for a comprehensive and meaningful review, they shall be returned to the designer without comments. No further plan reviews shall be conducted by the District until the designer demonstrates that the traffic signal design plans have been developed to a sufficient level of detail, adhering to all standard guidelines, manuals, and requirements.

A disposition of comments shall accompany each submittal. Specific dates may be established for the plan submittals. The District will not be responsible for changes resulting from the failure to follow the process as noted above.

The District reviewer's name will be included in the comments. If the designer does not agree with a comment, they should provide a full disposition of the reason and explain to the reviewer why the comment was not addressed or addressed in a different manner. A phone call or a meeting might be needed with the District reviewer if multiple comments are not agreed upon or misunderstood. A disposition of Yes, No, Agree, or OK to a comment is not sufficient.

Section 1.03(b) Plan Review

For the initial review, an 11"x17" set of plans shall be submitted together with the Specifications and Cost Estimate. A disposition of comments and the return of all marked up plans from all previous review comments supplied to the designer shall accompany each submittal. Incomplete or partial plans (80% complete plans) will not be accepted by the District for review. The intent of this provision is to minimize the number of reviews in the design process and to expedite the overall approval process.

For the final review, the complete signal plans shall be submitted to the District 1 Bureau of Traffic Operations, which shall have incorporated all previous review comments and be checked in depth by the designer prior to submittal. Failure to thoroughly check the signal plans and submitting these to the District will result in automatic rejection without review. A disposition of comments and the return of all marked up plans from all previous reviews shall accompany the final submittal.

Section 1.03(c) Final Plan Submittal

Upon final plan approval by the District 1 Bureau of Traffic Operations, the following shall be submitted electronically (permit projects may require hard copy submittal per Permit engineer):

- One 11”x17” plan set.
- Consultant will submit all electronic files in the current CAD format used by the District for traffic signal design plans.
- One final set of Specifications
- Cost Estimate with pay item code numbers, item description, unit, quantity, unit price and total cost.
- Signal Project File which includes:
    - Project scope of work
    - Review comments and disposition of comments
    - Correspondence with the Electric Utility
    - Copy of the Electric Utility service response or agreement
    - Correspondence with utility or telephone companies regarding utility reviews and/or conflicts
    - Correspondence from local agencies (municipalities, townships, counties, etc.) including a commitment for cost participation
    - Correspondence with the Illinois Commerce Commission (ICC) and any other railroad correspondence
    - Correspondence with any other Highway Agencies or IDOT Bureaus
    - Correspondence from local Fire Departments / Protection Districts regarding Emergency Vehicle Preemption (EVP)
    - Copies of temporary/permanent easement agreements
    - Copies of right-of-way dedication

Section 1.04 PS&E Formatting / Drafting Guidelines

The District has developed Example Traffic Signal Plans available in PDF format and a Traffic Signal Symbols and Templates file in DGN format to assist the designer during plan development. The firm's designer should utilize these files whenever starting a new traffic signal project. The files can be updated by the District at any time and can be found at the following link:

D1 Traffic Design

Additional information on proper drafting format can be found on the IDOT website under IDOT CADD Downloads and Guidelines:

https://idot.illinois.gov/doing-business/procurements/engineering-architectural-professional-services/consultant-resources/highways/cadd.html

Section 1.04(a) General Requirements

The following applies to **each sheet** in the plans:

- Include the designer's full name, firm name, firm address, firm logo, and date.
- Sheet size shall be 11x17.
- The orientation of North arrows shall be up or to the right on the plan sheets and shall be consistent throughout the plans.
- Minimum lettering size may be as small as 0.10 inches (3mm) if capital letters are used. Titles and Phase Diagrams must have 0.15 inch or larger lettering and should match the sample plans and CAD requirements.
- Traffic Signal plans should have a Traffic Signal number (TS#) and System Identification at the bottom right corner of the plan sheets.

The designer shall have a clear understanding of Part VII – Plans and Contracts of the IDOT BDE Manual Chapter 66.

It is understood that each project is unique, but to provide the maximum benefits from the design work, the designer is expected to adhere to the following format requirements and shall submit plan sets with sheets in the order as listed below beginning with Section 1.04(c). An example of each of these sheets is included in the Example Traffic Signal Plans. The District reserves the right to return any plan submittals that do not adhere to the format requirements without the need for justification.

Section 1.04(b) Bureau of Traffic Let vs Others

Plan set requirements will differ for IDOT Bureau of Traffic (BOT) let projects vs. projects let from IDOT Bureau of Design (BOD), IDOT Bureau of Local Roads & Streets (BLRS) or IDOT Permits. In general, traffic signal projects let from the BOT will not include major roadway improvements and will encompass a full set of plan sheets including the cover sheet, index/standards/general notes sheet, and summary of quantities sheets. A project let from the BOD/BLRS will require only those sheets related specifically to the traffic signal design.

Section 1.04(c) Cover Sheet (Only for BOT Let Projects)

- The designer's full name, phone number, stamp and signature shall be provided in the left side margin.

Section 1.04(d) Index, Standards, and General Notes Sheet (Only BOT Let Projects)

For Bureau of Traffic Let projects, following the Cover Sheet, the designer shall provide a sheet with an Index of Sheets (including District Standards), IDOT Highway Standards, General Notes, and locations with red light running equipment.

- The IDOT Highway Standards and District Standards are updated periodically. The designer shall check for the latest revision.
- Do not under any circumstances revise any Standard detail sheet.
- District Standards are listed in the Index of Sheets and are included in the plans.
- IDOT Highway Standards are typically only listed on this sheet and not included in the plans. An exception is in permit projects where they must be included in the plans or specifications.

Signal plans may include a combination of the IDOT Highway Standards and District Standards. These standards can be found in the following links:

IDOT Highway Standards

District Standards

Figure 1.1 contains a partial list of IDOT Highway Standards related to traffic signal projects. This list is not comprehensive.

Figure 1.1 List of IDOT Highway Standards Related to Traffic Signal Projects

701001	Off-Road Operations 2L, 2W, More Than 15’ Away
701006	Off-Road Operations, 2L, 2W, 15’ to 24” From Pavement Edge
701011	Off-Road Moving Operations 2L, 2W Day Only
701101	Off-Road Operations Multilane, 15 to 24” From Pavement Edge
701106	Off-Road Operations, Multilane, More than 15’ Away
701501	Urban Lane Closure 2L, 2W Undivided
701502	Urban Lane Closure, 2L 2W, with Bidirectional Left Turn Lane
701601	Urban Lane Closure, Multilane, 1W or 2W with Non-traversable Median
701602	Urban Lane Closure, Multilane, 2W with Bidirectional Left Turn Lane
701606	Urban Lane Closure, Multilane, 2W with Mountable Median
701701	Urban Lane Closure Multilane Intersection
701801	Sidewalk, Corner or Crosswalk Closure
701901	Traffic Control Devices
720001	Sign Panel Mounting Detail
814001	Handholes
814006	Double Handholes
873001	Traffic Signal Grounding & Bonding
877001	Steel Mast Arm Assembly and Pole 16’ Through 55’
877002	Steel Mast Arm Assembly and Pole 56’ Through 75’
877006	Steel Mast Arm Assembly and Pole with Dual Mast Arms
877011	Steel Combination Mast Arm Assembly and Pole 16’ Through 55’
877012	Steel Combination Mast Arm Assembly and Pole 56’ Through 75’
878001	Concrete Foundation Details
880001	Span Wire Mounted Signals and Flashing Beacon Installation
880006	Traffic Signal Mounting Details

Section 1.04(e) Summary of Quantities Sheet/s (Only BOT Let Projects)

- The Summary of Quantities sheet shall list pay items in pay item code numerical order, with the full pay item description. Each pay item shall be broken into sub-quantities per location and function. Individual columns are needed for multiple locations, interconnect items, EVP and specific county or local work based on Division of Cost (see IDOT BDE Manual Section 5-5.02(e)). The amount of sub-quantity to be paid for by each participating agency shall be listed. The total quantity shall match the balance of the sub-quantities.
- The body of the quantities should be in capital letters and include CODE NUMBER, ITEM, UNIT, AND QUANTITY. Items shall be in the same code number order as on the Estimate of Cost and schedules. These items shall be directly transferred from the IDOT database and should not be retyped causing errors in the process.

Section 1.04(f) Traffic Signal District Standards

- Do not under any circumstances revise any Standard detail sheet.
- District Standard TS-01 is required for all designs.
- District Standard TS-02 is required when street name sign panels are being installed on the traffic signal mast arms.

Section 1.04(g) Temporary Traffic Signal Installation and Removal Sheet

- The North arrow shall be pointed up or to the right and shall be in the same orientation as the Signal Layout Sheet.
- Geometric layout scale: 1" = 20' (1:250)
- Right of Way (ROW) shall be shown including temporary easements.
- Existing and proposed geometrics. The proposed geometry limited to edge of pavement only.
- Schedule of existing equipment to be removed, relocated, and/or returned. Items returned to IDOT Spare Parts shall include the model number. These items may include controllers (ASC3, Cobalt, M60, master controllers), TS2 cabinets, PTZ cameras, cell modems, and network switches. Items returned to local agencies include EVP and TSP. The return notes shall include the agency name and contact information.
- Dimension wood pole locations. Show approximate station and offset, or dimensions from fixed objects.
- Wood pole guy wire locations (ensure they are within the ROW).
- Locations of existing equipment.
- SCAT System Name and TS# shall be located in the bottom right corner (e.g., TS#4660, EAGLE 5N) and indicate any centralized system (IDOT Centracs, LCDOT Centracs, IDOT Tactics, former system number, etc.).
- Show Maintenance of Traffic (MOT) if construction is staged. Use multiple detail views to show signal head placement on projects with multiple stages of MOT. A post stage view shall be included on complex projects where multiple stages or signal configurations are needed.

Section 1.04(h) Temporary Cable Plan and Temporary Phase Diagram Sheet

- The North arrow shall be pointed up or to the right and shall be in the same orientation as the Signal Layout Sheet.
- A temporary cable plan and temporary phase diagram shall be shown. The same cable plan can be used for multiple stages if the signal head placement and phasing does not change.
- A temporary emergency vehicle preemption phase diagram shall be provided if applicable.
- For complex signals or railroad traffic signals, the appropriate sequence of operations charts shall be provided.
- SCAT System Name and TS# shall be located in the bottom right corner (e.g., TS#4660, EAGLE 5N) and indicate any centralized system (IDOT Centracs, LCDOT Centracs, IDOT Tactics, former system number, etc.).

Section 1.04(i) Geometric Plan and Signal Layout Sheet

- The North arrow shall be pointed up or to the right.
- Geometric layout scale: 1” = 20’.
- ROW shall be shown. Do not include superseded ROW or temporary easements.
- Break Lines are not allowed. All pavement, driveways and cross streets between the intersection and perimeter detector loops must be shown. Match lines will be allowed, with the geometric/signal information shown on additional sheets.
- Only proposed geometrics shall be shown.
- Dimension lane widths.
- Label roadway names.
- Dimension equipment locations. Show approximate station and offset, or dimensions from fixed objects.
- Include mast arm and post foundation size and depth.
- Dimension the detector loops. A separate Detector Loop Layout Plan is required when the signal layout sheet is crowded making it difficult to read the loop dimensions. A separate Detector Loop Layout Plan is required for all railroad traffic signal designs.
- Include conduit size and lengths.
- Show curb, sidewalk, driveways, buildings, and other features adjacent to R.O.W., etc.
- Include notes related to the traffic signal work. See Section 1.04(q).
- SCAT System Name and TS# shall be located in the bottom right corner (e.g., TS#4660, EAGLE 5N) and indicate any centralized system (IDOT Centracs, LCDOT Centracs, IDOT Tactics, former system number, etc.).

Section 1.04(j) Cable Plan and Phase Diagram Sheet

- The North arrow shall be pointed up or to the right and shall be in the same orientation as the Signal Layout Sheet.
- The cable plan represents the layout of the traffic signal equipment in its correct orientation and shows the cable type of each traffic signal item as necessary.
- The cable plan shall indicate all equipment present at the traffic signal intersection, including snow cones, heated visors, programmable signal heads, elongated visors, TSP, PTZ, cell modems, accurate fiber type, etc.
- The proposed controller phase diagram shall be shown as well as the proposed emergency vehicle preemption phase diagram if applicable. If these diagrams do not fit on this sheet, a separate sheet shall be used.
- When replacing or modifying an existing controller, both existing and proposed phase diagrams shall be shown.
- For complex traffic signals, a sequence of operation chart is required. An emergency vehicle preemption sequence of operation chart is also required if applicable.
- For railroad traffic signals, a sequence of operation chart and a railroad preemption sequence of operation chart are required. An emergency vehicle preemption sequence of operation chart is also required if applicable.
- Include the table for “Traffic Signal Electric Service Requirements”. Make sure the account number is shown (metered only).
- SCAT System Name and TS# shall be located in the bottom right corner (e.g., TS#4660, EAGLE 5N) and indicate any centralized system (IDOT Centracs, LCDOT Centracs, IDOT Tactics, former system number, etc.).

Section 1.04(k) Mast Arm Mounted Street Name Signs and Schedule of Quantities Sheet

- Schedule of Quantities only pertaining to the traffic signal itself and components in the traffic signal cabinet. Do not include interconnect items or lighting items. For traffic signal modification plans with fewer pay items, the Schedule of Quantities may be placed on the cable plan sheet if space allows.
- The body of the quantities should be in capital letters and include ITEM, UNIT, AND QUANTITY. Items shall be in the same code number order as on the Estimate of Cost and Summary of Quantities.
- Mast arm mounted street name signs may be designed manually or using software (e.g., SignCAD). Refer to Section 5.01.
- SCAT System Name and TS# shall be located in the bottom right corner (e.g., TS#4660, EAGLE 5N) and indicate any centralized system (IDOT Centracs, LCDOT Centracs, IDOT Tactics, former system number, etc.).

Section 1.04(l) Temporary Interconnect Plan Sheet

- The North arrow shall be pointed up or to the right.
- Geometric layout scale: 1” = 50’ (1:500).
- ROW shall be shown.
- Denote interconnect removal items.
- If only using temporary wireless interconnect and no handhole removals, a temporary interconnect plan sheet is not required, and a temporary interconnect schematic will suffice.
- SCAT System Name shall be located in the bottom right corner (e.g., EAGLE 5N) and indicate any centralized system (IDOT Centracs, LCDOT Centracs, IDOT Tactics, former system number, etc.).

Section 1.04(m) Temporary Interconnect Schematic Sheet

- The North arrow shall be pointed up or to the right and shall be in the same orientation as the Temporary Interconnect Plan Sheet.
- Show temporary system connection between project intersections.
- Show the fiber optic cable between controllers, tracer cable, and the location of the master controller and telephone service.
- SCAT System Name shall be located in the bottom right corner (e.g., EAGLE 5N) and indicate any centralized system (IDOT Centracs, LCDOT Centracs, IDOT Tactics, former system number, etc.).

Section 1.04(n) Proposed Interconnect Plan Sheet

- The North arrow shall be pointed up or to the right.
- Geometric layout scale: 1” = 50’ (1:500).
- ROW shall be shown. Do not include superseded ROW or temporary easements.
- Include conduit size and lengths.
- Intersection items (conduit, handhole, and equipment) should be shown as existing on the proposed interconnect plan. These items shall be denoted with an “I” or “IP” per the traffic signal legend.
- System items shall be denoted with an “S” or “SP” per the traffic signal legend.
- SCAT System Name shall be located in the bottom right corner (e.g., EAGLE 5N) and indicate any centralized system (IDOT Centracs, LCDOT Centracs, IDOT Tactics, former system number, etc.).

Section 1.04(o) Proposed Interconnect Schematic and Interconnect Schedule of Quantities Sheet

- The North arrow shall be pointed up or to the right and shall be in the same orientation as the Proposed Interconnect Plan Sheet.
- Schedule of Quantities for the interconnect items.
- The body of the quantities should be in capital letters and include ITEM, UNIT, AND QUANTITY. Items shall be in the same code number order as on the Estimate of Cost and Summary of Quantities.
- Show the fiber optic cable between controllers, type of fiber optic conductor between controllers, tracer cable, master controller, telephone service, cell modem, PTZ, type of fiber (hybrid, Single Mode (SM)), and wireless system.
- For signals on a closed loop interconnect system using a master controller, at a minimum, the proposed interconnect schematic shall show the impacted intersections including the adjacent intersections as well as up to the master controller.
- For signals on a centralized interconnect system, at a minimum, the proposed interconnect schematic shall show the impacted intersections and the adjacent intersections.
- Fiber splicing diagrams and traffic signal cabinet details for centralized systems are required. These shall be requested by the designer and Bureau of Traffic will provide as a pdf file to be included with the plans.
- SCAT System Name shall be located in the bottom right corner (e.g., EAGLE 5N) and indicate any centralized system (IDOT Centracs, LCDOT Centracs, IDOT Tactics, former system number, etc.).

Section 1.04(p) Special Details

- Each detail shall be labeled per pay item designation (if applicable).
- If multiple details are supplied on one sheet, they shall be labeled separately in the title block.
- Reference all special detail sheet numbers on the traffic signal plan sheet.

Section 1.04(q) Plan Notes

The designer shall include any necessary project specific plan notes on the traffic signal plan sheet. This may include notes for red light running camera (RLRC), changeable message sign (CMS) for new traffic signal installations, and locations of video or radar detection. Also, including but not limited to removal, relocation, or return of any special equipment like PTZ, network switches, TSP, EVP, and system optimization limits.

Section 1.04(r) Estimate of Cost

- Shall be on 8-1/2" x 11" sheets.
- Top right-hand corner shall have the Route Name, County, Local Agency, Section Number, and Contract Number on each sheet.
- Information paragraph should read "The proposed improvement consists of the traffic signal (*system, modernization, or installation*) at the intersection(s) of (*name*)
- Number the pages as "Sheet 1 of _____" etc.
- The body of the estimate should be in capital letters and include ITEM NUMBER, ITEM, UNIT, QUANTITY, UNIT PRICE, and TOTAL COST. Items shall be in the same code number order as on the Summary of Quantities sheet or Schedule of Quantities.
- Use Pay Item Reports from Transportation Bulletin Archives to generate unit pricing
- Non-standard prices should include explanations.
- Name of estimator and date.
- See IDOT BDE Manual Chapter 65 for additional information.
- See example in Appendix (to be provided at a later date).

Section 1.04(s) Estimate of Time

- Use IDOT form BDE 220A
- See IDOT BDE Manual Chapter 66 Section 2.03

Section 1.04(t) Special Provisions

- The latest District 1 Traffic Signal Special Provisions shall be used for all designs.
- Any additions to the District 1 Traffic Signal Special Provisions must be approved by the Traffic Signal Design Engineer. Modifications are not allowed.
- For Bureau of Traffic let projects, a full document will consist of District 1 Traffic Signal Special Provisions and any other special provisions required from other IDOT sections and bureaus. Use each section's appropriate checklist. The District 1 special provision generator shall be used which consists of proper formatting and all necessary information. Follow the instructions provided with the generator.
- The designers may submit the Special Provision Traffic Signal Checklist in lieu of a full specification package for the preliminary and pre-final review submittals only. The final review submittal requires a full document.
- The District 1 Special Provisions, special provision checklists, and special provision generator can be found in the following link:

  D1 Special Provisions

Chapter 2 Traffic Signal Operation

Prior to starting Phase II traffic signal design, the consultant should review the previously approved intersection design study (IDS) to gather the proposed phasing information for the intersection. If no IDS exists, the consultant can coordinate with the Bureau of Traffic to determine phasing options for nonstandard intersection designs. This section contains a brief summary of signal phasing concepts along with IDOT District 1's guidelines to aid the designer. Phasing from an approved IDS should be used when available.

Section 2.01 Signal Phasing

Signal phasing serves as a mechanism for the traffic signal controller to accommodate various roadway users at an intersection in a safe and efficient manner. Each signal phase represents one or more non-conflicting intersection movements. For example, a single phase may control through movements and right turn movements on an approach as well as pedestrian movements.

Generally, roadway users are within these four categories: vehicles, pedestrians, bicyclists, and transit. Most signalized intersections in IDOT District 1 follow the standard phasing shown below in Figure 2.1 and Figure 2.2, with transit and bicyclists using the same phasing as vehicles.

Figure 2.1 Sample Intersection Phase Diagram – Major Roadway East-West

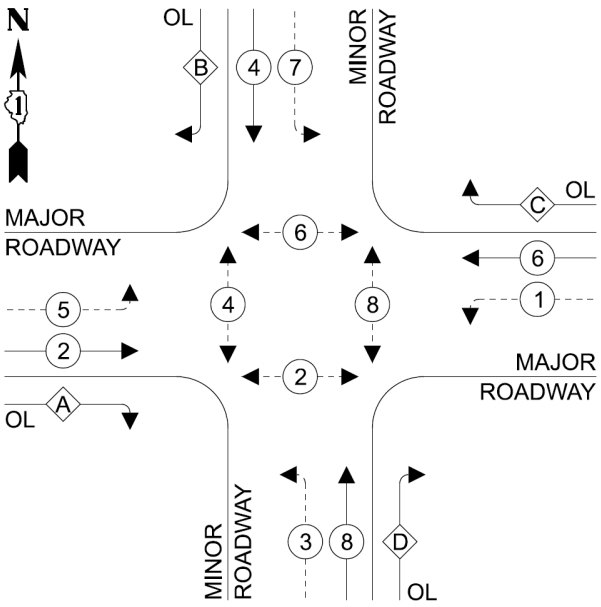
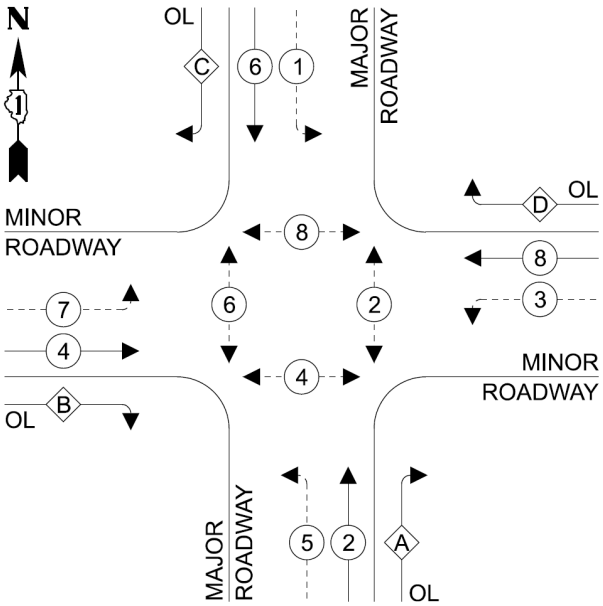


Figure 2.2 Sample Intersection Phase Diagram – Major Roadway North-South

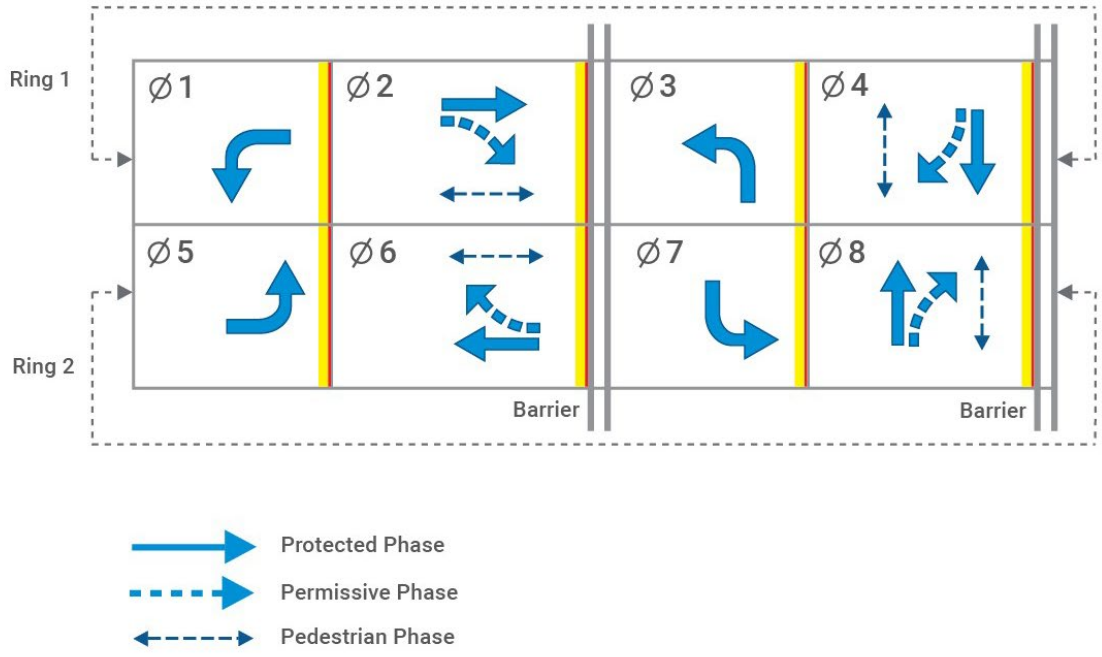


As the figures show, pedestrian phases are generally associated with the adjacent/parallel vehicle through movement but can be defined to include any non-conflicting vehicle movement. The right turn movements generally do not have their own phase and are associated with the adjacent through movement. Right-turn overlaps are labeled with letters instead of numbers. The standard phasing convention uses odd numbers for left turn movements and even numbers for through movements with Phases 2 & 6 assigned to the major roadway or coordinated route (with Phase 2 as the northbound or eastbound movement) and Phases 4 & 8 assigned to the minor roadway. The phase assignments shown in Figure 2.1 and Figure 2.2 represent a typical NEMA eight-phase controller sequence. Traffic signal controllers currently on the market offer up to 16 signal phases, to accommodate unusual intersection geometry or phasing operation.

Section 2.02 NEMA Standard Ring and Barrier Diagram

The National Electrical Manufacturers Association (NEMA) developed a series of standard practices for traffic signal cabinet wiring and controllers. NEMA uses a “Ring and Barrier” diagram to organize the signal phases into groups and separate the conflicting movements. Figure 2.3 below illustrates the standard Ring and Barrier Diagram for the sample intersection illustrated in Figure 2.1.

Figure 2.3 Sample Intersection Ring and Barrier Diagram



Rings 1 and 2 identify phases that are allowed to operate sequentially but not concurrently because of conflicting vehicle movements. For example, Phase 1 (WB LT movement) cannot operate during Phase 2 (EB through movement), because both phases are in Ring 1. For our sample intersection, Ring 1 consists of phases 1, 2, 3, and 4, while Ring 2 consists of phases 5, 6, 7, and 8.

The barrier separates the major street and minor street movements to avoid energizing different roadways at the same time. In addition, the barrier is used as a reference point in the cycle where both rings are required to terminate together in order to cross the barrier. Barrier 1 consists of phases 1, 2, 5, and 6, while Barrier 2 consists of phases 3, 4, 7, and 8.

Only one phase from each ring and barrier can operate concurrently. For example, in Barrier 1 of the sample intersection: phases 1 and 5, phases 1 and 6, phases 2 and 5, and phases 2 and 6 can all operate simultaneously. In Barrier 2, phases 3 and 7, phases 3 and 8, phases 4 and 7, and phases 4 and 8 can all operate simultaneously. These signal timing concepts should be familiar to the designer and aid in developing a proposed controller sequence.

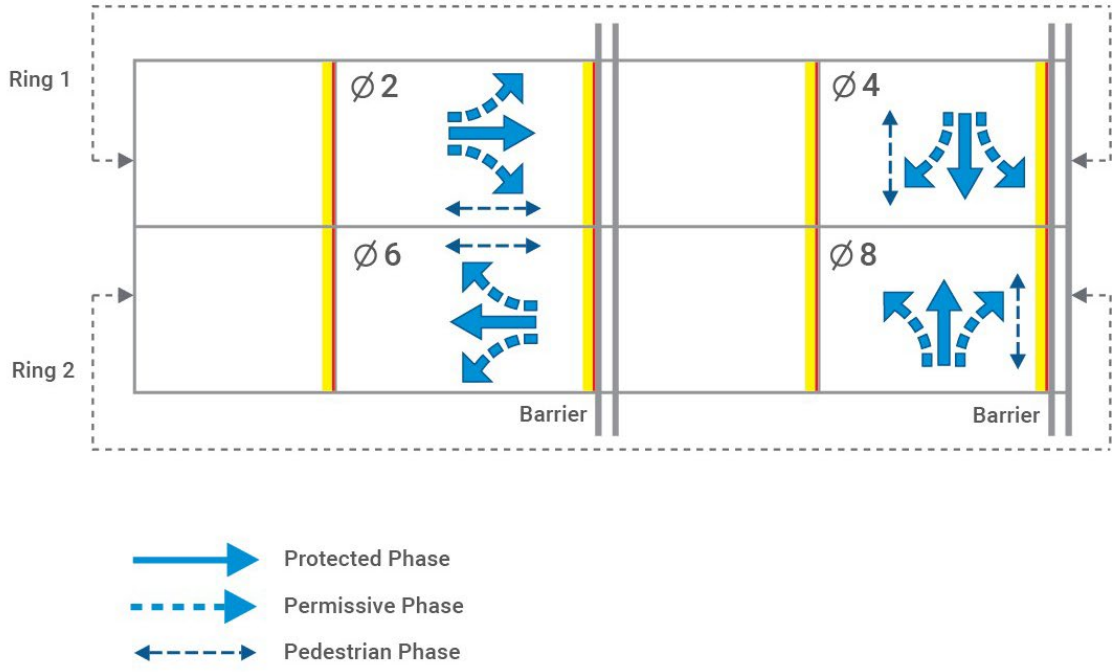
Section 2.03 Left Turn Phasing

Left turn phasing at an intersection can significantly affect how the intersection operates. On state highways, actuated left turn phases shall be used in most cases where separate left turn channelization exists. On non-state highways the use of actuated left turn phases shall be determined based on engineering evaluation of left turn volumes, conflicting through/right turn movements, and the presence of a dedicated left turn lane. The options for left turn phasing are permissive only, protected only, protected-permissive, split phasing, or prohibiting left turns.

Section 2.03(a) Permissive Only Left Turn Phasing

Permissive only left turn operations would require vehicles to yield to oncoming traffic and only be able to turn left when no conflict exists. In this scenario, left turning vehicles would receive a circular green “ball” indication at the same time as the oncoming traffic and adjacent through movement. An example of a ring and barrier diagram for permissive only left turn phasing is illustrated in Figure 2.4.

Figure 2.4 Permissive Only Left Turn Operation Ring and Barrier Diagram

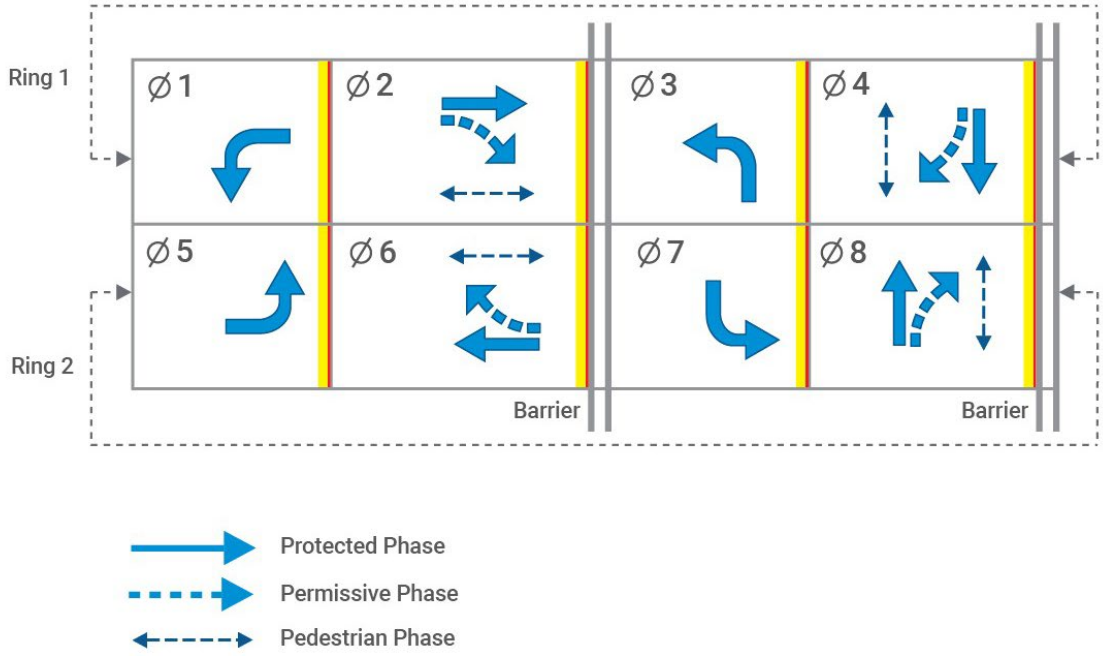


Permissive only left turns would generally only be used on roadways with low left turn volumes or where left turn channelization does not exist. As the left turn volume increases, the lane group delay increases because of vehicles queued behind the left turning vehicle waiting for a gap in oncoming traffic. This increase in delay could cause vehicles to turn prematurely and may result in safety issues at the intersection.

Section 2.03(b) Protected Only Left Turn Phasing

Protected only left turn phasing requires left turn channelization and have a designated, separate left turn phase where vehicles would only be allowed to turn left during that phase. This would separate them from conflicting vehicle movements and enhance safety measures. Left turning vehicles in this scenario would have a separate left signal head with three left turn arrow sections. An example of a ring and barrier diagram for protected only left turn phasing is illustrated in Figure 2.5.

Figure 2.5 Protected Only Left Turn Phasing Ring and Barrier Diagram



IDOT District 1 typically uses protected only left turn phasing in the following circumstances:

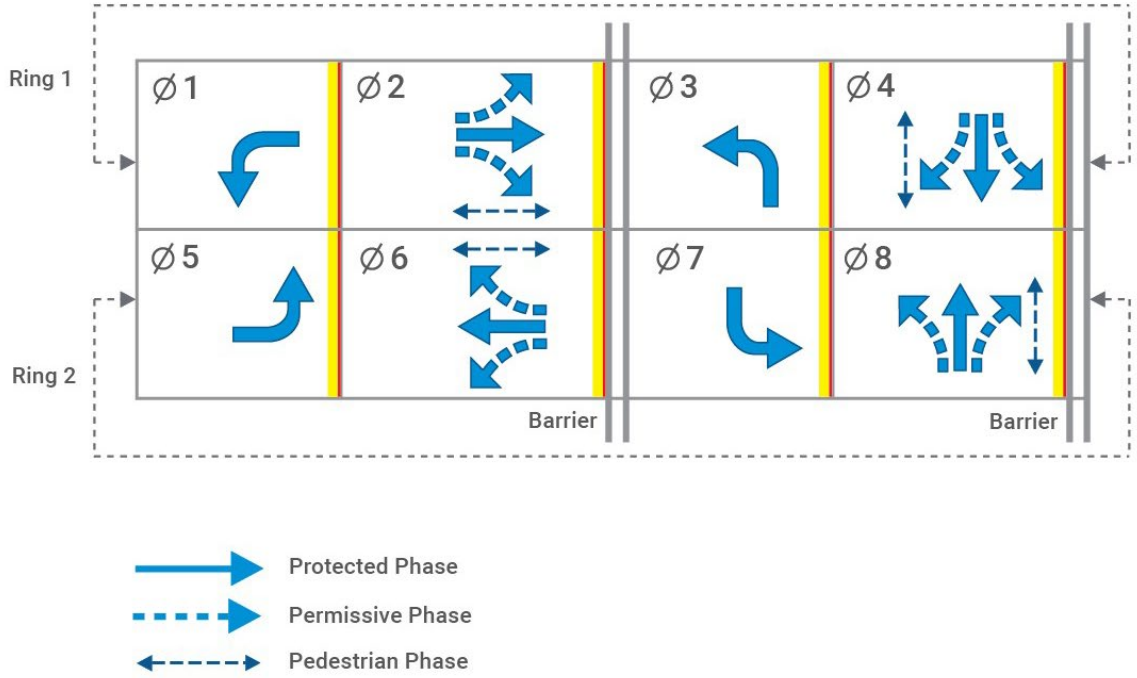
- Left turn movement from a dual left turn lane.
- Three or more opposing through lanes.
- Left turn movement opposing a protected only left turn movement (i.e., single left turn lane opposite a dual left turn lane; leading left turn phase opposite a lagging left turn phase).
- Wide intersections and/or skewed intersections where left turning traffic is exposed to conflicting traffic longer than the normal driver expectation. This requires approval from Traffic Signal Design Engineer.
- Intersections with a left turning crash history higher than normal. This requires approval from Traffic Signal Design or Traffic Studies Engineer.

The advantage of protected only phasing is the safety aspect of separating left turning vehicles from oncoming/conflicting movements. The disadvantage is the overall intersection delay attributed to providing separate left turning phases. This is the most restrictive left turn movement and once implemented, reverting to a less restrictive left turning movement will not be allowed.

Section 2.03(c) Protected-Permissive Left Turn Phasing

Protected-permissive left turn phasing generally requires left turn lane channelization and consists of a protected left turn phase followed by a “green ball” indication allowing permissive left turn movements. The left turn lane would have a signal head with five signal sections: red, yellow, green, yellow left turn arrow, and green left turn arrow. An advanced left turn phase without channelization can also be implemented if there is no left turn phase in the opposing direction. An example of a ring and barrier diagram with protected-permissive left turn phasing is illustrated in Figure 2.6.

Figure 2.6 Protected-Permissive Left Turn Phasing Ring and Barrier Diagram



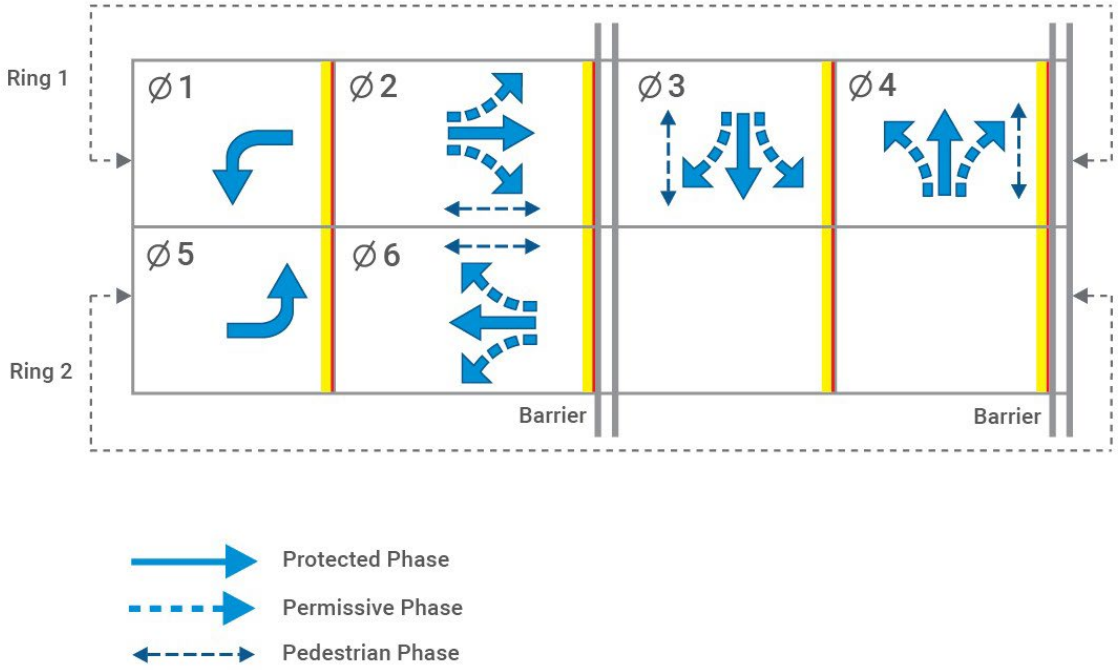
Protected-permissive left turn phasing can provide efficiency compared to protected only but with increased safety compared to permissive only. Protected-permissive left turn phasing is the most prevalent left turn phasing operation in District 1.

Intersections with roadways with a speed limit over 45 mph should have their crash history examined to see if protected only phasing could be implemented as a safety measure without adversely affecting capacity.

Section 2.03(d) Split Phase Left Turn Phasing

Split phasing consists of one leg of an intersection being serviced alone on its own phase with the opposite leg also being serviced alone on its own phase. Generally split phasing is used on approaches with shared lanes or at intersections with geometric deficiencies or during construction when staging does not allow for concurrent opposing movements. The vehicles on a split phased approach would have a signal head with four signal sections: red, yellow, green, and green left turn arrow. An example of a ring and barrier diagram with split phase left turning operation is illustrated in Figure 2.7.

Figure 2.7 Ring and Barrier Diagram with Split Phase Left Turn Phasing on the Minor Street



Split phasing should be avoided unless the geometry of the intersection does not allow for concurrent movements. If possible, modifications to the intersection geometry should be considered to allow for standard sequential phasing. Split phasing does not use the available cycle time in an efficient manner and usually leads to prolonged queuing on the major route.

Only one phase per movement on the same ring on the same side of the barrier should be utilized for this type of operation (i.e., one direction movement should be assigned Phase 3 and the opposite direction or movement should be assigned Phase 4). Phase 3 will be the first phase serviced on the side of the barrier operating the split phase and should be assigned to the minor street approach with the smaller traffic volume. Any unused time would then be available for Phase 4 or the major street phases.

Section 2.03(e) Prohibiting Left Turns

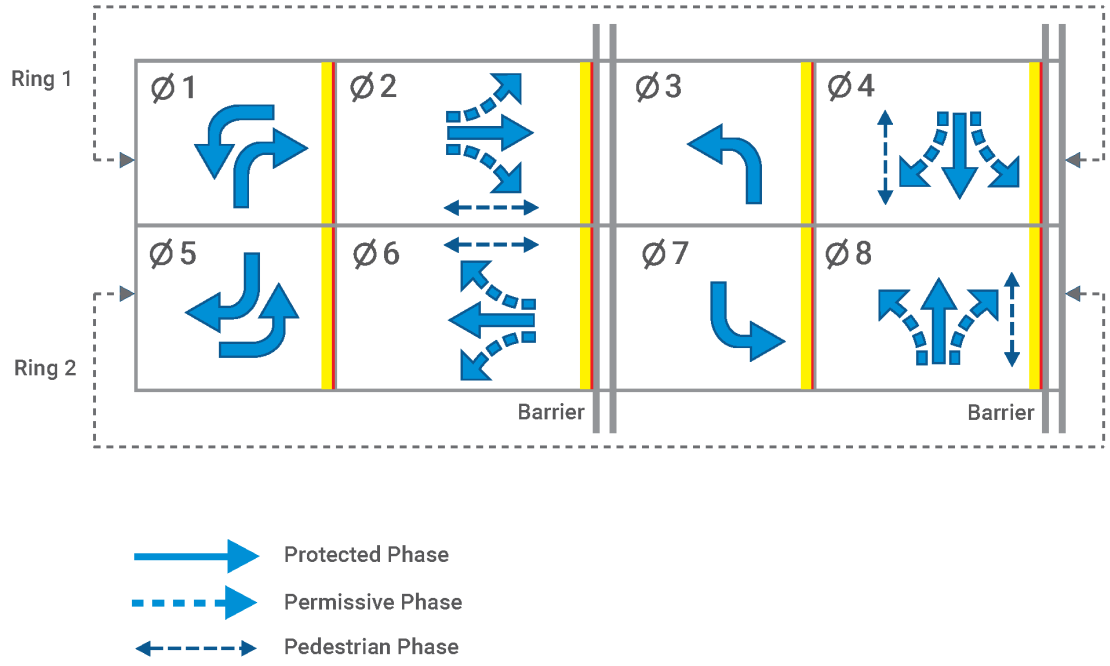
Prohibiting left turns consists of prohibiting select left turning movements to eliminate conflicts or accommodate geometry such as a one-way street or off-ramp. Intersection signage would need to be provided to inform drivers of the turning restrictions. In some cases, modifications to the curb line may be required to reinforce the turn restriction to the driver. Alternatively, an up arrow can be used in place of a green ball to emphasize the restriction.

Section 2.03(f) Right Turn Overlaps

It is the District's preference to add right turn overlaps to existing intersections when possible if there are no identified safety concerns involving conflicts with other movements such as U-turns.

Right turn overlap phases may be installed where separate right turn channelization exists with the complimentary protected left turn movements. When right turn overlaps are added to the signal phasing, the designer should take into consideration the volume of conflicting U-turn vehicles for the associated left turn movement. Signage describing which movement should yield may be installed as part of the project. This right turn/U-turn decision is usually made during Phase I when the intersection design study (IDS) is created. The designer should reach out to Traffic Programs for coordination on individual projects without a formal IDS. An example of a ring and barrier diagram with a right turn overlap is illustrated in Figure 2.8.

Figure 2.8 Ring and Barrier Diagram with Right Turn Overlap on Minor Road



Section 2.03(g) Left Turn Flashing Yellow Arrow

Left turn flashing yellow arrow refers to a left turn signal operation, in which the left turn lane has a separate four section signal head with the following indications: red arrow, steady yellow arrow, flashing yellow arrow, and green arrow. For lead-lead left turn phasing, the green arrow would be energized during the protected left turn phase, followed by the steady yellow arrow for the left turn clearance interval, followed by a permissive left turn phase with a flashing yellow arrow in lieu of a green “ball.” The flashing yellow arrow would then be followed by a steady yellow arrow for the clearance interval of the adjacent through movement and finally end with a red arrow. Typical signal head configuration for left turn flashing yellow arrow operation is illustrated in Figure 3.3.

The ring and barrier diagram for Left Turn Flashing Yellow Arrow is the same as the diagram for protected-permissive left turn phasing as illustrated in Figure 2.6.

Flashing yellow arrow operation is driven by the opposing through movement. Engineering judgement should be exercised in implementing a delayed flashing yellow arrow start time.

IDOT District 1 permits flashing yellow arrow operation when included on a corridor wide implementation project which crosses a State route. This is subject to individual project approval, and the designer should engage the District 1 Traffic Studies Section, preferably during Phase I engineering to discuss design requirements. Flashing yellow arrow operation may require traffic signal cabinet replacements and the designer will be responsible for verifying cabinet compatibility before completing design plans.

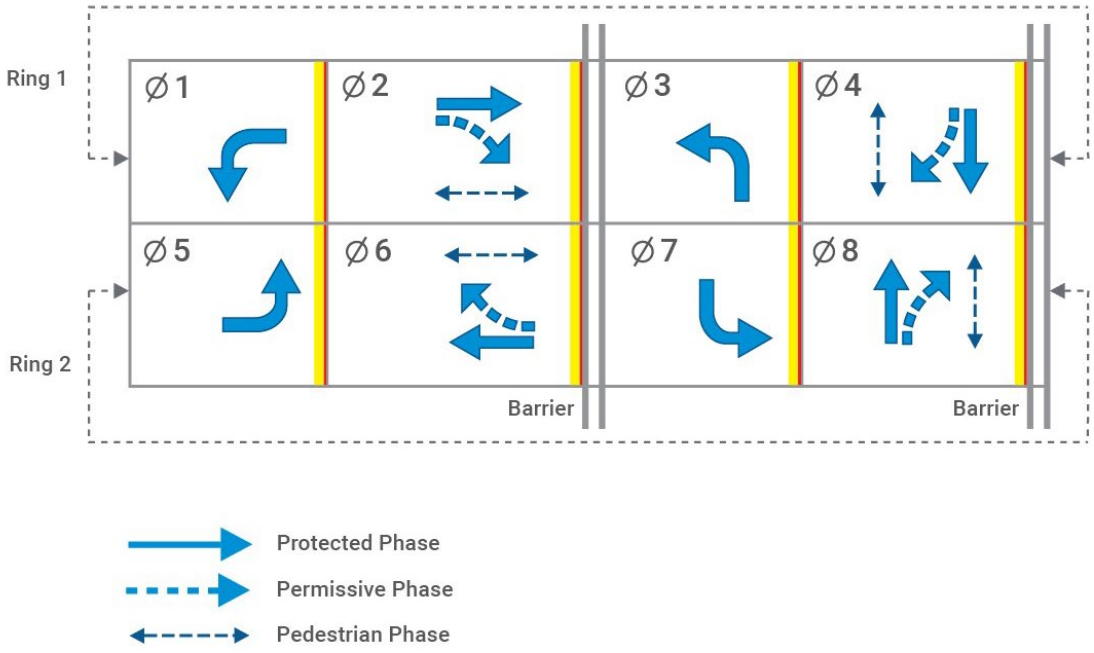
Section 2.04 Left Turn Phase Sequence Options

Depending on the traffic patterns, signal spacing, and coordination, the designer may need to change the sequence of the left turn phasing in relation to the adjacent through phase to improve mobility along the corridor. Options for sequencing the left turn phase are lead-lead, lag-lag, and lead-lag. Lead-lag and lag-lag are not desirable and should be avoided when using protected-permissive left turn phasing.

Section 2.04(a) Lead-Lead Left Turn Phasing

Lead-lead left turn phasing is the most used throughout District 1. This phasing sequence has the opposing left turn phases start together before the adjacent through phase. Figure 2.9 illustrates the ring and barrier diagram for lead-lead left turn phasing.

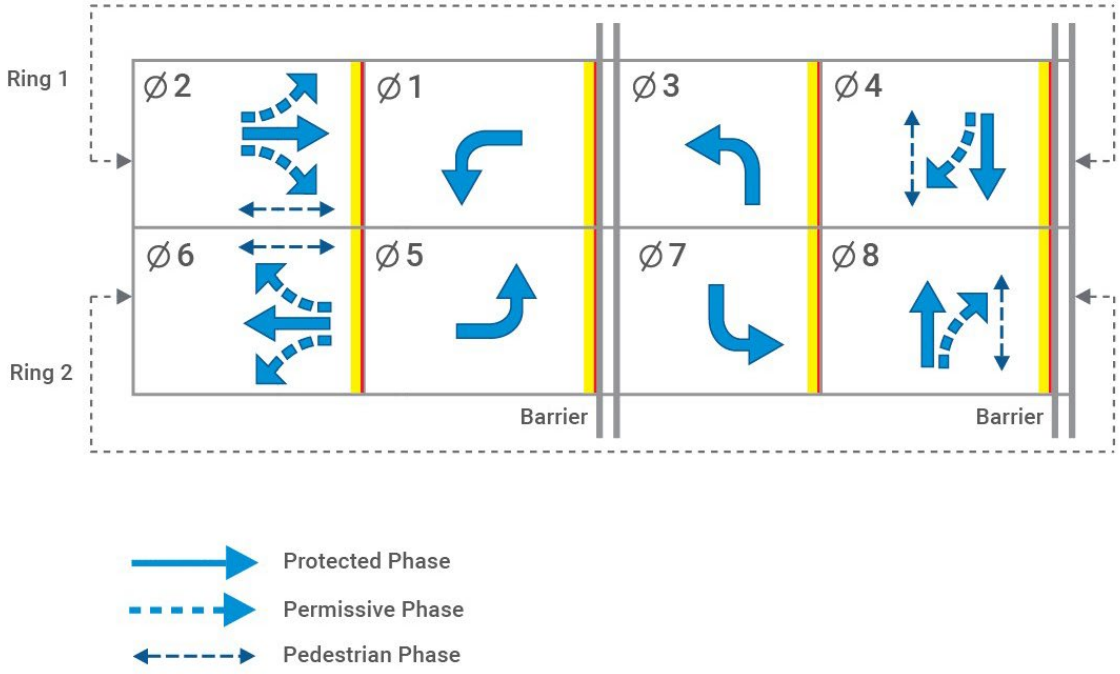
Figure 2.9 Ring and Barrier Diagram for Protected Only Lead-Lead Left Turn Phasing



Section 2.04(b) Lag-Lag Left Turn Phasing

Lag-lag left turn phasing refers to a sequence where the through phases are served first followed by the adjacent left turn phases. The left turn phases terminate together. Lag-lag left turn phasing should be protected only. Figure 2.10 illustrates the ring and barrier diagram for lag-lag left turn phasing on the major street.

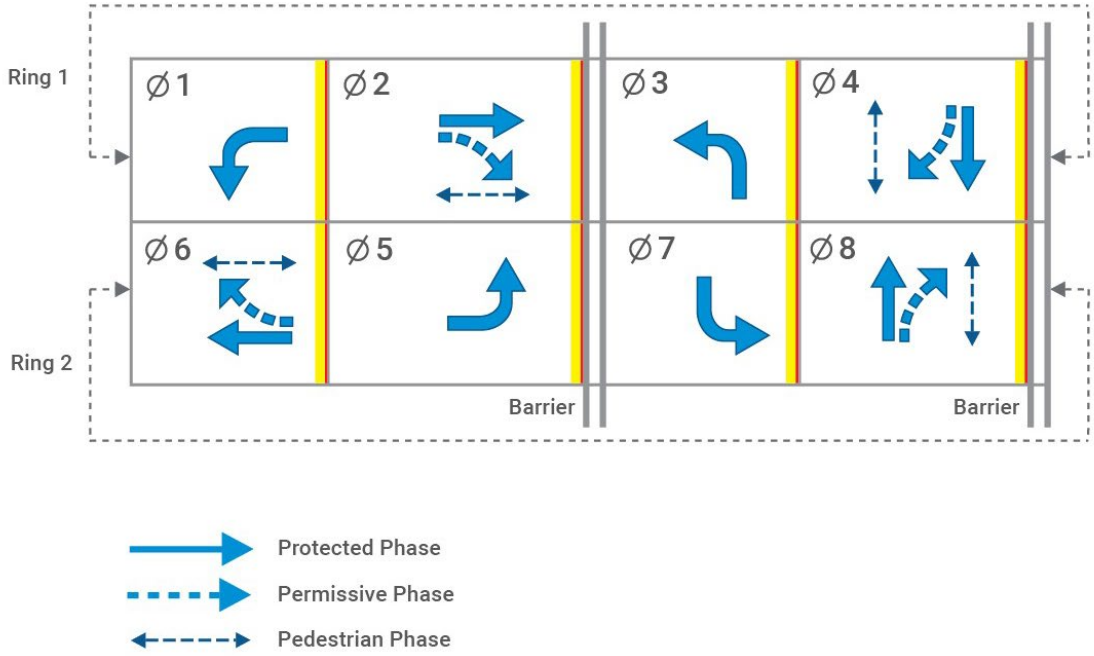
Figure 2.10 Ring and Barrier Diagram for Protected Only Lag-Lag Left Turn Phasing on the Major Street



Section 2.04(c) Lead-Lag Left Turn Phasing

Lead-lag left turn phasing refers to a sequence where the left turn movement and its adjacent through movement are served first followed by the through movements only and finally the opposing left turn movement and its adjacent through movement. Lead-lag left turn phasing should be protected only. Figure 2.11 illustrates the ring and barrier diagram for lead-lag left turn phasing on the major street.

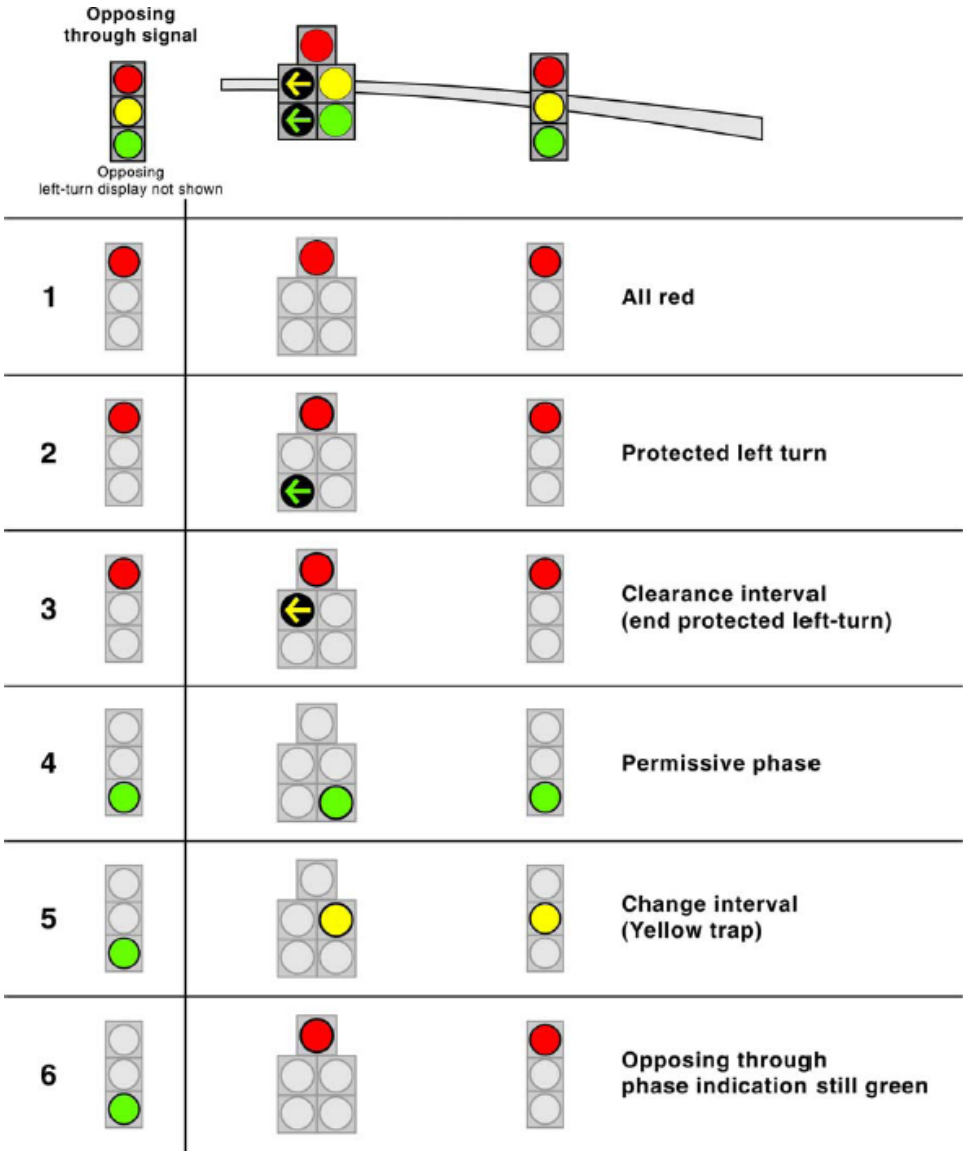
Figure 2.11 Ring and Barrier Diagram for Protected Only Lead-Lag Left Turn Phasing on the Major Street



Section 2.04(d) Yellow Trap

Yellow trap can occur during lag-lag or lead-lag left turn phasing using protected-permissive mode for the left turns. Yellow trap refers to a potentially dangerous situation caused by drivers turning left that are assuming oncoming traffic has the same signal indication as their adjacent through movement. Figure 2.12 illustrates the lead-lag phasing sequence with the yellow trap.

Figure 2.12 Yellow Trap with Lead-Lag Left Turn Phasing



Controller sequences that allow yellow trap to occur must be amended to completely avoid creating a dangerous situation for drivers. The solution to the yellow trap is to implement protected only left turn phasing for lead-lag or lag-lag sequences.

Yellow traps should be avoided whenever possible by having protected only left turns on the appropriate movements. Intersections where a yellow trap is unavoidable should have an appropriate sign to alert drivers of the presence of the yellow trap.

Section 2.05 Pedestrian Phasing

Pedestrian phases are associated with the adjacent vehicle “through” phase. See Appendix A for examples of pedestrian phasing. Pedestrian phasing would be provided using a pedestrian signal head with the indications of "Don't Walk", "Walk", and "Count Down Flashing Don't Walk". Special consideration should be given to adding a pedestrian crossing at a channelization median. It may require a signal head/phasing change to omit existing right turn overlaps. The use of controller programming such as “pedestrian protect” that omits the right turn arrow overlap when a push button is activated is currently not preferred by the District. Pedestrian phasing is typically programmed to allow pedestrians to cross the entire road section without stopping at the median refuge.

Exclusive pedestrian phases should not be used in the District on IDOT owned and maintained traffic signals.

Leading Pedestrian Interval (LPI) phasing allows pedestrians to get a head start crossing the intersection before vehicular movement begins. LPI phasing may be implemented at intersections with approval from the IDOT Traffic Studies Unit. See Section 4.05 for more information on using the LPI.

Section 2.06 Traffic Signal Preemption and Priority

Traffic signal preemption refers to a disruption in the signal sequence to serve a requested phase. The most common preemption event is emergency vehicle preemption (EVP), where an emergency vehicle requests priority from the traffic signal controller. Other priority events include railroad preemption for railroad interconnected intersections and movable bridge preemption for locations where the bridge opening requires the vehicles to clear the bridge. Transit priority requests are also included in this section, though instead of disrupting the signal sequence, the controller will make minor modifications to the timing splits to give “priority” to the requested phase.

Section 2.06(a) Emergency Vehicle Preemption (EVP)

EVP sequences are included in the intersection's cable plan. Typically, EVP is designated in the controller as preempt channels 3 through 6. The intersection's left turn phasing determines how many preemption channels are required for an intersection. The installation of a push button inside a fire station would require a separate preempt channel for the push button and should be noted in the cable plan. Figure 2.13, Figure 2.14, and Figure 2.15 provide examples of phase diagrams with EVP sequences on a typical traffic signal for different left turn phasing.

Figure 2.13 EVP Phase Diagram - Protected-Permissive or Permissive Left Turn Phasing on both Major and Minor Roadway

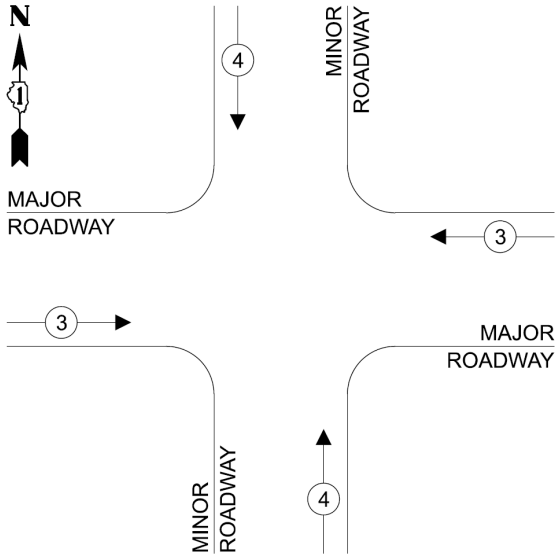


Figure 2.14 EVP Phase Diagram - Protected Only Left Turn Phasing on Major Roadway and Protected-Permissive Left Turn Phasing on Minor Roadway

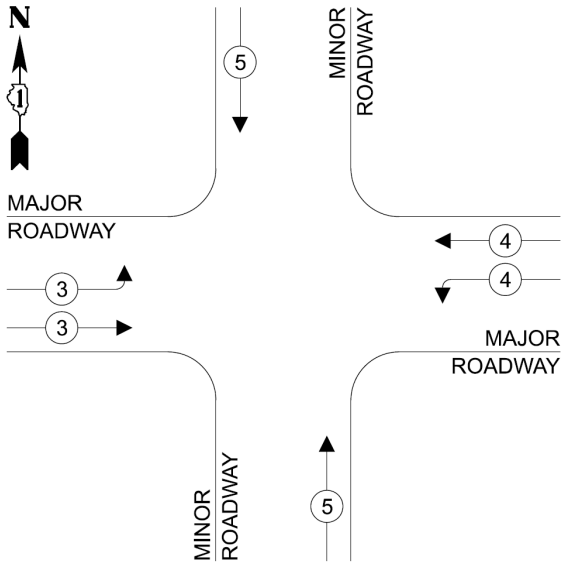
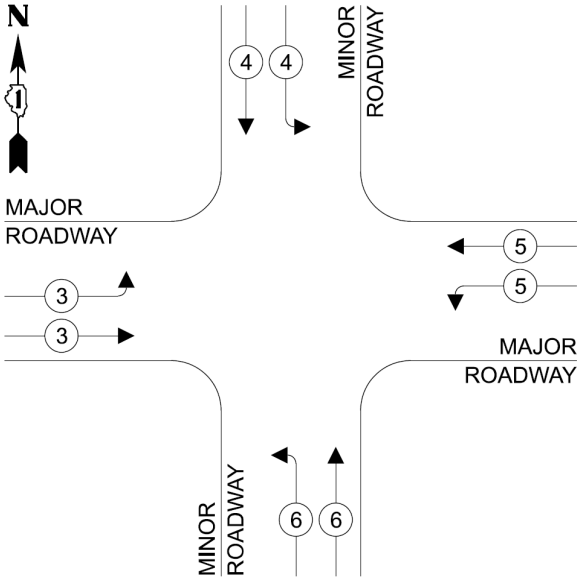


Figure 2.15 EVP Phase Diagram - Protected Only Left Turn Phasing on both Major and Minor Roadway



Section 2.06(b) Railroad Preemption

The Railroad Preemption Sequence shall provide sufficient time for the traffic to clear the tracks when the signal is preempted by any train movement. A railroad report approved by the Illinois Commerce Commission (ICC) is required for new traffic signal installations or other signal modifications when interconnected with an at-grade railroad crossing.

Normal railroad preemption in District 1 shall clear the railroad crossing approach while holding all other approaches red. If trains frequently cause long delays, the preempt may be allowed to cycle between all non-conflicting movements.

The controller sequence, EVP sequence (if applicable), and the railroad preemption sequence must be developed by the designer in Microsoft Excel chart form. If available, an existing Excel chart will be provided. The revised Excel chart must be provided with an accompanying signal plan for each review. Refer to Section 3.5 of the Railroad Traffic Signal Design Guidelines on developing a railroad preemption sequence design. Provisions for preemption shall be in accordance with current IDOT District 1 design criteria and the ITE report “Preemption of Traffic Signals at or Near Railroad Grade Crossings with Active Warning Devices” and sent to the ICC for recommendations and coordination. The railroad preemption phase(s) shall always be assigned to preemptor channel 1 or 2.

Section 2.06(c) Transit Priority Request

Transit priority refers to a signal operation in which transit vehicles can request priority through a signalized intersection by extending the green phase or truncating the red phase. District 1 allows transit agencies to implement this type of signal operation with IDOT coordination. This should be done prior to the design phase to ensure controller software and traffic signal cabinet compatibility for implementation.

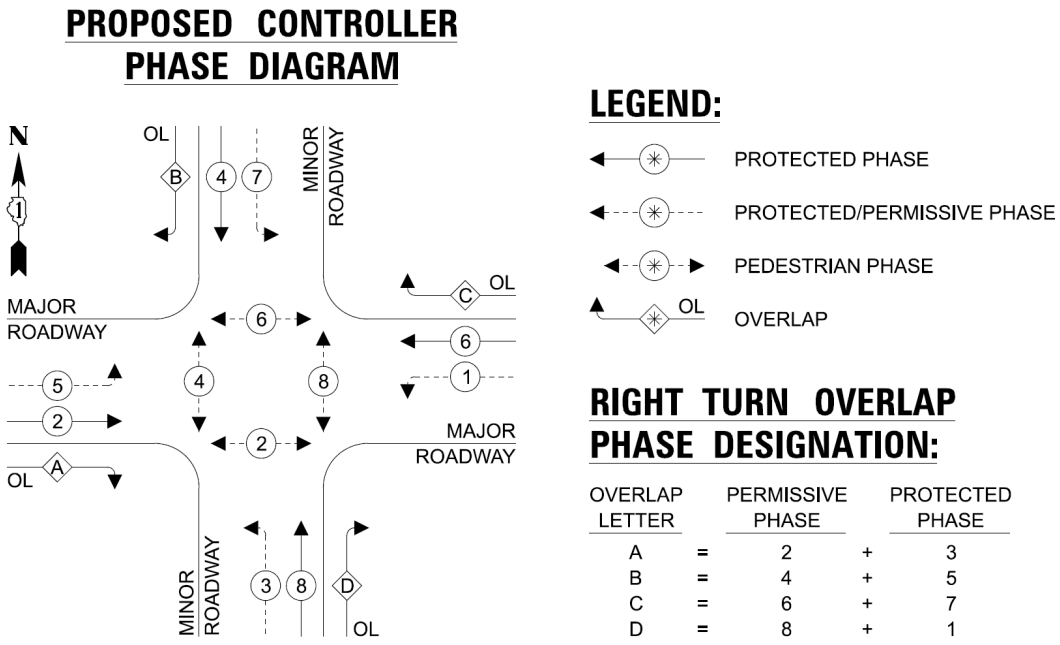
Section 2.07 Signal Operation and Contract Documents

Section 2.07(a) Signal Operation on the Cable Plan

The intersection’s proposed signal operation will be included in the contract documents via cable plan in the project’s traffic signal plan sheets. The cable plans will include the controller sequence (usually in the form of a phase diagram), emergency vehicle preemption sequence (if applicable), signal equipment and cable types at the intersection, and an energy requirements chart.

Phase diagrams shall be utilized, when possible, by the designer in developing the Sequence of Operation, in lieu of Sequence Charts. Most intersections contain geometric conditions in which these phase diagrams can be utilized. Appropriate notes and symbols should be used to designate each vehicle phase, pedestrian phase, and right turn overlaps. An example phase diagram is included in Figure 2.16.

Figure 2.16 Example Controller Phase Diagram



Sequence of Operations charts are required at complex traffic signal intersections. The designer shall coordinate with the IDOT Traffic Signal Design Engineer to determine if a sequence chart should be used.

When the improvement involves modifications to an existing controller sequence at an existing signalized intersection, both the existing and proposed phase diagrams must be included in the cable plan sheets.

Phase diagrams are not allowed at an intersection where railroad preemption is required. The Sequence of Operation charts should be developed in the initial design of the railroad interconnected signal and must include the signal operation per signal head under normal sequence of operation, railroad preemption sequence, and emergency vehicle sequence, if applicable. See the Railroad Traffic Signal Design Guidelines.

If the traffic signal design requires another left turn phasing sequence other than lead-lead, notes shall be provided on the phase diagram to describe the phasing sequence. Split phased intersections can use phase diagrams as well. Intersections with a continuous right turn arrow (hot right) may utilize a phase diagram with notes indicating the specific continuous right-turn overlap movement. When geometric conditions exist where the phase diagrams cannot be utilized, the designer must prepare a Sequence of Operation chart(s).

Section 2.07(b) Signal Timing Development

When applicable, the designer shall include provisions in the contract documents for the contractor to hire a signal timing consultant to provide the timing plan for the proposed controller sequence during construction. The TEMPORARY TRAFFIC SIGNAL TIMING pay item should be included in the plans to allow for the signal timing consultant to provide adjustments for each stage of construction as controller sequences and lane configurations change.

After construction is complete, intersections that are a part of an interconnect system where a new or revised timing is required, one of the following three pay items should be used:

- RE-OPTIMIZE TRAFFIC SIGNAL SYSTEM LEVEL 1 shall be included in the plans when minor changes are made at an intersection that require the contractor to hire a signal timing consultant to make timing adjustments as outlined in the special provision. Examples include the addition of a pedestrian phase or reconfiguration of the crosswalk design. This pay item shall be included whenever APS is added to an existing intersection. (One each per intersection)
- RE-OPTIMIZE TRAFFIC SIGNAL SYSTEM LEVEL 2 shall be included when major geometric or phasing changes are made to an intersection that require the contractor to hire a signal timing consultant to perform traffic counts and develop timing plans as outlined in the special provision. This shall be included for a new traffic signal installation. (One each per intersection only)
- OPTIMIZE TRAFFIC SIGNAL SYSTEM will be included in the construction plans when a new interconnect system is created, or the project changes the existing interconnect system significantly enough (i.e., major widening on the entire arterial), that a full study and re-timing of all intersections on the interconnect system is necessary as outlined in the special provision.

Section 2.07(c) Signal Ownership, Maintenance and Energy Costs

The energy requirements chart will list the agency responsible for the billing of energy costs as stated in the local agency's agreement with the State.

The maintaining agency is responsible for the maintenance cost as listed in the local agency's agreement of the traffic signal installation. All traffic signals on state routes are owned by IDOT and must follow District 1 design policies.

- State Highway Intersecting a Local Road - The Department and the local agencies will share responsibility for the maintenance and energy. The cost to each agency will be in proportion to the number of intersection approaches that it maintains. The existing maintenance agreement and cost participation split for an intersection can be requested from IDOT.
- State Highway Intersecting a County Highway or Unincorporated Road - The Department will assume both maintenance and energy.
- State Highway Intersecting a Private Benefit Access - The Department of Transportation has had a consistent policy since 1994 requiring that all traffic signal agreements be issued to a local municipality, County or other appropriate taxing body approved by the Department. The Department instituted this policy because the Department does not have the resources to keep up with the status of local businesses (relocations or closures). As a matter of standard practice, the Department requires that an agreement is issued to entities that are inherently solvent, stable, and have direct involvement in the success of the development for which the traffic signal agreement is being issued. Municipalities are the ideal entities for issuance of such an agreement. The municipality can make a separate joint agreement with the proposed development for reimbursement and rightfully assume risk inherent in the development which they approve and receive taxes. If a development is sold to another developer, the Department still has recourse to the municipality for the agreement obligations without any alteration of the agreement. The cost for maintenance and energy will be 100% local municipality, County or other appropriate taxing body approved by the Department.

Chapter 3 Signal Design and Equipment

The purpose of this chapter is to aid both the designer and reviewer with placement and design of traffic signal equipment and the corresponding underground facilities. There are many variables to be considered in the design of traffic signal equipment. This chapter does not describe all possible situations, rather it is to promote sound engineering and uniformity in the design of traffic signal equipment along state highways. Guidelines specified in this chapter shall be followed to the extent practicable and any deviations from these guidelines shall be with the approval of the District.

Section 3.01 Geometrics and Signal Layout

Intersection geometrics shall meet, as a minimum, all requirements outlined in the latest edition of the IDOT BDE Manual. Typically, any geometric or phasing changes at an intersection require an intersection design study (IDS) which shall be approved prior to the signal design and properly filed with IDOT for records.

During the IDS development, the designer shall consider at minimum the following key elements.

- Proper phasing shown on the IDS for safe operation of the traffic signal intersection.
- Phasing shall be final upon IDS approval and shall not be changed at a later time unless due to special circumstances.
- There shall be adequate ROW amount for proper traffic signal placement including future maintenance. If there is minimal ROW it shall be requested prior to IDS approval.
- Pedestrian crossings, sidewalks, and pedestrian signal equipment shall be considered in the IDS for proper placement.

The designer should follow the approved IDS for signal design. If the IDS geometry is not conducive to proper traffic signal layout and operation, as covered in these guidelines, the designer should notify the IDOT Traffic Signal Design Engineer of conflicts and discrepancies.

Raised corner islands often provide substantial benefits, especially in urban environments, but they require additional long-term maintenance. Corner islands can also help moderate vehicle turning speeds, provide pedestrian and bicyclist refuge areas, and allow for placement and optimal visibility of signs and signalized traffic control devices that may also include pedestrian signal heads and push buttons. Refer to IDOT BDE Manual Chapter 36 Section 2.02(b) for more information.

The sides of the island are controlled by minimum island size and visibility requirements. The sides should not be less than 12’ after rounding the corners. If traffic signal posts or pedestrian accommodations are installed within the island, the sides of the island may need to be increased above the minimum.

The minimum island size for rural areas is 100 ft^2. For urban islands, the island area should be 75 ft^2 but not less than 50 ft^2. The island area includes the concrete median surface from face of curb to face of curb. When traffic signal equipment or pedestrian accommodations are present within the island, the island size may need to be increased above these minimums.

Intersections, where traffic signal modifications or modernizations are proposed with no roadway work, should be reviewed for possible removal of islands and small sections of raised medians. These should be removed and replaced with pavement markings or a mountable median that is compatible with the remainder of the channelization. The designer shall identify the hazards of each raised island

or median and weigh them against the benefits as a channelization device to determine removal needs.

For any intersection located within 1000' of an at grade railroad crossing on any approach, the designer shall refer to the Railroad Traffic Signal Design Guidelines for both the IDS and the traffic signal plan development. Proper coordination and procedure shall be followed as outlined in that document.

At T-intersections, crosswalks should not be placed in conflict with the left turn movement off the roadway that is terminating.

The geometry and pavement markings should be designed with future pedestrian crossings in mind such that they would not require adjustments of the stop bar(s) or medians if installed in the future.

Section 3.02 Traffic Signal Cabinet and Controller

The traffic signal cabinet shall be placed according to the guidance below:

- The cabinet shall be placed so that the door can fully open (5 feet swing) within the existing ROW.
- The cabinet shall have a Concrete Foundation, Type C or Type D, with a concrete apron and spare conduit raceway per District Standard TS-01.
- The cabinet shall be place at a minimum 6 feet from the back of the barrier curb to the roadway side of the cabinet foundation. If a barrier curb does not exist, the cabinet shall be placed a minimum of 16 feet from the edge line of the right-most lane (or mountable curb) or 6 feet behind the edge of the shoulder to the roadway side of the foundation, whichever distance is greater. See District Standard TS-01 for the Traffic Signal Equipment Offset Minimums table.
- The cabinet shall be oriented such that when standing in front of the cabinet door, with the UPS on the right side, all signal equipment is visible to the maintainer.
- The cabinet shall not block the visibility of pedestrians waiting to cross.
- The cabinet should not be placed in locations prone to wide semi-tuck turns.
- The cabinet should not be placed in low points or at the bottom of ditches where water is likely to collect. If ditches are present at all corners of the intersection, the traffic signal designer shall coordinate the installation of a culvert with the roadway designer to provide a flat area for the cabinet. If it is not possible to avoid a low point or there are other circumstances that can result in flooding, the designer should callout for the cabinet to be installed on a special riser.
- The cabinet should be placed in the quadrant closest to the electric service feed.
- The cabinet shall not be painted.

Mast arm poles shall be placed at a minimum of 6 feet from the back of a barrier curb to the center of the foundation. If a barrier curb does not exist, mast arm poles shall be placed at a minimum of 10 feet from the edge line of the right-most lane (or mountable curb) or 2 feet behind the edge of the shoulder to the center of the foundation, whichever distance is greater. See District Standard TS-01 for the Traffic Signal Equipment Offset Minimums table.

The pay item “FULL-ACTUATED CONTROLLER AND TYPE IV STRETCHED CABINET” shall be specified for all intersections, except as noted below:

- The pay item “FULL-ACTUATED CONTROLLER AND TYPE SUPER R CABINET” shall be specified for all intersections where an existing Type C foundation is to be re-used.
- The pay item “RAILROAD, FULL-ACTUATED CONTROLLER AND TYPE SUPER R CABINET” shall be specified for all intersections that are interconnected with a railroad crossing.
- The pay item “RAILROAD, FULL-ACTUATED CONTROLLER AND TYPE IV STRETCHED CABINET” shall be specified for all intersections that are interconnected with a railroad crossing where an existing Type D foundation is to be re-used.
- The pay item “ADVANCED TRANSPORTATION CONTROLLER AND TYPE IV STRETCHED CABINET” shall be specified only at approved intersections.
- The pay item “ADVANCED TRANSPORTATION CONTROLLER AND TYPE SUPER R CABINET” shall be specified only at approved intersections where an existing Type C foundation is to be re-used.

When replacing a traffic signal cabinet on an existing concrete foundation, the correct cabinet shall be used to match the existing foundation. Type IV Stretch cabinets are installed on Type D concrete foundations and Super R cabinets are installed on Type C concrete foundations. See District Standard TS-01 for a detailed view of the Type C and Type D foundations.

Super R cabinets shall be specified at locations with Single Point Urban Interchanges (SPUI), Diverging Diamond Interchanges (DDI), locations that control multiple intersections from one cabinet, and as directed by the IDOT Traffic Signal Design Engineer.

If applicable, the designer will be responsible for ensuring controller and master controller compatibility with existing equipment in the vicinity of the proposed design. When the proposed controller or master controller is to be installed within an existing signal system, the pay item shall include the “SPECIAL” designation, and a system name shall be added to the plans at the bottom right corner of the plan sheet. The system name will indicate the controller brand to be installed. If the location is part of the centralized management system, then the management system name shall be indicated on the plans. The designer will be responsible for knowing the type of centralized system being used, its limitations, and connection methods. (See Section 3.10).

A traffic signal on an Econolite system or Centracs shall be replaced with an Econolite controller. A traffic signal on an Eagle system or Tactics shall be replaced with an Eagle controller. Traffic signal controllers going on a centralized system should be coordinated with the Traffic Systems Engineer.

In addition, the designer will be responsible for staying apprised of the District’s approved signal system manufacturers and their limitations (i.e., maximum number of system detector loops per master, maximum number of system detector loops per local, maximum number of controllers per master, special telemetry requirements for large systems, etc.). The maximum number of local controllers on an Econolite master controller is 24 and on an Eagle master controller is 32.

Section 3.02(a) Peripheral Devices

Traffic signal cabinets may contain equipment not owned or maintained by the District but by partnering transportation agencies. Examples include ITS equipment such as Transit Signal Priority, ethernet switches, cell modems, EVP equipment, and video encoders. The designer must coordinate with the agencies to determine how it should be returned, salvaged, or stored for reinstallation when there is work that will disrupt the communication to any of these devices. The designer is responsible for indicating these requirements with removal notes and/or construction notes on the traffic signal plan sheets. If the designer is not certain who to contact for coordination with the peripheral devices, then they should contact the IDOT Traffic Signal Design Engineer. Later sections discuss these items in more detail.

Section 3.02(b) Adaptive Signal Control

Adaptive Signal Control is operated either through in-cabinet equipment or managed through an ATMS (Advanced Traffic Management System). The District does not currently operate Adaptive Signal Control systems. Coordination with the District should start during the project's Phase I to determine if the intersection(s) with State jurisdiction are eligible for this signal operational change. Systems such as Adaptive Signal Control will only be considered on a case-by-case basis along with other traffic control systems.

Section 3.02(c) Uninterruptible Power Supply Systems

All traffic signal installations shall include an Uninterruptible Power Supply (UPS) system. UPS is required on traffic signal upgrades and modifications, permanent span wire traffic signals, and temporary traffic signal installations.

When installing a UPS system to an existing Type IV, Type V, or a proposed Type IV Stretch, the pay item will need to include the cabinet to house the UPS. The appropriate pay item would be: UNINTERRUPTABLE POWER SUPPLY AND CABINET, SPECIAL. The UPS shall be attached to the right side (when facing the inside of the cabinet) of the proposed cabinet unless conditions in the field do not allow it.

When installing a UPS in a proposed Super R cabinet, which has an integrated battery compartment, it will be paid for using the pay item: UNINTERRUPTABLE POWER SUPPLY, SPECIAL.

Depending on surrounding utilities or other conflicts in the field, attaching a new UPS cabinet to an existing traffic signal cabinet may not be feasible. In these cases, the UPS can be installed on a Type A concrete foundation, which is paid for separately. The pay item for the UPS would be: UNINTERRUPTABLE POWER SUPPLY, GROUND MOUNTED.

The UPS shall consist of an even number of batteries that can maintain normal operation of the signalized intersection for a minimum of 6 (six) hours with a minimum 1000-watt output. When the intersection is in battery backup mode, the UPS shall bypass all internal cabinet lights, ventilation fans, cabinet heaters, electric service receptacles, battery heating mats, signal lens heaters, luminaires, illuminated street name signs, and automated enforcement equipment. The UPS shall continue to provide battery back up to ITS equipment such as network switches, cell modems, and PTZ cameras.

Section 3.03 Signal Heads

All traffic signal installations shall utilize Light Emitting Diode (LED) signals. All traffic signal heads used in permanent signal installations shall be mast arm mounted and/or bracket mounted. Intersections being modernized or partially modified will require the signal heads to be uniform in age, quality, type, and color at minimum for each approach. When replacing signals heads on an approach, all signal heads facing that approach must be replaced. It is not acceptable to leave any existing signal heads in place.

Section 3.03(a) Vehicular Signal Heads

All traffic signal sections shall have 12-inch lenses. Intersections with 8-inch lenses must be upgraded to 12-inch lenses even if the intersection is only being partially modified.

All proposed mast arm mounted signal heads shall have louvered backplates that are constructed of formed plastic per the District 1 special provision. Traffic signal backplates shall not be installed on bracket mounted signal heads unless directed to do so by the District. Retroreflective backplates are considered a safety device and should only be installed as directed by the District's Traffic Studies Unit. Retroreflective backplates shall be louvered and shall consist of a 3'' wide retroreflective area on the backplate with a Type ZZ Sheeting.

Intersections shall have a minimum of three vehicular signal heads located on the far side of the intersection, including "T" intersections and interchanges, with a minimum of 2 overhead signal heads. The District requirement for mast arm mounted signal head placements is to align signal heads over the center of the lane. In the event there is only one lane, a minimum of two signal heads shall be provided and aligned with the lane lines. Designers will need to make adjustments for non-standard intersections. There shall be one signal head per lane. For dual left turn lanes, the left most mast arm mounted and far left signal heads meet the head per lane requirements. It is not required to have two left turn signal heads on the mast arm for dual left turn lanes. For dual right turn lanes, the signal head placement will depend on the final geometry of the intersection and may require additional mast arms. All signal heads shall be installed in a vertical position unless obstructions exist such as bridges which limit signal visibility. If signal heads are installed in the horizontal position, installation should follow guidance in the MUTCD and should be shown as such on the cable plan.

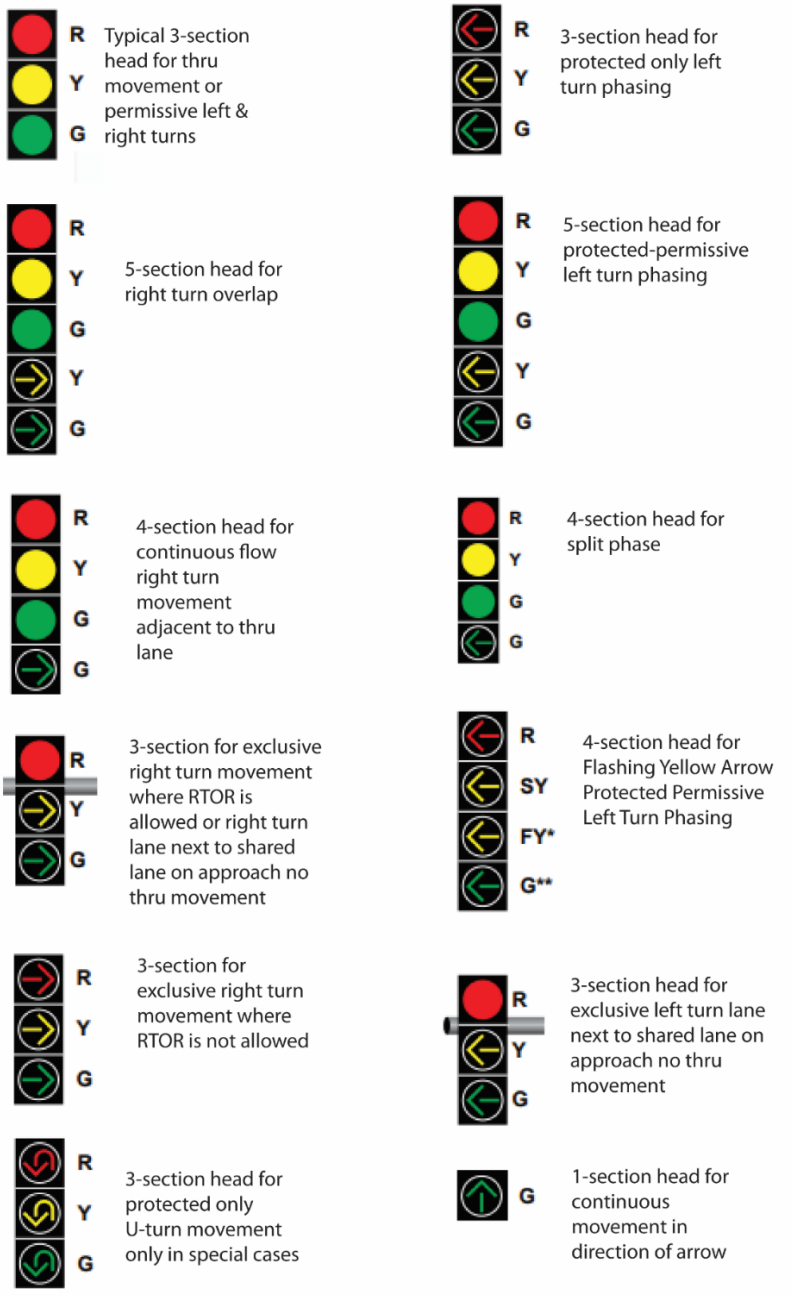
The designer shall ensure there are no obstructions to the visibility of the signal heads present in the final intersection configuration. Examples of obstructions may include traffic signals between bridges, adjacent to bridges, above bridges, behind sign structures, etc.

Appendix A illustrates typical geometric configurations and corresponding signal head placement. The designer shall make any adjustments necessary for intersections to conform to the latest MUTCD requirements. Signal head placement on the mast arms shall be dimensioned in the signal layout plan. Minimum spacing between signal heads is 8 feet per the MUTCD.

The designer should carefully choose the most appropriate signal indications based on the final intersection configuration and operation. Important factors to consider are pedestrian and bicycle facilities, protected turn movements, through indications, prohibited movements, continuous movements, and any other non-standard requirements.

Right arrows and left arrows pertain only to turning movements and do not pertain to through movements. The ultimate stop indication for any approach is a CIRCULAR RED signal indication. Figure 3.1 provides an explanation on when to use each signal indication.

Figure 3.1 Various Signal Indications (Source – MUTCD 11th Edition Chapter 4E & 4F)



All new or modernized traffic signal installations following standard operation shall utilize near right signals. Near right signal heads on a continuous right turn or continuous through movement shall be discussed with the IDOT Traffic Signal Design Engineer. There shall be a minimum of two identical indications of each type per approach so that an outage of one of the indications will not prevent drivers from seeing the appropriate signal indication.

Near right and far left signal heads shall be mounted on a mast arm over the lane when a right-turn lane is present and there are at least three through lanes on that approach to improve visibility. Near right signal heads mounted on a mast arm shall be positioned on the edge of pavement and the far-left signal head shall be positioned 8 feet from the near right signal head. Other circumstances may also warrant the near right and far left signal heads being mounted on a mast arm.

Section 3.03(b) Pedestrian Signal Heads

All pedestrian signal heads shall be countdown LED type signals, including at intersections interconnected with railroad warning devices. Figure 3.2 illustrates a pedestrian signal head with countdown timer.

Figure 3.2 Pedestrian Signal Head With Countdown Timer 16" X 18"

Pedestrian signal heads with countdown timers shall consist of a section displaying two numerals and a section displaying a double overlay message combining symbols of an upraised hand and a walking person.

All pedestrian signals at an intersection must be the same type and have the same display. Newly installed pedestrian signal heads shall not utilize text (Don't Walk/Walk) or outlined hand/walking person symbols. At intersections that are being modified, existing pedestrian signal heads displaying text or outlined hand/walking person symbols must be replaced.

All pedestrian signal heads shall be bracket mounted. It is preferred to install the pedestrian signal head with the corresponding push button on the same post specifically for all new or modernized traffic signal installations. However, it might not be practical to install the pedestrian signal head on the same post as the push button in congested urban environments or with limited ROW at a particular location.

The corresponding pedestrian signal head for a particular pedestrian crossing shall be placed as close to that crossing as practical and shall be aligned for best visibility to the pedestrian.

Section 3.03(c) Bicycle Signal Heads

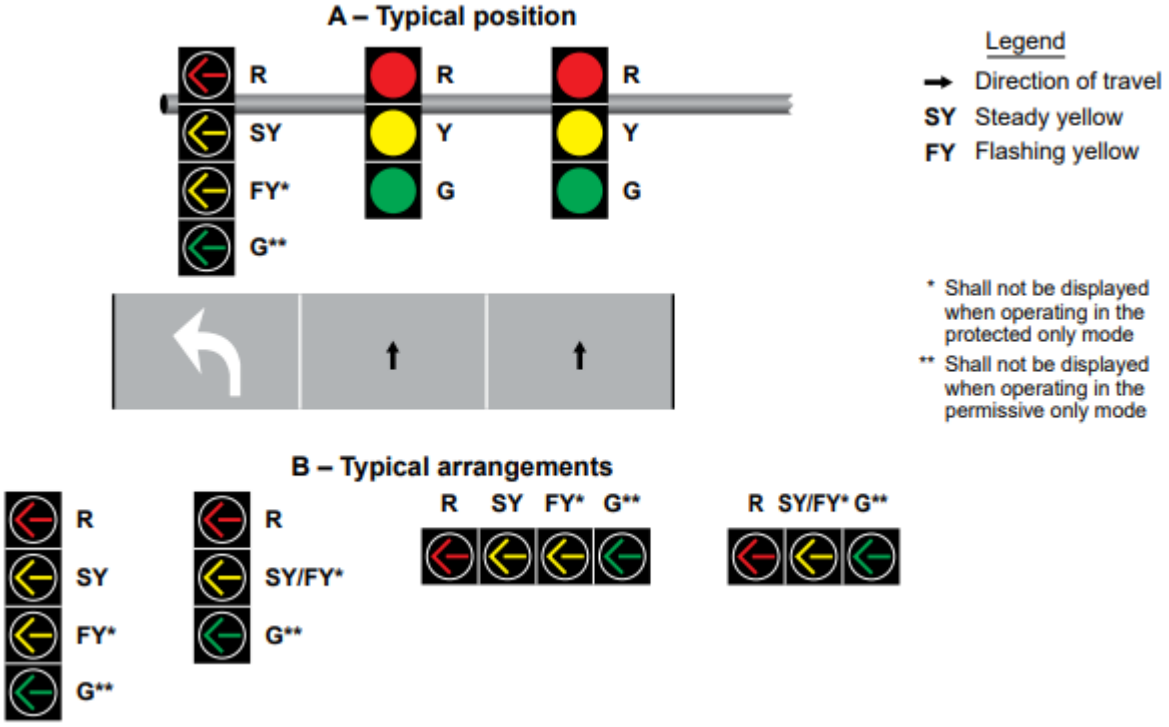
The MUTCD contains guidance on bicycle signal heads and all proposed installations must meet the MUTCD requirements. Local agencies must request and coordinate with the Bureau of Traffic prior to installing bicycle signal heads on State routes to see if the location is eligible. The location must have a high bicycle ADT for the State to consider bicycle signals.

Section 3.03(d) Flashing Yellow Arrow

Flashing Yellow Arrow installations may be allowed when a local agency is implementing a corridor wide flashing yellow arrow implementation that happens to cross a State route. Early coordination is preferred to see if the location is eligible.

In the District 1 geographic footprint, county and local agencies are currently using Flashing Yellow Arrow operations for single channelized left turn lanes, with either permissive or protected-permissive left turn phasing. Figure 3.3 illustrates the typical signal head configuration and position for flashing yellow arrow operation.

Figure 3.3 Typical Signal Head configuration and Position for Flashing Yellow Arrow Operation



Source – MUTCD 11th Edition Figure 4F-7

Section 3.04 Signal Support Structures

Typical support structures for traffic signals include mast arms assemblies and poles (including dual and combination), 5' & 10' pedestrian posts, signal posts ranging from 10' to 18', and span wire installations.

Section 3.04(a) Mast Arm Assembly and Poles

Mast arm assemblies consist of a pole attached to a concrete foundation with a cantilever arm extending in one direction. In the case of a dual mast arm, the cantilever arm extends in 2 directions, most commonly at a 90-degree angle. Combination mast arm refers to a structure with a cantilever arm for signal heads and another cantilever arm higher above for intersection lighting. For details see applicable standards.

Mast arm poles shall be placed at a minimum of 6 feet from the back of the barrier curb to the center of the foundation. If a barrier curb does not exist, mast arm poles shall be placed at a minimum of 10 feet from the edge line of the right-most lane (or mountable curb) or 2 feet behind the edge of the shoulder to the center of the foundation, whichever distance is greater. See District Standard TS-01 for the Traffic Signal Equipment Offset Minimums table.

The designer shall be familiar with the IDOT Highway Standards 877001 and 877002 for Steel Mast Arm Assembly and Pole, IDOT Highway Standards 877006 for Steel Mast Arm Assembly and Pole with Dual Mast Arms, and IDOT Highway Standards 877011 and 877012 for Steel Combination Mast Arm Assembly and Pole. Mast arm lengths shall be in two foot even increments between 16 feet and 74 feet [i.e., 16 ft., 18 ft…72 ft., 74 ft.]. Mast arms are also allowed in 55-foot and 75-foot lengths. Preferred designs will provide mast arms between 16 feet and 55 feet. Mast arms up to 75 feet are allowed but should be avoided if possible. If a mast arm over 75 feet is needed, the designer shall coordinate with the District to develop a solution.

The traffic signal head vertical clearance measured from the highest point of the pavement to the bottom of the traffic signal backplate shall be a minimum of 16 feet and a maximum of 18 feet according to IDOT Highway Standards.

The end of the mast arm shall extend a minimum of 2 feet from the traffic signal head that is furthest out.

Dual mast arm assemblies are not the preferred option for any traffic signal design and should be substituted with an additional mast arm to provide an equivalent design. The District will allow a dual mast arm assembly in special cases such as limited ROW, complicated intersection layout, or other special circumstances.

Combination mast arm assemblies are typically used at intersections with combination lighting which can be part of corridor wide lighting systems. Other reasons for use of a combination mast arm assembly are to install PTZ/CCTV cameras, video detection, or other special equipment requiring a higher installation elevation. Combination mast arm assemblies should be clearly labeled on the plan sheet with the appropriate callout and should specify how many luminaire arms are needed (typically 1 or 2). The layout of the combination arm assemblies shall reflect the lighting plan design.

When possible, narrower but deeper mast arm foundations should be used to minimize the footprint of the foundations when push buttons are proposed to be placed on mast arm poles. More information on mast arm foundations and requirements for soil borings can be found in Section 3.06(d).

Section 3.04(b) Signal Posts

Signal posts shall be galvanized steel or aluminum in composition.

Signal posts shall be placed at a minimum of 4 feet from the back of the barrier curb to the center of the foundation. If a barrier curb does not exist, signal posts shall be placed at a minimum of 10 feet from the edge line of the right-most lane (or mountable curb) or 2 feet behind the edge of the shoulder to the center of the foundation, whichever distance is greater. See District Standard TS-01 for the Traffic Signal Equipment Offset Minimums table.

The vertical clearance measured from the adjacent grade to the bottom of the signal housing shall be a minimum of 10 feet for traffic signal heads and a minimum of 8 feet for pedestrian signal heads.

The table in Figure 3.4 shows the required signal post heights to be used with bracket mounted traffic signal heads and other post mounted equipment. Height is considered from the top of the concrete foundation to the top of the signal post.

Figure 3.4 Required Signal Post Heights

Signal Equipment	Post Height
3,4, and 5-section signal heads	16’
Internally illuminated sign (fiber-optic, LED, or other)	18’
Emergency vehicle preemption light detectors	18’
Optically programmed signal heads	18’
Pedestrian signal head	10’ pedestrian post
Pedestrian push button	5’ pedestrian post

Section 3.04(c) Span Wire Installation

Permanent span wire installations are highly discouraged and should be avoided. The District will have to approve a permanent span wire installation. Early coordination is required to ensure the location is eligible for a permanent span wire installation in lieu of a traditional mast arm design. Minimum offsets for wood poles must be met, just as for mast arms.

Signal head placement on span wire installations is similar to permanent signal installations including near right signal heads for each approach. Far side signal heads shall be positioned to align over the center of the lane.

Detector loops shall be incorporated in the design with uptight detection on the minor route and far back detection on the major route at 250 feet from the stop bars. Left turn lanes shall also be actuated with a typical left turn lane detector loop layout. All detector loops should be saw cut to the closest edge of pavement with coilable nonmetallic conduit running between this point and 10 feet up the closest wood pole with the splices made on the wood pole. Handholes are typically not included for permanent span wire installations. The designer shall use appropriate notes on the plans to specify the above requirements.

Section 3.05 Detection

Vehicle, Pedestrian and Bicycle (if approved by the Bureau of Traffic) Detection should be provided for each individual phase at a traffic signal in both temporary and permanent installations to allow for fully actuated traffic signal operation. The type of detection allowed varies as outlined in the following sections.

Section 3.05(a) Pedestrian Detection – Push Button

All new traffic signal installations with pedestrian accommodations shall utilize Accessible Pedestrian Signals for each pedestrian phase to meet the Statewide OPS-T-13 Policy. Any traffic signal modification, reconstruction, or installation will require that all existing push buttons be upgraded to APS push buttons. If one push button is being upgraded to APS, then all push buttons must be upgraded at that intersection.

APS push buttons shall be placed to meet the following criteria:

- With the face of the push button directly adjacent to the pedestrian access route but no further than 10 inches.
    - If the push button is being installed on a mast arm pole or a signal post adjacent to the pedestrian access route with a side curb, the foundation shall be installed within the side curb to meet the reach requirement. A pedestrian post can be installed ***immediately*** behind the side curb and still meet the reach requirement, but it is preferred to also design this post to be installed within the side curb.
    - Push buttons should not be installed on mast arm assemblies with a 42-inch diameter foundation.
- With the face of the push button parallel to the crosswalk that it controls.
- Within 5 feet of the crosswalk limit that is furthest from the intersection for the crosswalk that the APS push button controls.
- Between 1.5 feet and 6 feet from the edge of curb, shoulder, or pavement, but no further than 10 feet.
- Push buttons in the same corner should be at least 10 feet apart.
    - If 10 feet is not feasible, maintain separation down to a minimum of 7 feet.
    - If separation must be less than 7 feet, the push buttons should be installed on one post.
    - If separation is less than 10 feet, the audible “Walk” message must be replaced with a speech message identifying the street to be crossed. Custom walk messages must be coordinated with the Bureau of Traffic during the catalog cut submittal.
    - There may be special circumstances where existing posts can be used for the APS push buttons without the 10-foot separation if these are ideally positioned relative to the sidewalk and crosswalk.
- Adjacent to a firm, stable, and slip resistance surface, with a clear space measuring a minimum 2.5 feet x 4 feet, with a slope of less than 5% and a cross slope of less than 2%.
- Connected to an accessible pathway

- Behind the detectable warning.
- Mounted at a height of 36 inches above the sidewalk. With special approval, the push button may be installed at a height between 30 inches and 42 inches above the sidewalk.

Other considerations include the following:

- Push button extensions shall not be included in the traffic signal design. Push button extensions shall only be considered due to constructability issues in the field.
- The push button and corresponding pedestrian signal head should be installed on the same post on new or fully modernized traffic signal installations.
- Raised corner islands will require one APS push button per crossing and each push button will require a unique message.
- Video or radar detection for pedestrian detection is not approved and shall not be proposed on projects.
- Dual call push buttons are not permitted.
- Pedestrian crossings shall not be placed on the railroad leg of an intersection to avoid conflicts with pedestrians and vehicles during railroad preemptions.
- Equestrian push buttons shall also be APS and be mounted at a height of 6 feet above the sidewalk.

When reconstructing ADA ramps at an existing signalized intersection, care should be taken to avoid lowering the adjacent sidewalk surrounding a traffic signal post. The designer should analyze the ADA ramp design for significant elevation changes that may leave existing post foundations significantly exposed. If side curbs are used to avoid exposing the existing concrete foundation, care should be taken to verify that the 10-inch reach requirement is met.

To qualify as a pedestrian refuge, a median must be wide enough to meet PROWAG requirements for detectable warnings and clear space to warrant having a push button. This requires a median at least 6 feet wide. If the median is 20 feet wide or less, one push button can be used for both directions if it is within 10 feet from the face of both curbs. Under most circumstances, the pedestrian clearance interval will be sufficient to cross the entire section, not just to or from the median and therefore no pedestrian signal heads are required. If the median is wider than 20 feet, 2 push buttons and 2 pedestrian signal heads are required.

APS push buttons shall be indicated on the traffic signal plan sheet as well as the cable plan. Special details or close up views of ADA ramp design may be required for intersections being upgraded to APS. See Appendix for examples (to be added a later date).

The information in this section follows the guidelines of the MUTCD and PROWAG with additional District 1 requirements. See District Standard TS-01 for more information and details regarding push button design and installation.

Section 3.05(b) Bicycle Detection

Bicycle detection requires coordination with the Bureau of Traffic for intersections with State routes. If a route has a high bicycle ADT, or if there is other justification for providing separate detection for bicyclists, then acceptable detection methods would be roadside push buttons, detector loops, or video detection. Bicycle detection should be shown as a dedicated push button, detector loop, or video detection on a cable plan.

If preferred by the local agency, roadside push buttons designed to be used by bicyclists may be added to the signal design on State routes. NACTO (National Association of City Transportation Officials) recommends that bicycle push buttons be installed at the stop bar curbside facing the travelled way of the bicycle at a height and setback such that cyclists do not have to dismount the bicycle to activate. Providing this button will increase efficiency of bicycle travel and discourage red light running by bicyclists. All bicycle push button locations and design features should be coordinated with the Bureau of Traffic.

Section 3.05(c) Vehicle Detection and Detector Loop Replacement

Vehicle detection on State routes is comprised mainly of three methods: detector loops, radar detection, and video detection. The District has discontinued the use of radar detection.

i) Detector Loops

The District's preference for State route approaches of an intersection is to use detector loops for left turn, uptight (for the minor State route if the intersection includes two State routes), and far back detection. Interchange ramps should have queue detectors 250' and 500' from the stop bar.

Each detector loop shall have its own saw cut (homerun for preformed detector loops) from the loop to the edge of pavement or to a handhole in the pavement. Each detector loop shall have its own 1-inch coilable nonmetallic conduit (CNC) between the edge of pavement and the adjacent handhole. Each CNC run shall be shown on the plans by the designer with the standard CNC note but shall not be paid for separately; this is included in the pay item for the detector loops. The detector loop pay items are described below:

DETECTOR LOOP TYPE I - shall be used when the detector loop is to be placed (saw cut) in an existing pavement or new bituminous binder course. This pay item shall be used when the contractor is taking maintenance of the traffic signal.

DETECTOR LOOP REPLACEMENT - shall be used when the contractor will not take maintenance of the traffic signal. This pay item is otherwise the same as Detector Loop Type I.

PREFORMED DETECTOR LOOP - shall be used when new Portland Cement Concrete (PCC) pavement is being constructed. The detector loops are to be placed in the substrate. Maintenance of the traffic signal is required for installation of preformed detector loops

The width of all detector loops must be 6 feet minimum. The width of an individual detector loop shall not exceed 25 feet. Intersections with wide corner radii may necessitate adding a second smaller detector loop to provide full coverage for the turning lane. Detector loop quantities are not measured based on the actual length of the wire. Instead, Type I detector loop quantities are measured along the sawed slot in the pavement containing the loop and lead. Preformed detector loops are measured along the detector loop and lead embedded in the pavement. Multiple detector loops on the same lead-in cable shall be similar in size.

See Appendix B for typical detector loop layouts for far back detection, uptight detection, protected left turn detection, and protected-permissive left turn detection. For new designs or traffic signal modifications, detector loops should be avoided on private driveways or commercial entrances with video detection being used instead. In addition, all preformed detector loops shall be labeled with a “P” on the signal layout and cable plan to distinguish them from Type I detector loops. The District also allows the use of circular cut detector loops versus the standard square detector loops.

The pay item for lead-in cable shall be “ELECTRIC CABLE IN CONDUIT, LEAD-IN, NO. 14 1 PAIR”. This cable provides connection between the handhole adjacent to the detector loop and the traffic signal cabinet.

ii) Video Detection

Video detection is the preferred detection method for private driveways, commercial entrances, and other similar entities or in cases where lack of ROW does not allow for detector loop installation. Video detection is not currently used as the main State route detection or as far back detection, except in situations where detector loops are not feasible such as on bridge structures.

iii) Radar Detection

Radar detection is no longer allowed on any new traffic signal installations or modernizations. Radar detection has been used for some time and is still in use on various traffic signals. Designers encountering existing radar detection should replace it with video detection or contact the IDOT Traffic Signal Design Engineer for guidance on a case-by-case basis. Removed radar detectors shall be disposed or delivered to STATE spare parts.

iv) System Detectors

System Detectors are used to collect traffic volume and density data on State routes. When system detectors are required for an approach of an intersection, the detection method used for intersection actuation can also be used as system detectors. If the detection method is a detector loop, then each loop requires a separate lead-in cable and a separate inductive loop detector in the traffic signal cabinet. Each far back detector loop with a separate lead-in cable can be assigned as a system detector by a signal timing consultant. The signal timing consultant will select and number the detector loops used as system detectors staying within the capacity of each manufacturer’s master controllers where they are still in use. The system detector assignments should provide adequate coverage to allow for effective traffic responsive signal system operation. With all agencies moving towards ATMS, limits for the number of system detectors on a particular arterial will no longer be applicable.

Section 3.06 Underground Facilities

Section 3.06(a) Handholes

Traffic signal handholes may be cast in place, pre-cast, or composite per IDOT Highway Standards 814001 and 814006. The preferred handhole placement is outside of the sidewalk to meet ADA surface requirements. Proposed handholes are not allowed within the ADA ramps. Per the IDOT D1 special provision, the identification lettering on the lids shall match their use such as traffic signals, lighting, or RLR (red light running). Handholes should be designed close to traffic signal equipment but should be placed away from the curb or crowded areas with posts and utilities. These can be placed further away if ROW is available so that in the future the handholes are easy to drill into or access. Designers should consider future access and maintenance in exercising their best judgement to determine handhole placement.

A handhole is required when there is a change in direction of any conduit run that is 90 degrees or less. Conduit runs with a change in direction of 90 degrees or less, but that occur over a long distance (i.e., large radii) may not require a handhole. Typical traffic signal intersection designs will consist of 1 handhole at each corner. Up to three lanes of detection can be serviced from a handhole outside the pavement area.

Handholes that have sunk or protrude from the surrounding ground should be rebuilt to the grade of the surrounding ground (i.e., dirt, grass, concrete, etc.).

A double handhole shall be specified when eighteen or more cables enter a handhole or when next to the traffic signal cabinet.

Heavy-duty handholes shall be specified at all locations where vehicles could drive over them, such as within the pavement, within shoulders, or behind shoulders. If heavy equipment can drive over a location (i.e., tractors mowing ditches) then a heavy duty handhole should be installed.

Heavy-duty handholes shall be specified in the pavement only where left turn lane detector loops are being installed. The heavy duty handhole should be centered on the left turn lane and should be behind the stop bar.

Heavy-duty double handholes are not allowed. It is important to place double handholes away from areas where vehicles can drive over them.

Interconnect handholes should be placed as close to the right-of-way line as possible. Cross sections must be analyzed to ensure proper placement of interconnect handholes (i.e., outside drainage ditches and where a Contractor can build handholes). Interconnect handhole placement at or near the right-of-way line is extremely important when designing signal systems located on S.R.A. routes.

The maximum spacing for interconnect handholes is 300 feet for electric cable and 600 feet for fiber optic cable.

Composite handholes will be designated by the pay item COMMUNICATION VAULT and would only be used for fiber optic and interconnect installation, not traffic signal cable equipment.

Section 3.06(b) Conduit

Conduit shall be rigid galvanized steel with a few exceptions. One exception is for the conduit that carries the detector loop cable, which is low voltage, between the edge of pavement and the adjacent handhole. This type of conduit is coilable nonmetallic conduit (CNC). Another exception is for interconnect conduit which can be galvanized steel or HDPE micro duct if outside the traffic signal installation conduit system.

Conduit must be placed a minimum of 30 inches below the finished grade per the IDOT D1 special provision.

All main conduit runs and road crossings shall be 4-inch conduit. If eighteen or more cables need to cross a leg of an intersection, two separate runs of 4-inch conduit will be required with a double handhole at each end.

Four runs of 4-inch conduit shall be installed between the traffic signal cabinet and the adjacent double handhole. A spare 4-inch conduit with a threaded cap will be installed coming out of the cabinet.

The conduit coming from the electric service shall enter directly through the traffic signal cabinet foundation for all permanent traffic signal installations.

Conduit crossing railroad tracks shall be 5-inch conduit in an 8-inch galvanized steel casing. For more information refer to the Railroad Traffic Signal Design Guidelines.

CONDUIT FILL CALCULATION PROCEDURE

1. Using the table in Figure 3.5, identify and add cross sectional areas of all cables in the conduit for which size is to be determined.

Figure 3.5 Conduit Fill Calculation Table

Cable Type	CS Area (SQ IN)	No. of cables (EACH)	Total (SQ IN)
Tracer, No. 14 1C	**0.021**		
Signal No. 14 2C	**0.084**		
Signal No. 14 3C	**0.093**		
Signal No. 14 5C	**0.133**		
Signal No. 14 7C	**0.156**		
Lead-In, No. 14 1 Pair	**0.103**		
Railroad, No. 14 3C	**0.126**		
Electric Service, No. 6 2 C	**0.146**		
Equipment Grounding Conductor, No. 6 1C	**0.073**		
EVP System Line Sensor Cable, No. 20 3/C	**0.071**		
Fiber Optic, No. 62.5/125, MM12F SM24F	**0.176**		
Street Name Sign, No. 14 3C, Type SOOW	**0.225**		
Coaxial Cable (RG-59/U)	**0.073**		
Network Cable (CAT5E)	**0.053**		
Video Detection (vendor specified)	**0.097**		
Radar Detection (vendor specified)	**0.120**		
Combination Lighting, 600V XLP 2/C No. 10*	**0.156**		
* Combination lighting cable is spliced at the pole base therefore two cables are located inside the conduit between the combination mast arm and the first handhole.		**Total Conduit Fill (SQ IN)**	

2. Using the total conduit fill found in Step 1, find the conduit size using 40% conduit fill according to Figure 3.6.

Figure 3.6 Conduit Size Based on Fill Table

Conduit Size (IN)	40% Fill (SQ IN)	100% Fill (SQ IN)
2	**1.363**	3.408
3	**3.000**	7.499
4	**5.153**	12.882
5	**8.085**	20.212

3. Compare the conduit size found in Step 2 with the minimum conduit size required per Figure 3.7 and use whichever is greater.

Figure 3.7 Minimum Conduit Size Table

Conduit Segment	Minimum Conduit Size
Pedestrian Signal Post (Type A – 12 Inch Fdn.)	2”
Signal Post (Type A – 24 Inch Fdn.)	3”
Mast Arm	3”
Combination Mast Arm	4”
Detector Loop HH	2”
Double HH to Traffic Signal Cabinet	4 @ 4”
Roadway Crossing*	4”
Interconnect System	2”
Traffic Signal Cabinet to Railroad	2”
Service Conduit	2”
Telephone Service	2”
Conduit Stub Out at Traffic Signal Cabinet	4”
Conduit Stub Out at Ground Mounted Service Cabinet	2”
Detector Loop CNC Raceway**	1”
Conduit Crossing Railroad Tracks	5”
Casing Under Railroad Tracks***	8”

*2 @ 4” if number of cables is more than 18

**Included in the price of detector loop

***Refer to IDOT District 1 – Railroad Traffic Signal Design Guidelines

Section 3.06(c) Electric Cable

IDOT D1 requires continuous electric cable from the traffic signal cabinet to each traffic signal component and does not allow cable splicing for permanent installations.

i) Grounding of Traffic Signal Equipment

All traffic signal systems shall be grounded. A continuous equipment grounding network shall be included in all new or modernized traffic signal installations. Grounding conductor shall be installed in all metallic or non-metallic conduits, including empty or spare conduit, that contain traffic signal circuit runs. Grounding conductor is not required in conduit that contains only detector loop lead-in cable, circuits under 50 volts, and/or fiber optic cable.

The equipment grounding conductor and associated ground rods shall be illustrated in the cable plan. See Example Traffic Signal Plans for examples of cable plans. Ground rods are required for all signal post and service cabinet (Concrete Foundation Type A), traffic signal cabinet (Concrete Foundation Type C or D) and mast arm (Concrete Foundation Type E) foundations. The ground rods are included with the concrete foundation pay items. The equipment grounding conductor is paid for separately as ELECTRIC CABLE IN CONDUIT, EQUIPMENT GROUNDING CONDUCTOR, NO. 6 1C. Handholes shall be grounded if there is any AC power running through the handhole.

ii) Electric Cable Length

The vertical cable length (See Figure 3.8) and cable slack length (See Figure 3.9) requirements are to be used in calculating cable length quantities.

Figure 3.8 Required Vertical Cable Length

Vertical Cable	Length
Mast Arm Mounted Signal Head (L = mast arm length - distance to signal head from end of arm)	20'+L
Bracket Mounted Signal Head (mast arm pole or signal pole)	13'
Pedestrian Signal Head	10'
Pedestrian Push Button	6'
Service Installation Pole Mount to Service Drop	13.5'
Service Installation Pole Mount to Ground	13.5'
Service Installation Ground Mount	6'
Foundation (signal post, mast arm, traffic signal cabinet, service cabinet)	3'

Figure 3.9 Required Cable Slack Length

Cable Slack	Length
Handhole	6.5’
Double Handhole	13’
Signal Post	2’
Mast Arm	2’
Traffic Signal Cabinet or Service Cabinet	1.5’
Fiber Optic Cable at Traffic Signal Cabinet	13’
Ground Cable at Signal Post, Mast Arm, or Cabinet	1.5’
Ground Cable between Handhole Frame and Cover	5’
Ground Cable at Handhole and Double Handhole	6.5’

Cable lengths with slack and vertical lengths included should be shown on the cable plan at the end of the cable (for example next to signal head).

iii) Electric Service Cable – Voltage Drop Calculations

The designer must follow the procedure outlined below to calculate the size of the electric service cable required for each intersection. Commonwealth Edison (ComEd) typically supplies 120 volts but is allowed to drop voltage to no more than 10% which results in minimum voltage of 108V. NEC 210-19 outlines that voltage drop should not exceed 5% at the furthest outlet in a circuit in order to provide reasonable efficiency of operation. Therefore, the designer must verify that the voltage drop across the traffic signal circuit does not exceed 5% so that the minimum final voltage is not less than 102.6V. NEMA controller can operate at the lowest voltage of 95V

1. Determine the total wattage needed for the entire intersection based on the equipment present using the table in Figure 3.10.

Figure 3.10 Traffic Signal Electric Service Requirements

Traffic Signal Electric Service Requirements				
Type		**Quantity**	**Unit Wattage**	**Total Wattage**
Signal Head	3 - Section		11	
	4 - Section		14	
	5 - Section		13	
Programmable	3 - Section		22	
	4 - Section		32	
	5 - Section		28	
Pedestrian Signal Head			15	
Controller			150	
Master Controller			100	
UPS			25	
Detection	Radar or Video		20	
Blank-Out Sign			25	
Network Switch	II or III		35	
Cellular Modem			15	
PTZ Camera			75	
TOTAL UPS SIZING				
UPS Charging			225	
Battery Heater Mat			180	
Cabinet Heater			200	
Flasher			15	
LED Street Name Sign			120	
Luminaire			240	
TOTAL ELECTRIC SERVICE WIRE SIZING				

2. The table in Figure 3.11 contains the size of the service cable required for each condition to meet the maximum voltage drop of 5%.

Figure 3.11 Electric Service Cable Size

Electric Service Cable Size										
Total Wattage	Distance (ft)									
	100	200	300	400	500	600	700	800	900	1000
250	No 6	No 6	No 6	No 6	No 6	No 6	No 6	No 6	No 6	No 6
500	No 6	No 6	No 6	No 6	No 6	No 6	No 6	No 6	No 6	No 6
750	No 6	No 6	No 6	No 6	No 6	No 6	No 6	No 4	No 4	No 4
1000	No 6	No 6	No 6	No 6	No 6	No 4	No 4	No 4	No 2	No 2
1250	No 6	No 6	No 6	No 6	No 4	No 4	No 4	No 2	No 2	***
1500	No 6	No 6	No 6	No 4	No 4	No 2	No 2	No 2	***	
1750	No 6	No 6	No 6	No 4	No 4	No 2	No 2	***		
2000	No 6	No 6	No 4	No 4	No 2	No 2	***			
2250	No 6	No 6	No 4	No 2	No 2	***				
2500	No 6	No 6	No 4	No 2	No 2	***				

***Coordinate with ComEd to bring the electric service closer to the intersection.

Section 3.06(d) Foundations

All Type A concrete foundations (signal post, pedestrian signal post, and ground mounted service cabinet), Type C concrete foundations (Super P and Super R cabinets), and Type D concrete foundations (Type IV and Type V cabinets) shall have a 4 ft minimum depth.

Type E concrete foundations used for mast arm assemblies shall have depths per the table in Figure 3.12. These foundations depths are based on sites which have cohesive soils along the length of the shaft with an average unconfined strength greater than 1 tsf (100 kpa).

Figure 3.12 Mast Arm Assembly Foundation Depths

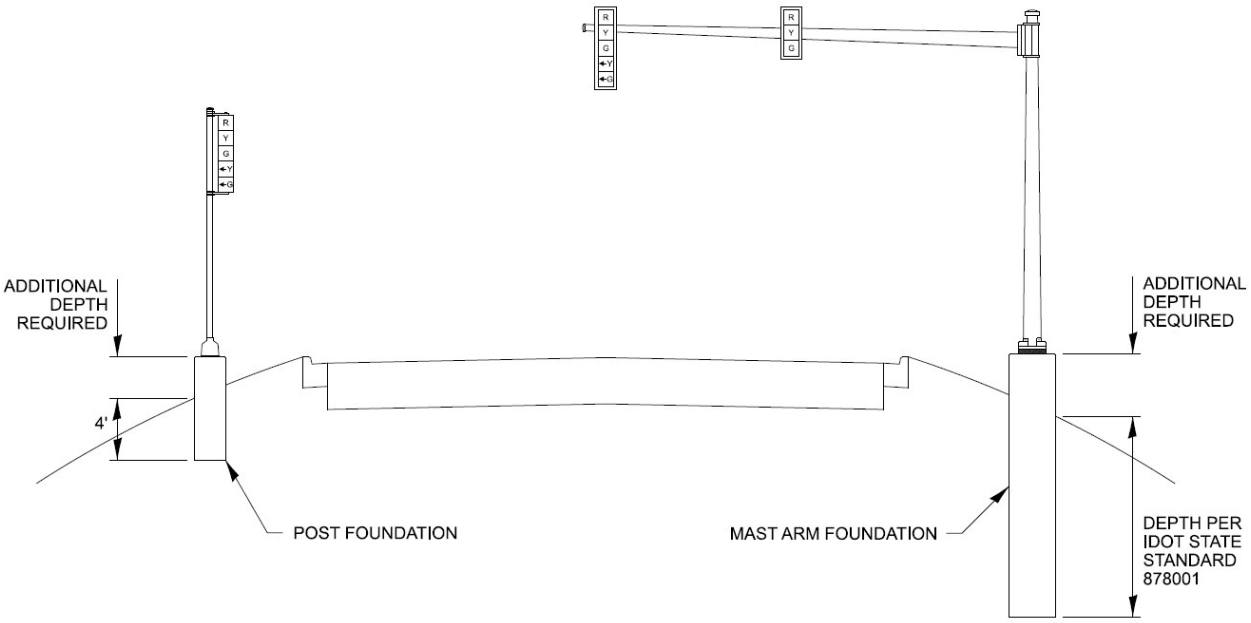
Mast arm length	Foundation depth	Foundation Diameter	Spiral Diameter	Quantity of rebars	Size of rebars
Less than 30’	10’	30”	24”	8	#6
Greater than or equal to 30’ and less than 40’	13.5’	30”	24”	8	#6
	11’	36”	30”	12	#7
Greater than or equal to 40’ and less than 50’	13’	36”	30”	12	#7
Greater than or equal to 50’ and up to 55’	15’	36”	30”	12	#7
Greater than or equal to 56’ and less than 65’	21’	42”	36”	16	#8
Greater than or equal to 65’ and up to 75’	25’	42”	36”	16	#8

Notes:

1. The table is for standard and combination mast arm assemblies. Foundation depths for standard dual mast arms with the longest arm length up to 55’ shall increase 1’ of that shown in the table, based on the longer of the two arms.
2. See State Highway Standard 878001 Concrete Foundation Details for more information.

Depending on roadside geometry and soil conditions, mast arm assemblies may require deeper foundations than those specified in the table. One example is when a foundation is to be installed on a backslope. This will require additional foundation depth to ensure the standard foundation depth is in the ground and not exposed. The top of the foundation should be aligned with the crown of the roadway. See Figure 3.13 for detail on mast arm foundations being installed on sloped surfaces.

Figure 3.13 Foundations on Sloped Surfaces



Where the soil compressive strength is less than 1.0 tsf, the Bureau of Bridges and Structures shall be contacted for a revised design. In these cases, soil borings should be extended to 25 ft at each corner of intersection to determine the foundation design.

Smaller but deeper mast arm foundations should be used when possible to minimize the footprint of the foundations when push buttons are proposed to be installed on mast arm poles or when space is critical (i.e., lack of ROW, ADA sidewalk clearance).

Helix foundations shall not be used.

Section 3.07 Electric Service

A ground mounted, metered service installation shall be installed at all new traffic signal installations and reconstructions, as well as modernization projects when possible. The electric service shall be brought directly into the service cabinet foundation using a 2-inch conduit from a location that has public access. The service installation should be installed at least 25 to 50 feet away from the traffic signal cabinet when space allows. Otherwise, it should be placed far enough to not obstruct pedestrians near a crossing or interfere with maintenance of the traffic signal cabinet. The meter will be supplied by the utility company.

For new traffic signal installations, the designer must contact the electric utility or municipal controlled power source to determine the location of the electric service and initiate billing if required. The designer shall contact the local agency or the Bureau of Traffic for the account number and billing information based on the intergovernmental agreements. Neither ComEd nor the designer will decide who will be billed for the energy costs. If ComEd is providing the electric service, an account number must be provided for ComEd to assign a New Business Representative to the project. If the electric service provider is a company other than ComEd, the designer is responsible for contacting the local power service company and determining the requirements including the process for obtaining service. The designer will be responsible for determining if any permits are required and if any special provisions are needed. Typically, the local agency will have a “tower account” including all traffic signals within a municipality. If the electric service is currently unmetered, and the new service will be metered, a new tower account number will be required for the metered service. Unmetered and metered traffic signal electric services cannot be included under the same tower account.

Generally, the energy charges are billed to the local agency if one or more approaches to the signalized intersection are under the local agency’s jurisdiction. If all approaches to the intersection are under the State’s jurisdiction, IDOT typically pays the energy charges. The designer should always verify the billing at each location.

Section 3.08 Emergency Vehicle Preemption

The District allows Emergency Vehicle Preemption (EVP) to be used when requested by the local agency. However, the District will not participate in the cost of the EVP equipment or its installation or relocation. EVP equipment will not be maintained by IDOT. An agreement with the local agency will be required in which it states that the local agency will pay for the EVP installation and any future maintenance.

For locations where a new traffic signal is proposed, the designer shall reach out to the local agency to determine if they want EVP installed. If EVP equipment exists at a signalized intersection to be modernized, the designer shall reach out to the local agency to determine if they prefer to relocate the existing EVP to the proposed traffic signal or to have the EVP equipment upgraded. If the existing EVP is being replaced, the designer shall provide the contact information and address where the equipment is to be returned. In either case, the designer shall provide documentation that includes concurrence from the local agency that they are responsible for all costs associated with the EVP equipment. The appropriate removal or relocation note shall be included in the traffic signal plans.

The following note is required when EVP equipment is going to be replaced or removed entirely:

THE FOLLOWING ITEMS SHALL BE REMOVED BY THE CONTRACTOR AND SHALL REMAIN THE PROPERTY OF THE AGENCY LISTED BELOW. THE CONTRACTOR SHALL SAFELY STORE AND ARRANGE FOR THE PICKUP OF THE EQUIPMENT TO BE RETURNED TO THE LISTED AGENCY.

NAME OF AGENCY
CONTACT PERSON
PHONE NUMBER

__ EACH CONFIRMATION BEACON
__ EACH LIGHT DETECTOR
__ EACH LIGHT DETECTOR AMPLIFIER

The following note is required when EVP equipment is being relocated to a modernized traffic signal and a temporary traffic signal is utilized during construction:

THE FOLLOWING ITEMS SHALL BE REMOVED BY THE CONTRACTOR, SAFELY STORED, AND RELOCATED TO THE PROPOSED MAST ARMS AND TRAFFIC SIGNAL CABINET:

__ EACH CONFIRMATION BEACON
__ EACH LIGHT DETECTOR
__ EACH LIGHT DETECTOR AMPLIFIER

The following note is required when EVP equipment is being relocated to a modernized traffic signal with no temporary traffic signal installed.

THE FOLLOWING ITEMS SHALL BE REMOVED BY THE CONTRACTOR AND RELOCATED TO THE PROPOSED MAST ARMS AND TRAFFIC SIGNAL CABINET:

__ EACH CONFIRMATION BEACON
__ EACH LIGHT DETECTOR
__ EACH LIGHT DETECTOR AMPLIFIER

Section 3.09 Traffic Signal Priority

Traffic Signal Priority (TSP) equipment is present at some IDOT signals. This equipment is owned by the transit agency, such as Pace or the Chicago Transit Authority (CTA) and can consist of additional hardware in the traffic signal cabinet and/or additional detector loops. If the TSP equipment has to be relocated to a new traffic signal cabinet, or upgraded to new equipment, the transit agency is responsible for 100% of the cost. The designer shall inform the transit agency of project impacts to the TSP equipment. The following note shall be included in the removal notes section of the traffic signal plans indicating the presence of TSP equipment:

THE FOLLOWING ITEMS INSIDE THE TRAFFIC SIGNAL CABINET ARE PACE PROPERTY. THE CONTRACTOR SHALL CONTACT PACE AT 847-228-4287 OR 847-613-5889 FOR REMOVAL AND RELOCATION PRIOR TO ANY TRAFFIC SIGNAL CABINET WORK. REFER TO THE SPECIAL PROVISION FOR PACE EQUIPMENT HANDLING.

Section 3.10 Traffic Signal System Interconnect

Section 3.10(a) Telephone Service

Telephone service is being eliminated and replaced with cellular modems, routers, and switches. These items will be paid for with separate pay items as described in the special provisions.

If telephone service needs to be maintained in unusual cases, the conduit coming from the service feed shall enter the traffic signal cabinet foundation directly for new foundations. The telephone service conduit may enter the double handhole adjacent to the traffic signal cabinet only if the existing foundation is being re-used. If the telephone service is routed through the double handhole, it shall be installed in a 1-inch unit duct through the double handhole and into the traffic signal cabinet to reduce electrical interference from the electric cables in the handhole. This work is part of the MASTER CONTROLLER pay item.

Section 3.10(b) Local System Communication Requirements

When a traffic signal is, or will be, connected to a county or municipal area-wide signal system, the designer is responsible for making initial contact and coordinating the design and cost participation with the responsible agency. Plan submittals will need to be made to both IDOT and the agency. The designer shall coordinate design and equipment requirements, as well as operational needs for the communication system. It may also be necessary to incorporate specific design considerations to maintain system operations during construction. Contact information for agencies with area-wide signal systems can be obtained from the IDOT Traffic Signal Design Engineer.

As IDOT moves forward with developing its own centralized system, coordination and intergovernmental agreements between agencies will be required to address how connections will be made, what rights and controls will be granted to agencies, etc.

Section 3.10(c) Centralized Systems

Information on centralized systems to be added at a later date,

Section 3.11 Railroad Interconnect

The designer should refer to the Railroad Traffic Signal Design Guidelines when a traffic signal is within 1000 feet of a railroad crossing. The guidelines specify requirements and coordination for Phase I and Phase II engineering when developing plans for railroad interconnected traffic signal installations.

The designer shall contact the IDOT District 1 Railroad Crossing Coordinator prior to beginning a design involving a railroad crossing within 200 feet of a traffic signal and/or when the existing or projected vehicular queue will extend beyond the crossing. Determination on whether railroad preemption is required will be based on the railroad signal report.

The ICC must review and approve all traffic signal plans that include railroad preemption. At the beginning of the design process, the designer and/or the District shall contact the ICC to inform them of the project and request a copy of the most recent railroad signal report. The railroad signal report details essential information regarding the operation of the two systems. It includes the traffic signal preemption worksheet, the geometric parameters including clear storage and clearance distances, and any other traffic signal requirements. If a recent railroad signal report is not available, the ICC may require a new report to be prepared. The railroad signal report must be completed and approved by the District and the ICC prior to beginning traffic signal design work.

Section 3.12 Temporary Traffic Signal Installation

The installation of temporary traffic signals at locations with existing traffic signals is required when the existing signal equipment is being disrupted by construction or when staging of traffic reduces the visibility of the existing signals. While these are the two most common cases, there are other situations that will require the use of temporary traffic signals. In special cases where temporary traffic signals are not practical, the designer may obtain approval from the IDOT Traffic Signal Design Engineer to avoid the use of temporary traffic signals. Temporary traffic signals are not allowed at newly signalized intersections prior to the installation of the permanent traffic signal.

When temporary traffic signals are specified for a project, the designer should also include the pay item “TEMPORARY TRAFFIC SIGNAL TIMING” for each intersection to provide for modified signal timings during construction. The item is paid for on a per intersection basis, regardless of the number of construction stages, therefore every intersection with a temporary traffic signal installation should include a quantity of 1 EACH.

Section 3.12(a) Temporary Pole and Signal Head Placement

The placement of temporary poles shall take into consideration existing and proposed geometrics, R.O.W. limits, construction staging, ground contours, drainage, etc. A minimum of three LED signal heads with 12-inch lenses shall face traffic on each approach. One of these heads shall be a near right signal head. For particularly large intersections, where additional signal heads may be needed, the designer should contact the IDOT Traffic Signal Design Engineer early in the design process to coordinate the signal head placement. When protected only left turn phasing is required, a minimum of five signal heads with 12-inch lenses is required for that approach. This will include two signal heads for the left turn movement displaying red, yellow, and green left turn arrows and an R10-5 “LEFT ON GREEN ARROW ONLY” sign. Temporary traffic signal heads should be aligned on the lane line.

See Example Traffic Signal Plans for an example of a temporary traffic signal installation.

Section 3.12(b) Temporary Interconnect

Where there is an existing signal system (closed loop, centralized system, yellow offset, etc.), the designer shall ensure that this system is maintained throughout construction.

Closed loop and centralized systems require that the temporary controller match the manufacturer, model number, and software revision of the existing controller. A transceiver is required on closed loop systems and a network switch is required on centralized systems. If the master controller is located at an impacted intersection, a temporary master controller and communication service for the master shall be provided.

The designer should use the existing fiber interconnect cable, when possible, to maintain the integrity of the closed loop system. If the existing fiber cannot be maintained, the designer shall provide temporary interconnect. Wireless interconnect is the typical temporary interconnect method that should be used for closed loop systems. The designer must account for roadway curvature, obstructions, topography to determine if signal repeaters are necessary in their design. If wireless interconnect is not feasible, temporary fiber interconnect is required. Additional wood poles may be required to run the temporary fiber aerially. Wood poles can be placed at a maximum of 200 feet apart or at a spacing where the proposed cable has a sag of 1% or less, whichever spacing is shorter.

Temporary fiber interconnect and/or a temporary cellular modem may be required for an intersection connected to the District’s centralized system (Centracs, Tactics). Site specific designs may be required.

Yellow offset systems require that the existing interconnect cable and coordinating unit be maintained with the temporary signals.

Section 3.12(c) Temporary Preemption

When emergency vehicle preemption or railroad preemption is present at exiting signals, it must be incorporated into the temporary traffic signal design. Any existing emergency vehicle preemption equipment (light detectors, light detector amplifiers, etc.) may not be relocated to the temporary traffic signals. The equipment can be stored and installed on the new traffic signal installation. However, the designer should contact the Municipality or Fire Department to determine if they would prefer to have the equipment upgraded.

If the location contains transit signal priority (TSP) equipment, the appropriate transit agency shall be contacted to remove or deactivate the equipment when the use of temporary traffic signals is required. The designer shall include the following note in the removal notes section of the temporary signal plan indicating the presence of TSP equipment:

THE FOLLOWING ITEMS INSIDE THE TRAFFIC SIGNAL CABINET ARE PACE PROPERTY. THE CONTRACTOR SHALL CONTACT PACE AT 847-228-4287 OR 847-613-5889 FOR REMOVAL AND RELOCATION PRIOR TO ANY TRAFFIC SIGNAL CABINET WORK. REFER TO THE SPECIAL PROVISION FOR PACE EQUIPMENT HANDLING.

Section 3.12(d) Construction Staging

Construction staging may require multiple temporary traffic signal plan sheets showing the signal layout for each stage. Each stage with a different lane configuration layout will require a corresponding temporary traffic signal plan sheet. If there are several stages with the same lane configuration, one temporary traffic signal plan sheet can be used with the title block stating the stages the sheet corresponds to.

Another example would be when during one construction stage, protected-permissive left turn phasing is required but a subsequent stage requires the use of protected only left turn phasing. In this case, two separate temporary traffic signal designs and cable plans will be required since different phasing, signal displays, and number of signal heads are required for each of these stages. The designer should minimize the number of changes in left turn phasing between stages. Left turn phasing should be as consistent as practical through all stages.

Only the signal heads that are required for the initial stage of construction shall be installed. Any signal heads that are required for subsequent stages shall not be installed until required by a particular stage. This also applies to signs (i.e., “Left on Green Arrow Only”).

The designer shall review the turning radii of the opposing left turn movements to determine if the turning movements will be in conflict. Construction staging where opposing left turn movements cannot run concurrently shall be avoided if feasible. The designer shall coordinate with the Bureau of Traffic to determine if the MOT plans can be adjusted to avoid this conflict. In cases where the turning paths of opposing left turn movements will be in conflict, left turn phasing shall be utilized that does not allow the left turn movements to run concurrently for that stage of construction.

It is imperative that the designer obtain final construction staging plans before the temporary traffic signal design is finalized to make certain they match.

Section 3.12(e) Temporary Pedestrian Signals

Temporary pedestrian signal equipment is required for temporary traffic signal installations at intersections that have existing pedestrian signal equipment.

If temporary pedestrian signals are installed, a pedestrian push button is required for pedestrian actuation. Pedestrian push buttons shall be placed per Section 3.05(a) and as shown in District Standard TS-01. The use of temporary barrel mounted pedestrian posts may be needed to achieve proper placement. Countdown pedestrian signal heads shall be installed in all cases.

If APS is present at the existing traffic signal, APS must be maintained on the temporary traffic signal, or an APS compliant detour route must be provided.

Section 3.12(f) Temporary Vehicle Detection

Temporary vehicle detection shall be included for all approaches of the intersection. Types of temporary detection that may be considered include video detection, wireless detectors, and standard inductive loops. Video detection is the typical temporary vehicle detection method.

Section 3.12(g) Temporary Traffic Signals for Single Lane Staging

When temporary traffic signals are required for single lane staging, roadway lighting must also be included. The designer should contact the Electrical Design section prior to determine the extent of the lighting required. When possible, the temporary traffic signal installation and the roadway lighting should be designed to utilize the same electric service and the same wood poles to minimize construction cost. District Standard BE-805 should be followed for the design of the temporary traffic signal. The designer will have to provide a custom temporary traffic signal design if unique factors such as driveways or access points are within the single lane staging area. For single lane staging areas with a high frequency of driveways, the feasibility of single lane staging must be analyzed and alternative staging considered. If no driveways or access points exist within the single lane staging area, the BE-805 standard is sufficient and no additional modifications are needed.

Section 3.12(h) Temporary Electric Service

The electric service for the temporary traffic signal is typically pole mounted and spans aerially to the temporary wood pole where the temporary traffic signal cabinet is located. Temporary traffic signal installations with temporary luminaries located on the temporary traffic signal wood poles shall be energized through the temporary traffic signal cabinet and include a temporary lighting controller in the cabinet. Designers will need to specify an additional 15A circuit breaker in the temporary traffic signal cabinet to shut off the luminaires separately if needed.

Locations with an existing ground mounted service installation should utilize it for the temporary traffic signal installation when possible. Existing ground mounted service installation shall be reused and/or relocated when possible. Existing electric meters shall be relocated to the proposed traffic signal cabinet or the ground mounted service cabinet if the existing electric meter location is impacted.

Chapter 4 Other Devices and Policies

In addition to traffic signal installations, there are other devices that require approval for installation within state right-of-way. This section contains a summary of those devices. The designer shall contact District 1 Bureau of Traffic for current guidance and requirements (notably for any devices not covered herein or elsewhere within these guidelines), as well as meet with District staff to present the improvement scope and objectives. Requirements for permit applications, inter-governmental agreements, and design review requirements by other departments/bureaus should also be discussed.

Section 4.01 Red Light Running Camera (RLRC)

Red Light Running Camera (RLRC) systems are used for law enforcement operations. RLRC systems require an interface with the existing traffic signal equipment to operate properly. RLRC systems are the responsibility of the local agency and/or the camera vendor. Designers shall consult with the District and the IDOT website for the most recent policy and information.

When located at an IDOT traffic signal that is being modernized, the local agency and/or camera vendor will be responsible to deactivate the RLR equipment prior to the start of construction. RLRC systems will be deactivated during construction and when the maintenance of the existing traffic signal is not under the IDOT EMC contractor. Deactivation requires complete power shut off and disabling of any sensors and/or cables that are connected to the traffic signal cabinet. The following note shall be included in the Traffic Signal Plans:

DUE TO THE PRESENCE OF A RED LIGHT RUNNING CAMERA (RLRC) WITHIN THE PROJECT LIMITS, THE CONTRACTOR SHALL NOTIFY (LOCAL AGENCY) AND (RLRC VENDOR) PRIOR TO THE START OF CONSTRUCTION. THE (LOCAL AGENCY) OR (RLRC VENDOR) SHALL DEACTIVATE AND BAG THE RLRC EQUIPMENT FOR THE DURATION OF CONSTRUCTION. ANY RLRC CAMERA EQUIPMENT THAT IS IN CONFLICT WITH THE PROPOSED WORK SHALL BE REMOVED BY ITS OWNERS PRIOR TO THE START OF CONSTRUCTION.

LOCAL AGENCY	RLRC VENDOR
ADDRESS	ADDRESS
PHONE NUMBER	PHONE NUMBER

Once the RLRC system is deactivated, it cannot be reactivated without authorization. The local agency that operates the RLRC system will have to make a request to reactivate or reinstall in writing to IDOT Traffic Permits.

Section 4.02 License Plate Readers (LPR)

License Plate Readers (LPR) are technology used by law enforcement agencies to gather license plate data. An LPR installation may consist of cameras, controllers, electrical power, structures, and communications equipment.

The District does not allow the installation of LPR cameras or related equipment on IDOT-owned structures. The District will not allow sharing of IDOT's electric service. The District shall not host or move data for other agencies, nor record data for storage or transmission. If an LPR is found on a traffic signal, the District should be contacted immediately.

LPR applications shall include a map of all LPR's proposed or existing within the municipal boundaries they are proposed in. Field inspections and utility coordination should be completed prior to the LPR plan submittal to avoid plan revisions due to conflicts.

The following considerations shall be addressed by the permit applicant when submitting LPR installations for review and approval:

1. The location of the LPR installation should be within the jurisdictional boundaries of the requesting local agency. If not, separate permit applications shall be submitted by all local agencies involved. Documentation of an agreement or cooperative arrangements between the multiple agencies involved shall also be provided.
2. The LPR installation shall be performed by an IDOT prequalified electrical contractor at the applicant's expense. A prequalified traffic signal/electrical designer shall prepare the associated design documents accompanying the permit application.
3. Utility Protection – The applicant will be responsible for contacting locating services and protecting existing utilities including all State owned, local agency, and private/commercial utilities.
4. When LPR equipment is mounted to existing local agency structures, a structural engineer shall stamp documentation that demonstrates that the existing structure can accommodate the additional loading of the LPR equipment.
5. The crashworthiness of LPR installations shall be analyzed and documented. NCHRP 350 compliance is acceptable for LPR installation supports that are not MASH (Manual for Assessing Safety Hardware) tested.
6. The applicant shall file appropriate traffic control forms for each individual incidence of traffic control as specified in the permit for LPR installation.
7. LPR installations should be independently powered via solar power or an electric utility service.
8. LPR installations shall utilize separate communication methods. Data collection shall not involve the Department's communications infrastructure in any way. This protection is necessary because if LPR data is carried on Department communications equipment, the Department may be liable for FOIA requests, demands for network reliability, and otherwise become involved in enforcement activities.
9. Additional considerations for the applicant include:
    a. The applicant is responsible for repairing any damage to any part of the LPR installation.

b. The applicant shall provide a 24-hour contact for emergency repair calls and be available to de-energize or otherwise deactivate the equipment at the District's request. A mutually agreeable response timeframe shall be included.

c. The applicant shall be responsible for the resolution of all waste, special waste, and refuse when work is completed within the state right-of-way. All areas disturbed by equipment and workers shall be repaired and returned to the original condition.

d. IDOT staff or designee shall inspect the installation to verify general compliance with the applicant's proposal and with the terms of the permit.

e. The LPR and related equipment shall not interfere with driver sight distance or visibility of traffic control devices.

f. Newly installed supports as part of the LPR installation shall include the display of LPR vendor information or other identification.

g. A separate OPER 1051 permit form shall be submitted by the applicant and approved by the District before the removal of an LPR installation. Similarly, a separate OPER 1051 permit form should be submitted by the applicant and approved by the District before any maintenance work is performed on an LPR installation.

h. The District shall notify the applicant of any planned actions or activities which impact an LPR installation. The applicant shall be required to remove or relocate all LPR equipment impacted by the District's planned actions or activities, and as required or requested by the District.

Section 4.03 High Intensity Activated Crosswalk Beacon (HAWK), also known as Pedestrian Hybrid Beacons (PHB)

The District shall be contacted to ensure an agreed upon scope and approach for crossing locations relative to adjacent side streets, driveways, signalized intersections, or railroad grade crossings. Guidelines for HAWK or (PHB) designs can be found in the MUTCD and/or IL MUTCD.

Section 4.04 Rectangular Rapid Flashing Beacon (RRFB)

Guidelines for Rectangular Rapid Flashing Beacon (RRFB) are covered in the MUTCD 11th Edition.

The RRFB installation shall be designed similar to pedestrian signals with respect to post and push button placement. Signage for the RRFB push button and the operation guideline shall be reviewed by the District as part of the design development. Plans shall identify the point of electric service with energy cost and supply information similar to the traffic signal electric service requirements table.

RRFB's shall have APS push buttons that can be programmed to play an audio message.

When RRFB's are used on roadways with four or more lanes, it is strongly recommended to use mast arms for the flashing beacons and signing to maximize visibility to all lanes of traffic. In addition, it is strongly recommended to consider additional design features such as but not limited to a pedestrian refuge in the median.

See Appendix (to be added at a later date) for an example RRFB plan set.

Section 4.05 Leading Pedestrian Interval (LPI)

Leading pedestrian intervals (LPI) at signalized intersections are a low-cost pedestrian safety countermeasure. If used properly, LPI can provide one or more of the following benefits: increased visibility of crossing pedestrians, reduced conflicts between pedestrians and vehicles, increased likelihood of motorists yielding to pedestrians, and enhanced safety for younger and older pedestrians.

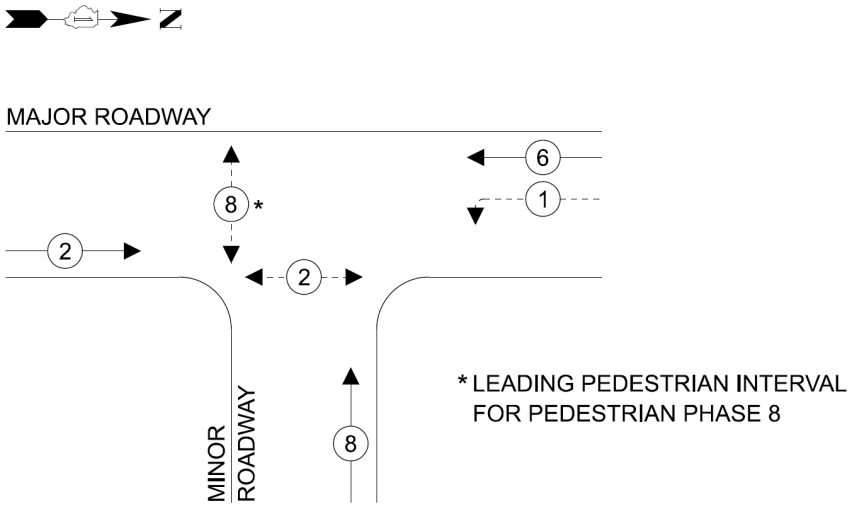
LPI consists of displaying the walk symbol to pedestrians several seconds ahead of parallel vehicular traffic receiving a green signal so that pedestrians receive a 'head start' to occupy the crosswalk and increase their visibility. The downside to LPI is that it can create increased vehicular delay and queues at the intersection.

LPI should not be utilized at the following locations:

- Where the crosswalk travels through a corner island that separates the adjacent through and right turning traffic.
- Crosswalks that conflict with a protected-permissive left turn phase unless the protected portion of the left turn phase is lagging or flashing yellow arrows are utilized.
- Where a "no right turn on red" restriction is not or will not be established. Exceptions for this may be made at locations where the primary concern is conflicts between pedestrians and opposing left turning traffic. The use of the R10-15 Turning Vehicles Yield to Pedestrian sign or dynamic "no right turn on red" symbol/text signs where the sign is only activated if there is a pedestrian actuation may also be considered.
- Signalized intersections that are currently near/over capacity or have a poor vehicular level of service.

Although pedestrian crosswalks at T-intersections should not be placed on the main route to the left of the roadway that is terminating, LPI is recommended to be implemented where these conditions exist. If the traffic signal controller needs to be upgraded to properly implement the LPI then that must be included in the scope of work. A controller phase diagram with LPI at a T-intersection is illustrated in Figure 4.1.

Figure 4.1 Controller Phase Diagram with Leading Pedestrian Interval



Chapter 5 Signing

This section provides information on signs related to traffic signal operation and are mounted on traffic signal poles. Detailed information on other highway signs may be found in the *Illinois Standard Highway Signs Book*, the *District 1 Signing Design Guidelines*, and the *Manual on Uniform Traffic Control Devices* (MUTCD).

Section 5.01 Street Name Signs

Section 5.01(a) Aluminum Street Name Signs

Mast arm mounted signs for street names shall be provided except where the crossroad does not have a name (e.g., private entrances). It is preferred that the sign is attached to the mast arm and not on the vertical pole. The designer should verify that there is enough space for the sign to be mounted on the arm between the vertical pole and the first signal head. The secondary option is to mount the sign on the vertical pole. All mast arm mounted street name signs shall use reflective Type ZZ sheeting. Examples of street name sign designs are included in Example Traffic Signal Plans.

Mast arm mounted street name sign design shall meet the following:

- The FHWA Standard Alphabet shall be used
- 8-inch upper case and 6-inch lower case letters shall be used.
- Only the first letter of each word shall be upper case except when the abbreviations of United States (US) or Illinois (IL) are used.
- The spacing between the words should be a minimum of 6 inches but may be reduced to 5 inches when spacing is critical.
- A minimum of 2 ½ inches shall be included between the word and the left and right edges of the sign.
- Aluminum sign lengths are in 6-inch increments.
- There is no stated limit to the length of street name signs, but the total area of the sign is limited to 20 square feet per the IDOT Highway Standards.
- It is preferred to use the Series D alphabet on a one-line sign that is 18 inches in height. If the proposed lettering does not fit on a one-line sign, a 30-inch two-line sign can be used. If Series D lettering does not fit, then Series C should be tried. The designations (i.e., Street, Avenue, Road) should be spelled out on the second line if space is available.
- Street name signs for marked US or State routes with a common name shall use a two-line sign. The top line shall be the marked route (e.g., IL Rte 72) and the second line shall be the common name (e.g., Higgins Rd).
- If a roadway has different names on each side of the intersection, the preferred design is to include a two-line sign to display both street names with arrows as shown on District Standard TS-02. The street name to the left shall be on the top line. The secondary option is to provide two signs for each street name, with or without arrows as space on the sign allows. Each pair of signs with the same street name shall be mounted back-to-back on the mast arm on the same side of the intersection as the respective street name.

Figure 5.1 shows the abbreviations and word lengths for the street name designations based on the FHWA Standard Alphabets and have been rounded up to the nearest eighth of an inch. Depending on the software used, actual word lengths may vary.

Figure 5.1 Mast Arm Mounted Street Name Sign Abbreviations (length in inches)

Name - Abbreviation	"D" Series	"C" Series
Avenue – Ave	18.25	15
Boulevard – Blvd	20	17.125
Circle – Cir	13	11.125
Court – Ct	9.625	8.25
Drive – Dr	10.125	8.625
Highway – Hwy	22	18.375
Illinois – IL	8.25	7
Lane – Ln	10.75	9.125
Parkway – Pkwy	27.375	23.375
Place – Pl	7.75	7.125
Road – Rd	11.125	9.625
Route – Rte	14.5	12.625
Street – St	9.125	8
Terrace – Ter	14.625	12.625
Trail – Tr	9.125	7.75
United States – US	12.25	10.375

District Standard TS-02 - Mast Arm Mounted Street Name Signs shall be included in plan sets when mast arm mounted street names signs are required.

Software programs or the FHWA Highway Alphabets Sign Word Calculator may be used as an alternative to the lengths shown in District Standard TS-02. The FHWA Standard Alphabets Highway Sign Word Length Calculator can be found at:

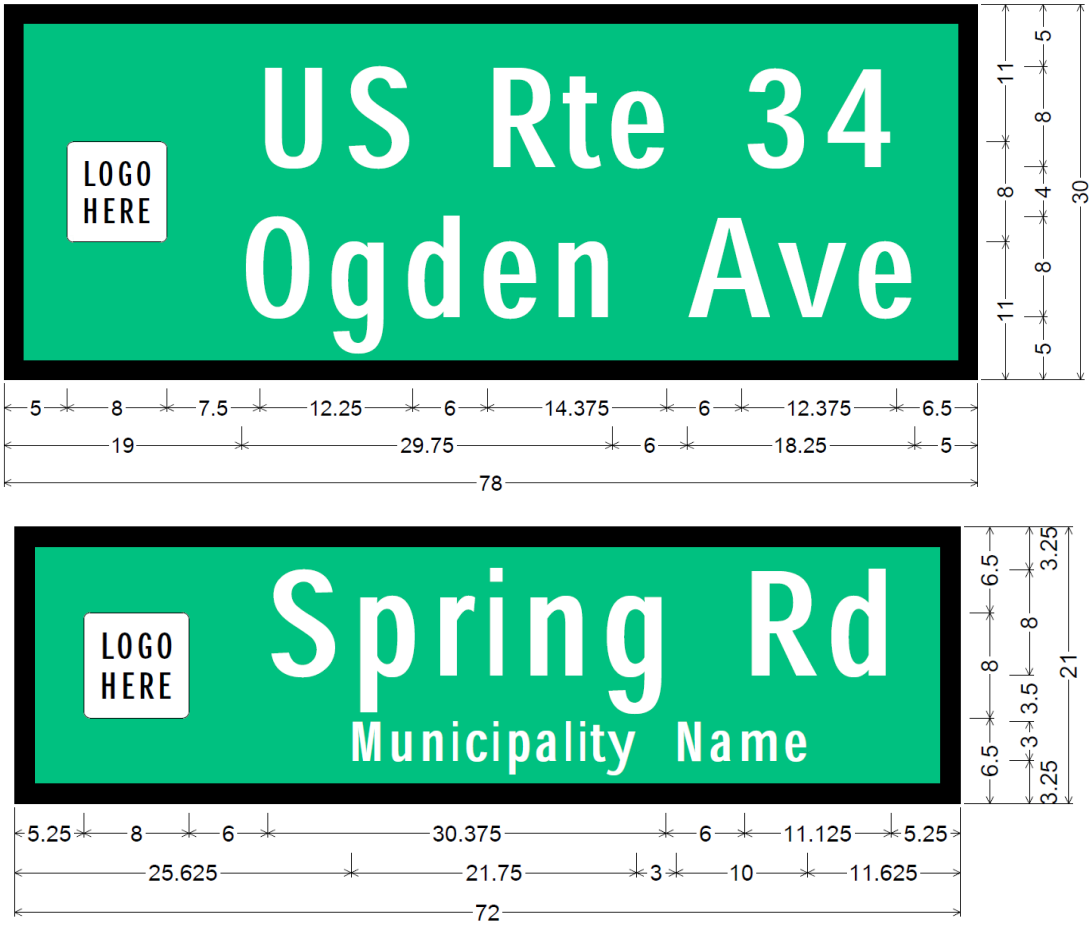
FHWA Highway Alphabets Sign Word Calculator

Section 5.01(b) LED Internally Illuminated Street Name Signs

The District allows LED internally illuminated street name signs to be used when requested by a municipality. However, the District will not participate in the cost of these signs or their installation. The designer shall provide the District with the written request for the LED street name signs from the municipality. The request shall include concurrence from the municipality that they are responsible for all costs associated with the signs. LED street name signs will not be maintained by IDOT. An agreement with the municipality will be required in which it states that the municipality will pay for the LED street name sign installation and any future maintenance.

LED street name signs generally follow the same design criteria as outlined for aluminum street name signs in Section 5.01(a). The municipality has the option to include their logo and/or municipality name on the LED street name sign depending on the size of the sign. The name of the municipality is not allowed on LED street name signs that require two lines for the name/s of the roadway. The ability to include the municipality logo will be based on the length of the sign after accounting for the length of the roadway text. Figure 5.2 provides an example of a one-line and a two-line LED street name sign with these features. The sign design included in the signal plans must show a clear depiction of any special wording or symbology. The wording and symbology will have to be approved by the District.

Figure 5.2 LED Street Name Sign Examples



LED internally illuminated street name sign lengths are typically available in 6-inch increments. The viewable height is typically 18 to 21 inches for a one-line sign and 27 to 30 inches for a two-line sign. Specific sizes available vary by manufacturer. The area of the LED street name sign, including the housing, shall be no more than 20 square feet. The maximum illuminated street name sign weight shall be 100 lbs.

LED street name signs shall be double-sided when traffic approaches from both directions. Double-sided signs shall have the same message and symbology on both sides of the sign.

The LED street name sign shall always be located to the right of the signal heads on the mast arm. The sign shall be mounted such that the bottom of the sign is between 16 feet and 18 feet above traveled pavement.

LED street name signs may be mounted on most newer existing steel mast arms. The signs cannot be mounted on “trombone” style aluminum mast arms or older steel mast arms such as mast arms with only one signal head. When proposing LED street name signs on newer existing steel mast arms, the additional loading must be compared to the original shop drawings from the mast arm assembly was installed to verify the maximum loading is not exceeded. IDOT shall have final approval on whether the LED street name signs will be allowed to be installed on existing mast arms. In some cases, structural evaluation and approval from the IDOT Bureau of Bridges and Structures will be required.

Chapter 6 Lighting at Signalized Intersections

This section provides information on intersection lighting at signalized intersections owned and maintained by IDOT. More information on lighting in District 1 can be found in IDOT District 1 *General Guidelines for Lighting Design* (August 2025).

Warrants for roadway lighting installations shall be reviewed and approved by the IDOT District 1 Bureau of Traffic Operations, Electrical Design section. The designer shall contact the Bureau for the lighting requirements. If the lighting is owned by the county or municipality, the designer should coordinate with the local agency.

Section 6.01 Intersection Combination Lighting

If roadway lighting will be installed in conjunction with a traffic signal installation, the designer must contact the Electrical Design section prior to beginning the design to discuss the use of combination mast arms. The use of combination mast arms is encouraged to minimize the amount of equipment at the intersection. The combination luminaires shall be powered from the traffic signal cabinet.

Section 6.02 Intersection Transition Lighting

Intersection lighting should include transition lighting. Intersection transition lighting shall be designed to adequately enhance visual cues to the driver approaching an intersection and to mitigate sight adaptation for the driver leaving the lighted intersection. The designer shall contact IDOT District 1 Bureau of Traffic Operations, Electrical Design section prior to beginning design to discuss intersection transition requirements.

Section 6.03 Requirements

Intersection lighting calculations are required for all combination lighting at signalized intersections and shall follow the requirements in IDOT District 1 *General Guidelines for Lighting Design.*

A 4-inch conduit shall be provided for a traffic signal mast arm with combination lighting. Electrical cables for lighting and traffic signals shall be placed in the same conduit at an intersection since these are connected to the traffic signal cabinet. Lighting quantities will be reviewed by IDOT District 1 Bureau of Traffic Operations, Electrical Design section. These quantities will be shown in the lighting schedule of quantities and not in the traffic signal schedule of quantities. Combination lighting symbols shall be shown on both the traffic signal plan and the traffic signal cable plan. Based on the lighting requirements at the intersection, the traffic signal plans shall specify if the combination mast arm requires one or two luminaire arms. The traffic signal plan shall match the lighting design plans and luminaire alignment. The cable plan shall have a note stating that the luminaire placement should be per the lighting design plans.

Chapter 7 Miscellaneous

Section 7.01 Supplemental Local Requirements

District 1 is comprised of a number of non-state agencies. Some of these agencies have unique design requirements for traffic signals that are on their roadways. For state led projects that impact traffic signals on non-state roadways, coordination with the appropriate non-state agencies and their design requirements will be required.

Section 7.02 Special Waste Coordination

Early in the design process, it may be necessary to provide the locations and excavation depths of traffic signal foundations in order to include them in the Preliminary Environmental Site Assessment (PESA) response. The designer shall provide a plan, map, or exhibit of locations of excavations along with the depth and quantity of excavation at each location. Historic and Architectural Resources Geographic Information System (HARGIS) maps will also be required to indicate any historical significance. For Traffic let projects, the designer will provide this information directly to the Environmental Studies Unit (ESU). Local Roads projects should coordinate with the Bureau of Local Roads for environmental coordination. For larger projects led by the Bureau of Design, the designer will furnish this information to Design if requested.

ESU requires a substantial lead time on these submittals which later may be updated and/or revised. A typical lead time required for submittal is 6 to 8 months before the letting date. If wetlands are present the lead time can be up to 12 months

Section 7.03 SUE Survey Request

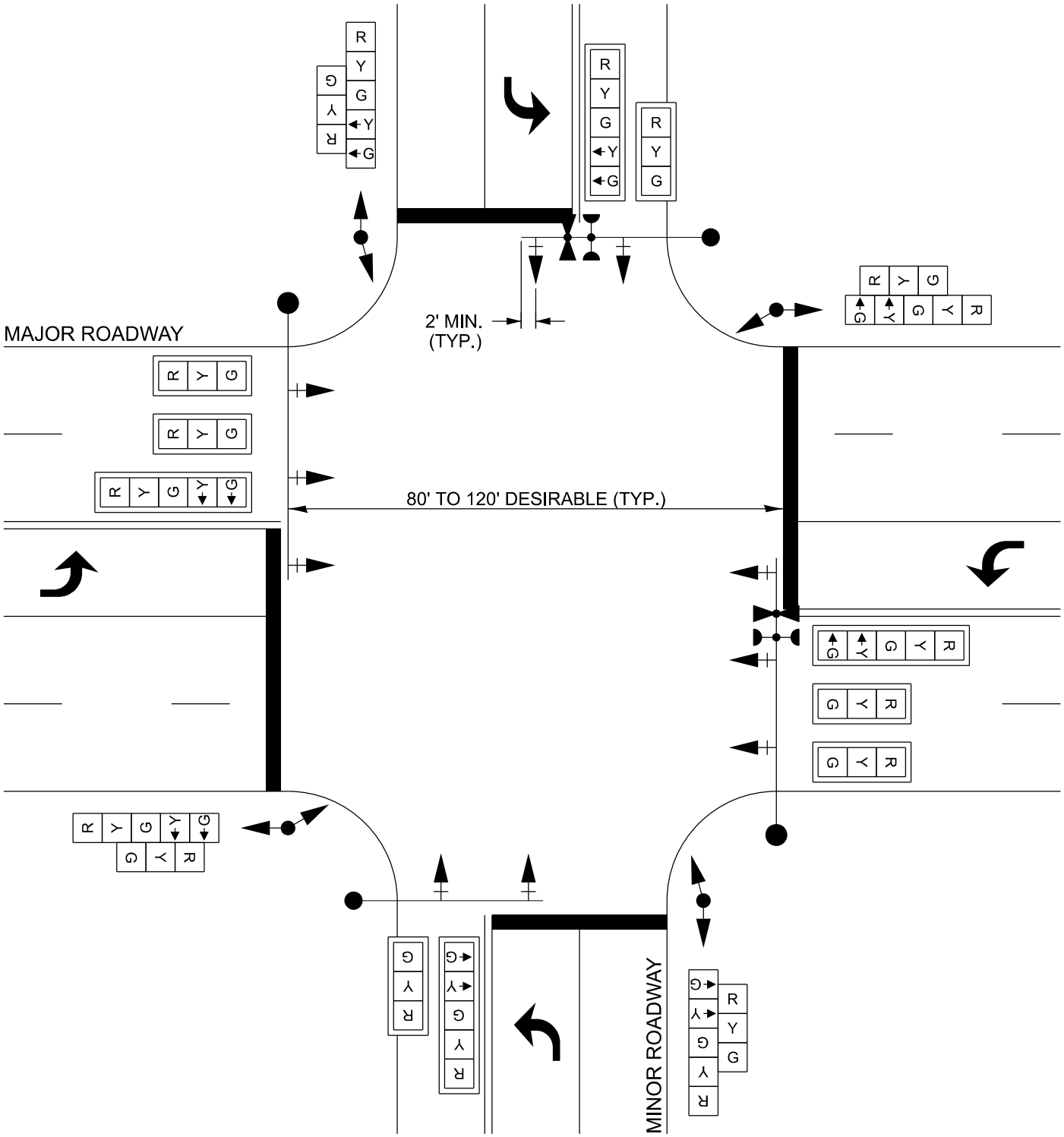
A Subsurface Utilities Engineering (SUE) Survey provides accurate, detailed information on the utilities in the particular area with depths and locations of each utility. Typical lead time for such a survey should be expected at a minimum of two months. SUE Survey requests are processed through the Design-Utilities section of IDOT and require CADD files for the right-of-way, topographic survey, and alignment to be sent with the request. The determination of the SUE Survey requirement will be completed by IDOT staff. Not all projects and locations will qualify for this survey. Locations with constrained right-of-way, limited space for traffic signal equipment, or signs of an extensive amount of utilities

APPENDIX A

Signal Layout & Phase Diagrams Examples

EXAMPLE A–1

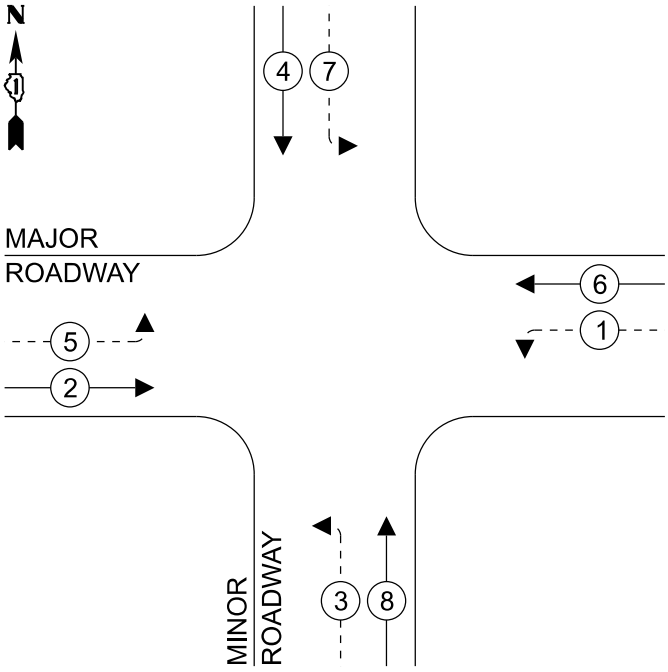
PROTECTED-PERMISSIVE LEFT TURN PHASING FOR BOTH ROADWAYS



EXAMPLE A–1

PROTECTED-PERMISSIVE LEFT TURN PHASING FOR BOTH ROADWAYS

CONTROLLER PHASE DIAGRAM



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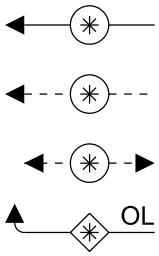
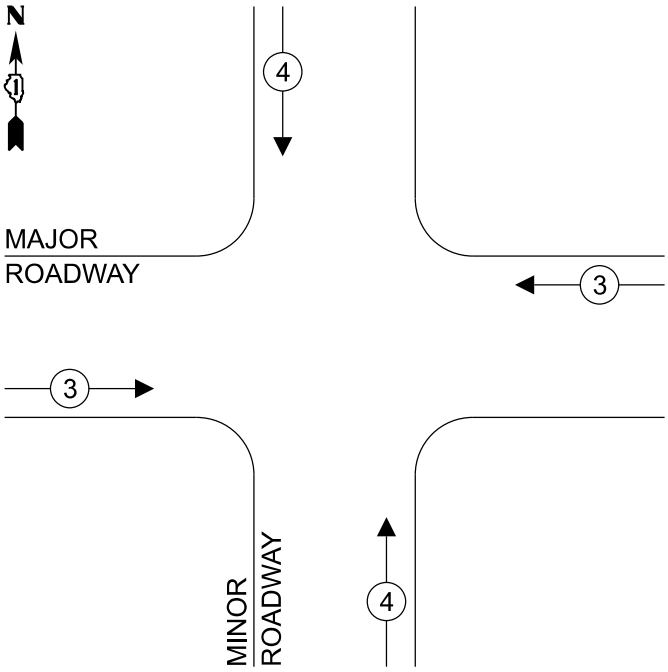
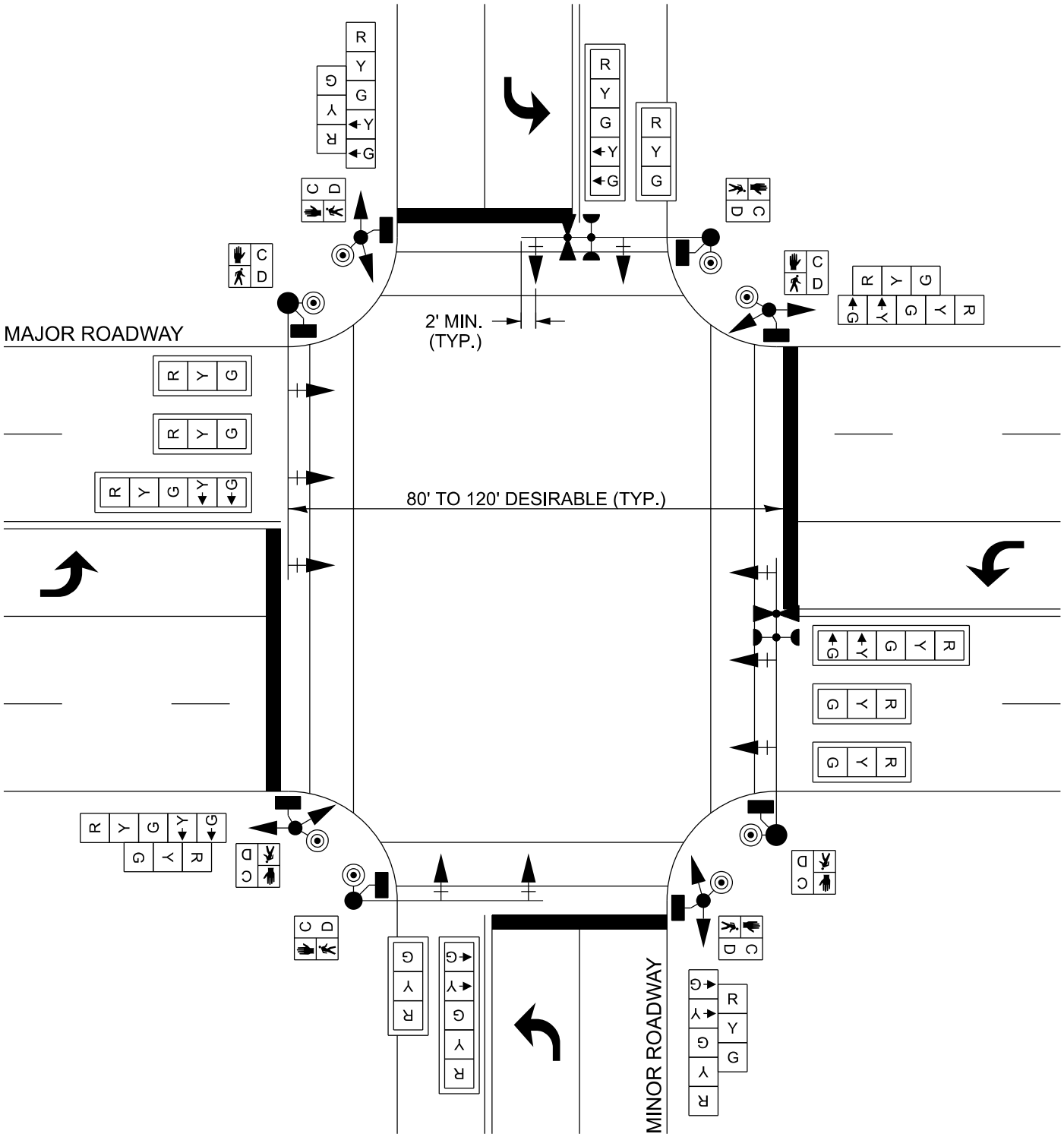


EMERGENCY VEHICLE PREEMPTION PHASE DIAGRAM



EXAMPLE A–2

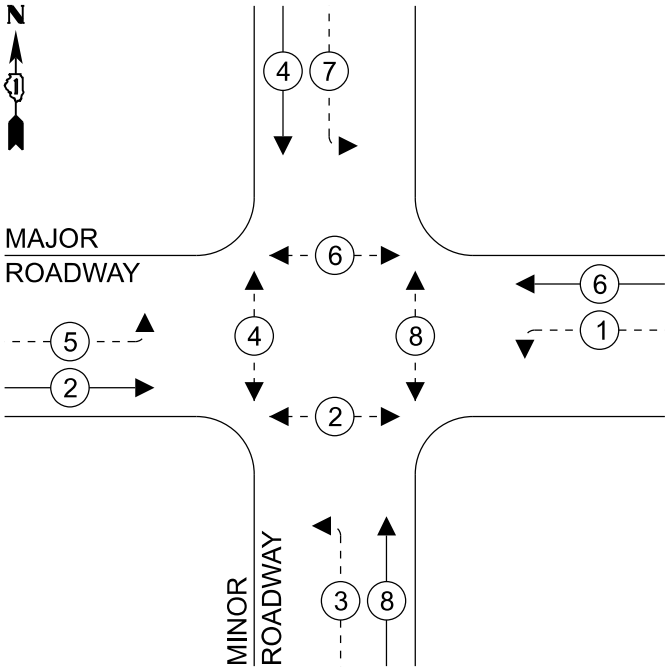
PROTECTED-PERMISSIVE LEFT TURN PHASING FOR BOTH ROADWAYS
WITH PEDESTRIANS ON ALL APPROACHES



EXAMPLE A–2

PROTECTED-PERMISSIVE LEFT TURN PHASING FOR BOTH ROADWAYS
WITH PEDESTRIANS ON ALL APPROACHES

CONTROLLER PHASE DIAGRAM



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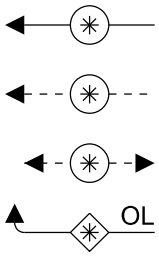

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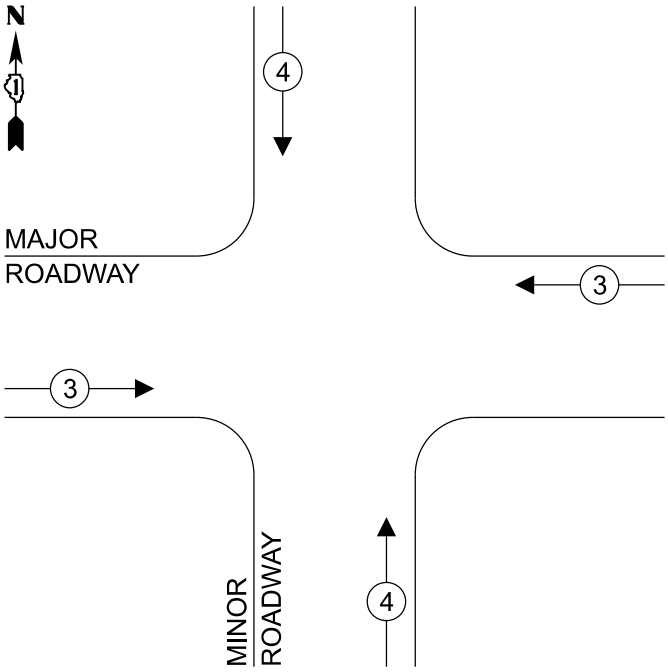
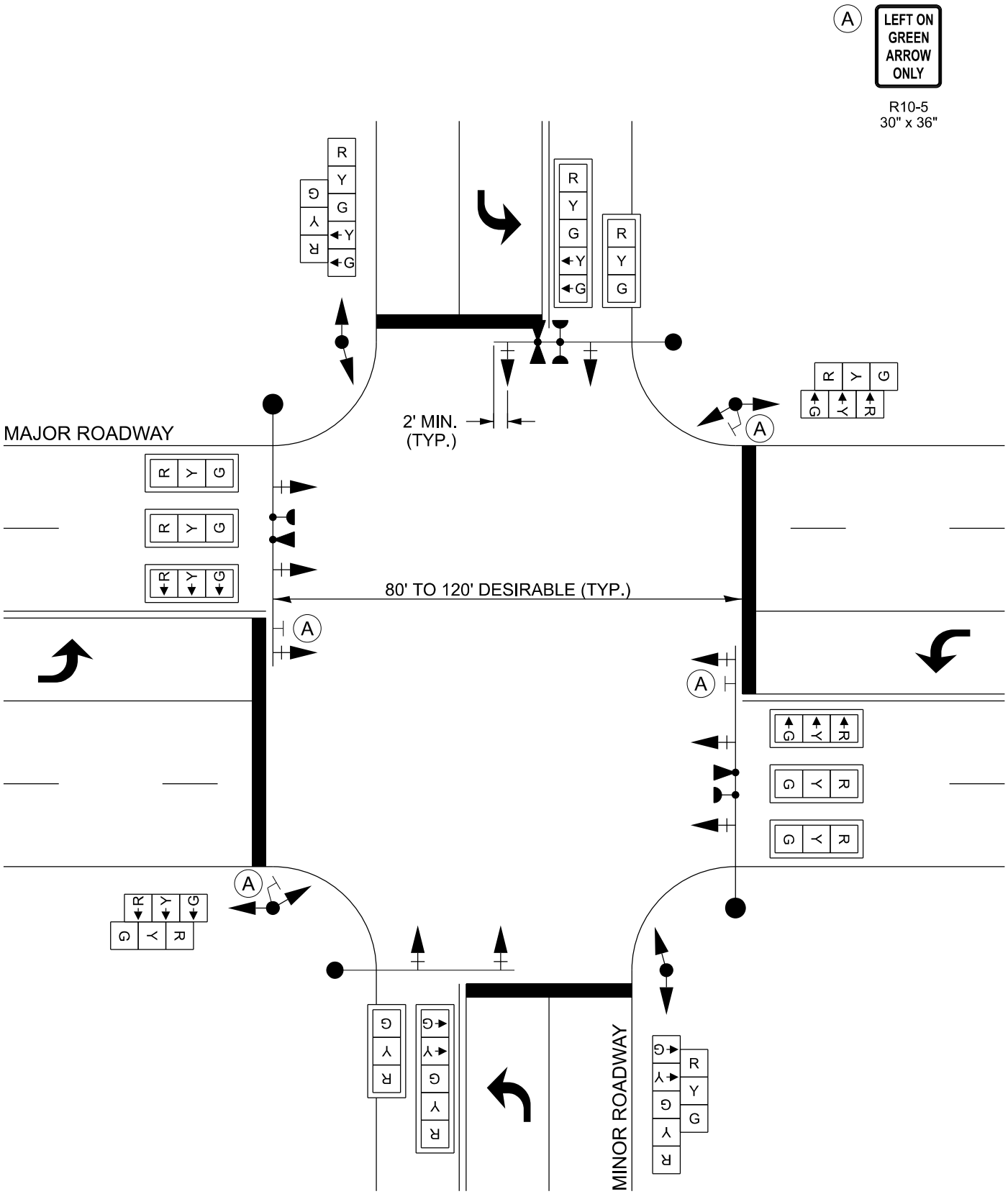


EXAMPLE A–3

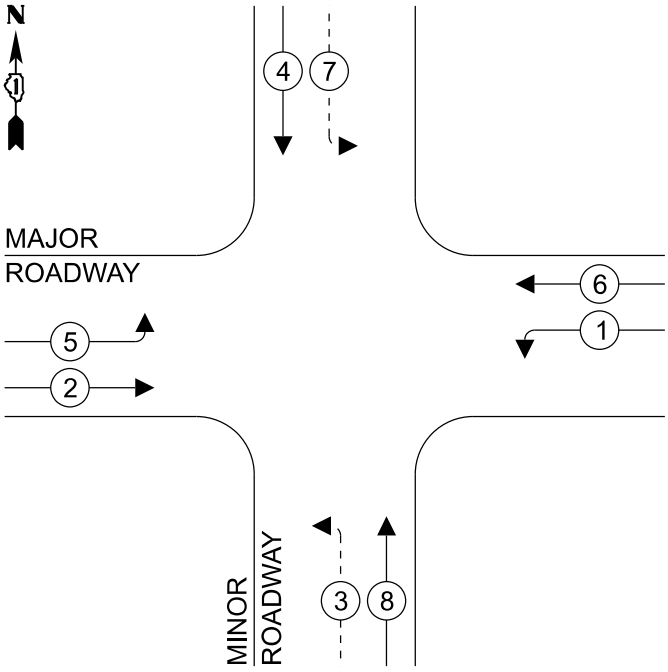
PROTECTED ONLY LEFT TURN PHASING FOR MAJOR ROADWAY AND
PROTECTED-PERMISSIVE LEFT TURN PHASING FOR MINOR ROADWAY



EXAMPLE A–3

PROTECTED ONLY LEFT TURN PHASING FOR MAJOR ROADWAY AND
PROTECTED-PERMISSIVE LEFT TURN PHASING FOR MINOR ROADWAY

CONTROLLER PHASE DIAGRAM



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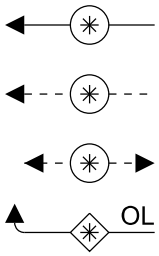
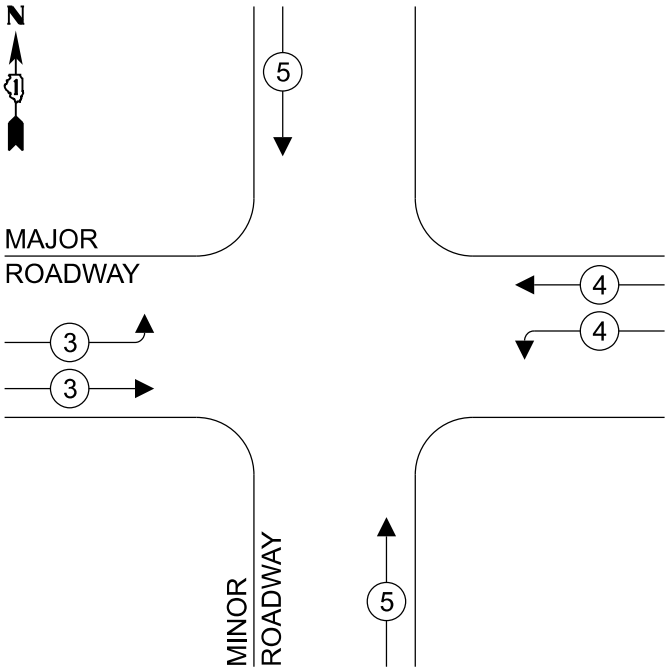
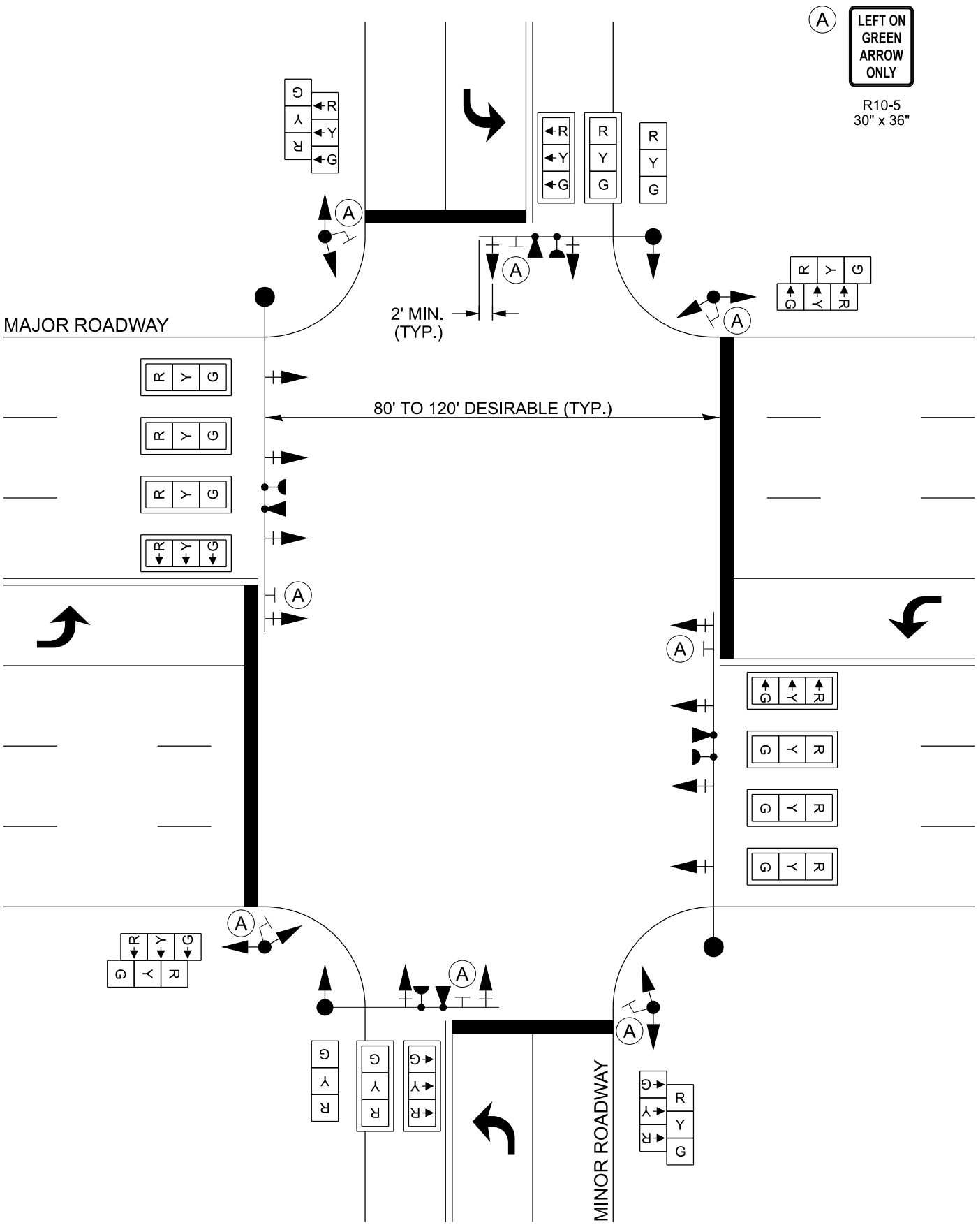


EMERGENCY VEHICLE PREEMPTION PHASE DIAGRAM



EXAMPLE A–4

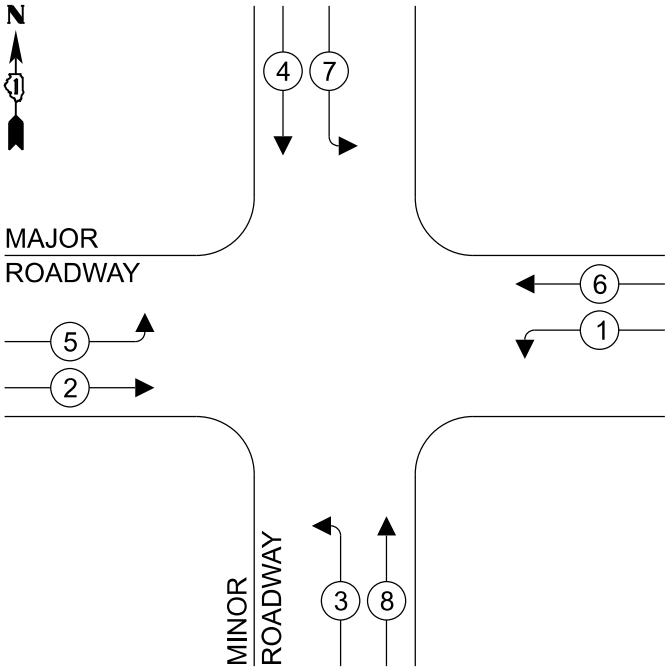
PROTECTED ONLY LEFT TURN PHASING FOR BOTH ROADWAYS
SINGLE THROUGH LANE ON MINOR ROADWAY



EXAMPLE A–4

PROTECTED ONLY LEFT TURN PHASING FOR BOTH ROADWAYS
SINGLE THROUGH LANE ON MINOR ROADWAY

CONTROLLER PHASE DIAGRAM



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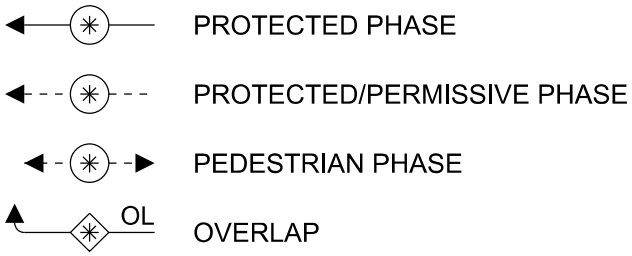
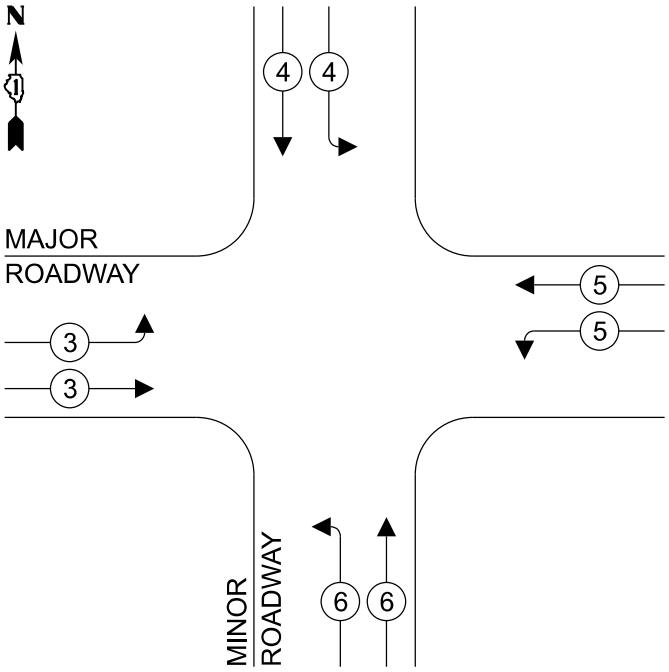
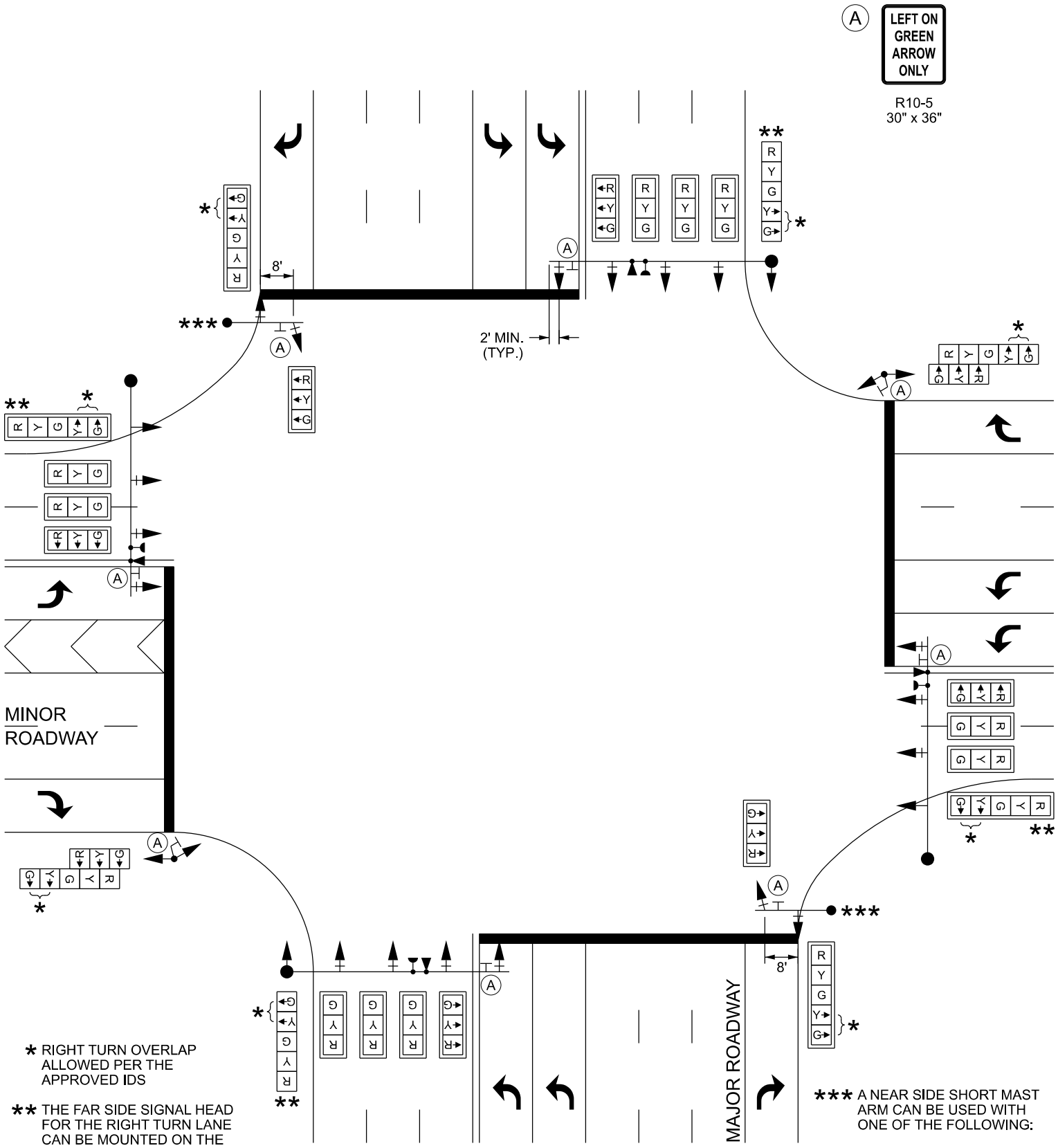


EMERGENCY VEHICLE PREEMPTION PHASE DIAGRAM



EXAMPLE A–5

PROTECTED ONLY LEFT TURN PHASING FOR BOTH ROADWAYS
DUAL LEFT TURN LANES ON THREE APPROACHES AND
ONE APPROACH WITH SINGLE LEFT TURN LANE AND ADJACENT LANE HATCHED
RIGHT TURN LANES ON ALL APPROACHES



* RIGHT TURN OVERLAP ALLOWED PER THE APPROVED IDS

** THE FAR SIDE SIGNAL HEAD FOR THE RIGHT TURN LANE CAN BE MOUNTED ON THE ARM IF THERE IS SUFFICIENT SPACE WITH THE MAST ARM STREET NAME SIGN

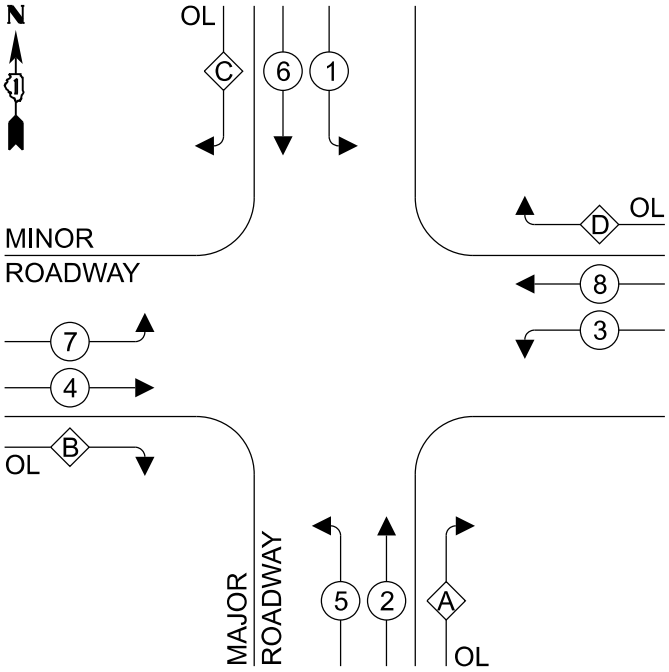
*** A NEAR SIDE SHORT MAST ARM CAN BE USED WITH ONE OF THE FOLLOWING:

-3 THROUGH LANES WITH A RIGHT TURN LANE
-DUAL RIGHT TURN LANES

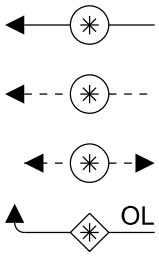
EXAMPLE A–5

PROTECTED ONLY LEFT TURN PHASING FOR BOTH ROADWAYS
DUAL LEFT TURN LANES ON THREE APPROACHES AND
ONE APPROACH WITH SINGLE LEFT TURN LANE AND ADJACENT LANE HATCHED
RIGHT TURN LANES ON ALL APPROACHES

CONTROLLER PHASE DIAGRAM



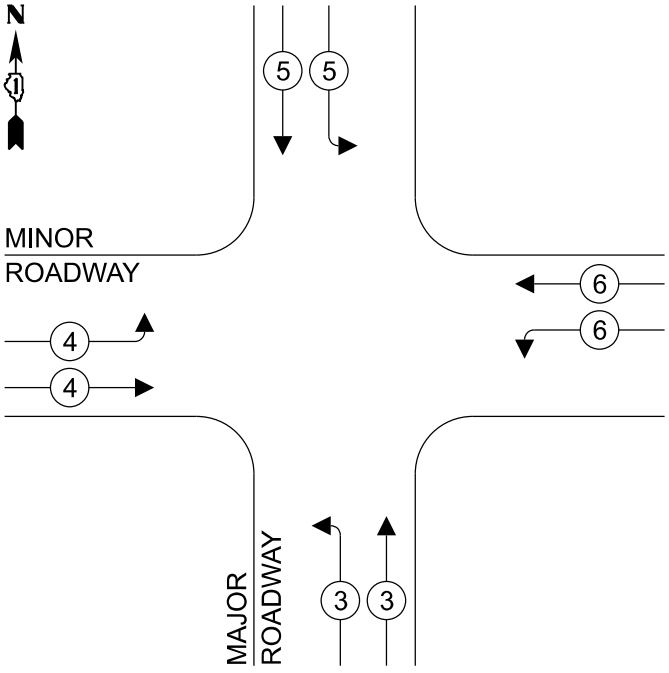
LEGEND:



RIGHT TURN OVERLAP PHASE DESIGNATION:

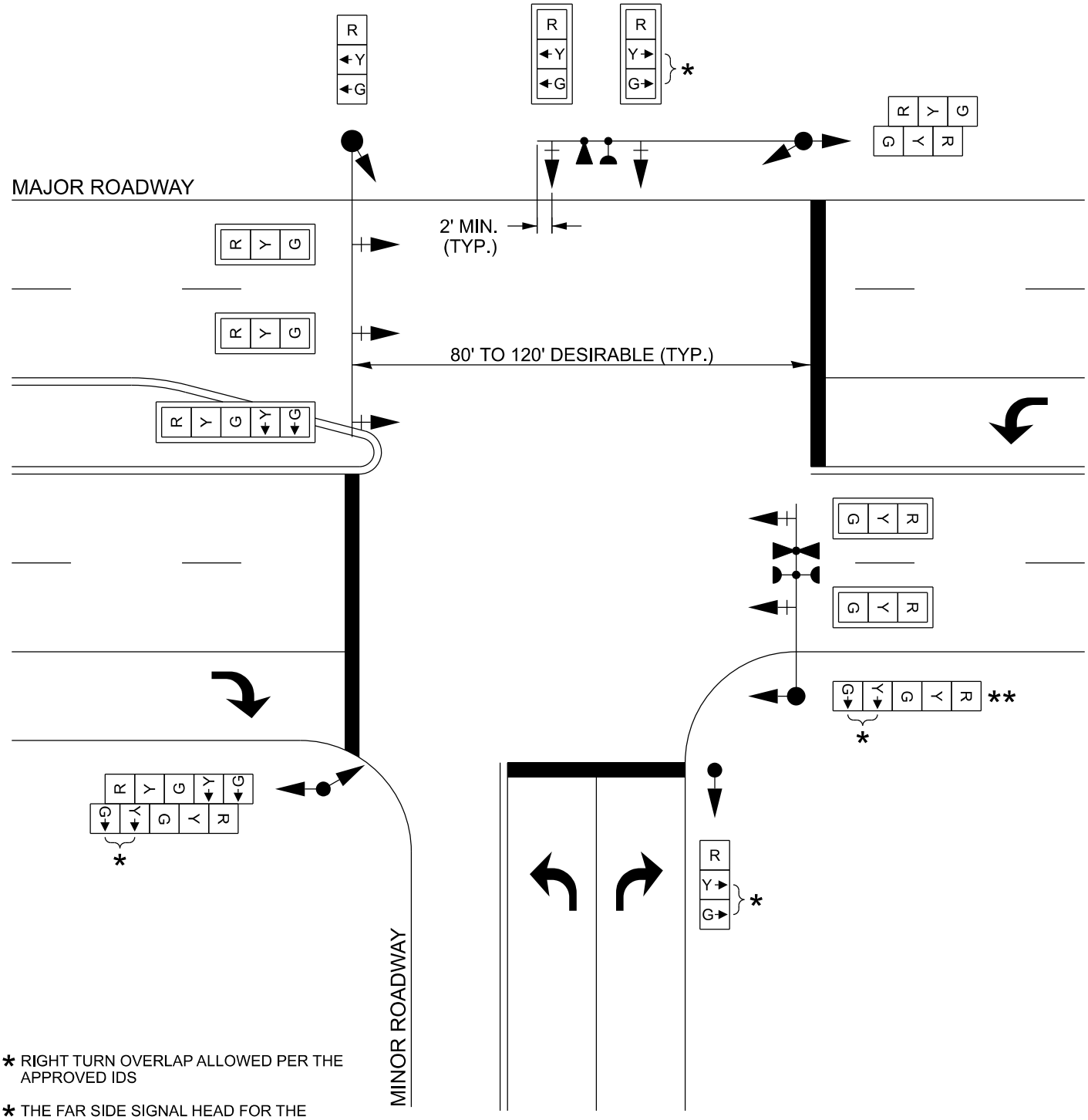
OVERLAP LETTER		PERMISSIVE PHASE		PROTECTED PHASE
A	=	2	+	3
B	=	4	+	5
C	=	6	+	7
D	=	8	+	1

EMERGENCY VEHICLE PREEMPTION PHASE DIAGRAM



EXAMPLE A–6

T-INTERSECTION
NO PEDESTRIANS



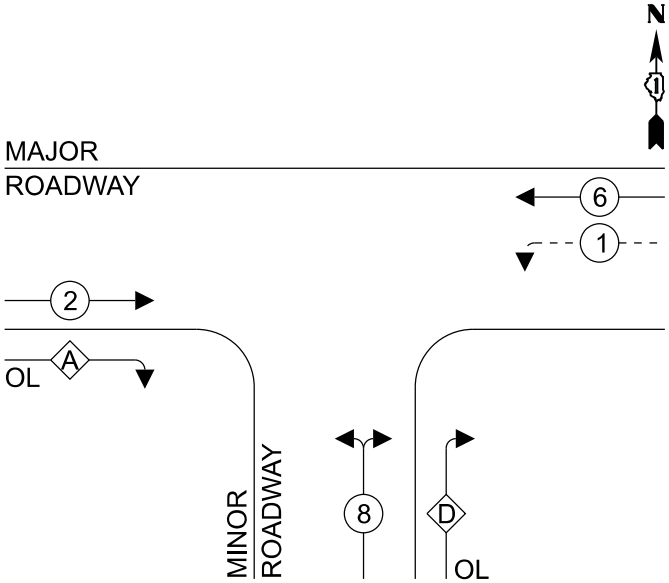
* RIGHT TURN OVERLAP ALLOWED PER THE APPROVED IDS

** THE FAR SIDE SIGNAL HEAD FOR THE RIGHT TURN LANE CAN BE MOUNTED ON THE ARM IF THERE IS SUFFICIENT SPACE WITH THE MAST ARM STREET NAME SIGN

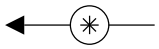
EXAMPLE A–6

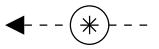
T-INTERSECTION
NO PEDESTRIANS

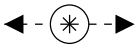
CONTROLLER PHASE DIAGRAM

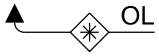


LEGEND:


PROTECTED PHASE


PROTECTED/PERMISSIVE PHASE


PEDESTRIAN PHASE

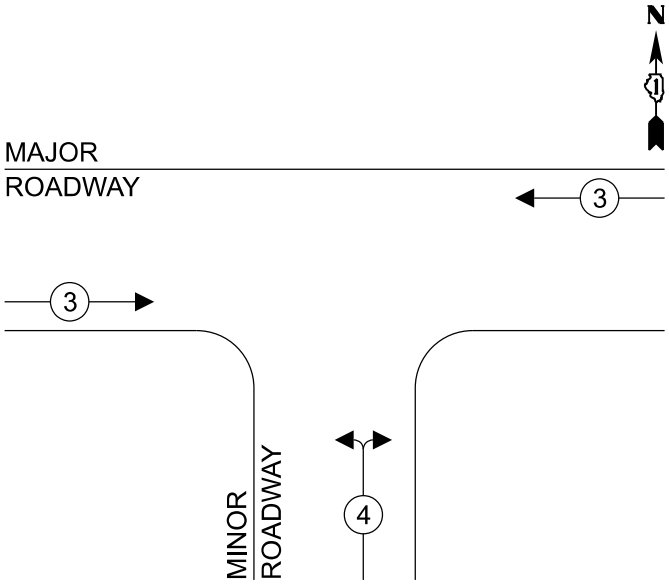


OVERLAP

RIGHT TURN OVERLAP PHASE DESIGNATION:

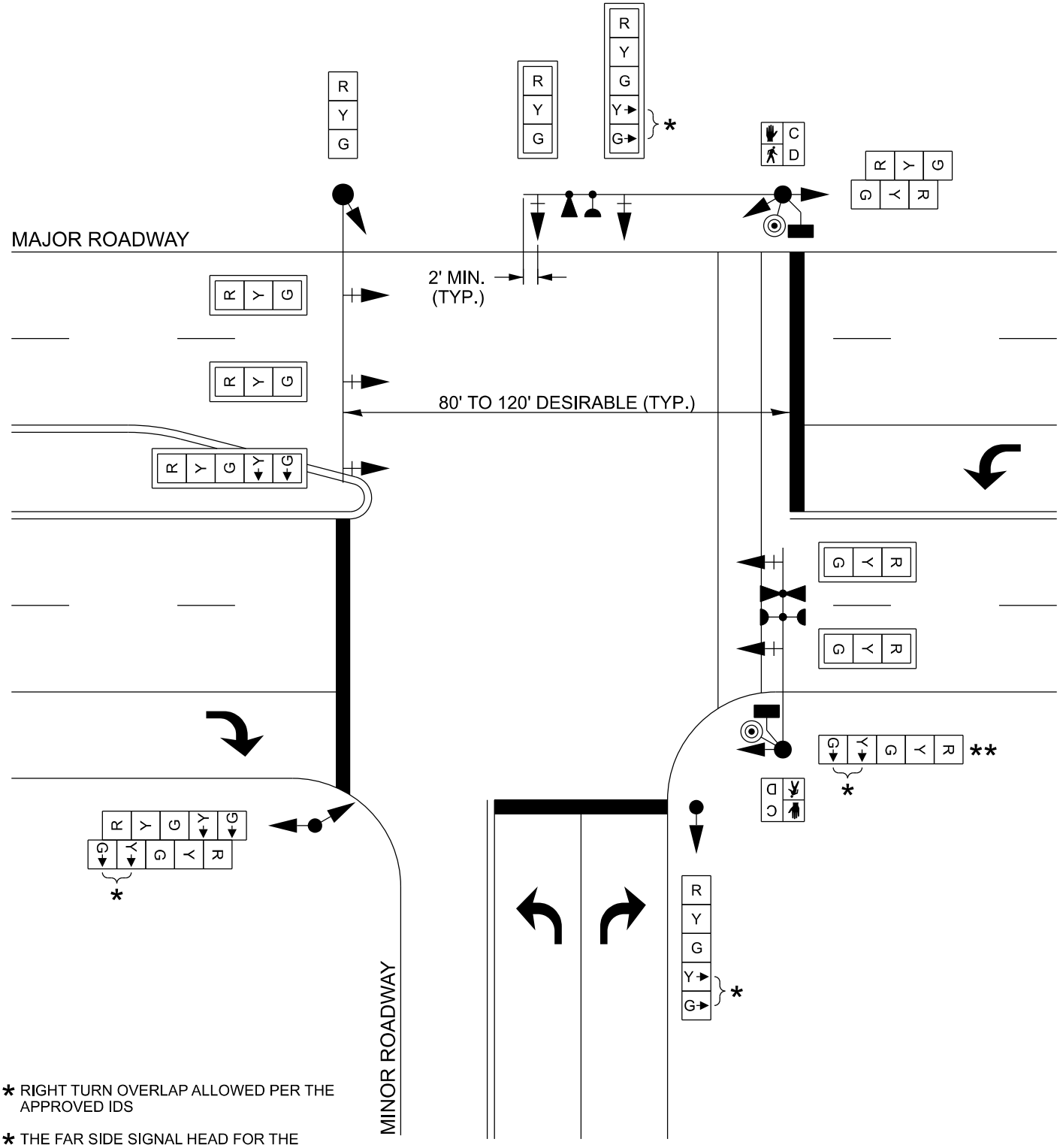
OVERLAP LETTER		PERMISSIVE PHASE		PROTECTED PHASE
A	=	2	+	8
D	=	8	+	1

EMERGENCY VEHICLE PREEMPTION PHASE DIAGRAM



EXAMPLE A–7

T-INTERSECTION
WITH PEDESTRIANS



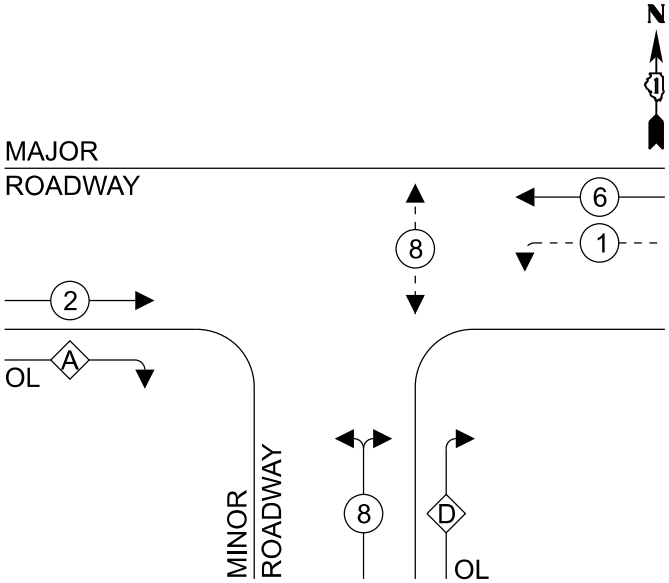
* RIGHT TURN OVERLAP ALLOWED PER THE APPROVED IDS

** THE FAR SIDE SIGNAL HEAD FOR THE RIGHT TURN LANE CAN BE MOUNTED ON THE ARM IF THERE IS SUFFICIENT SPACE WITH THE MAST ARM STREET NAME SIGN

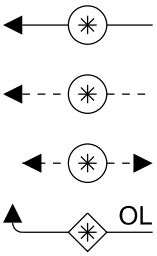
EXAMPLE A–7

T-INTERSECTION
WITH PEDESTRIANS

CONTROLLER PHASE DIAGRAM



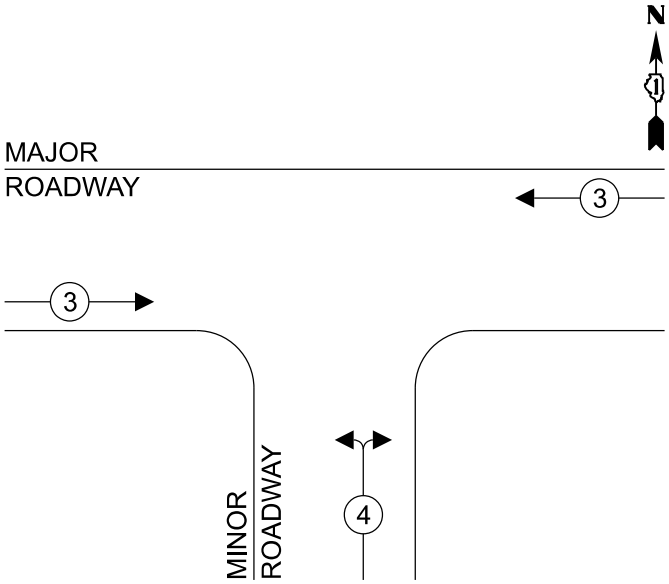
LEGEND:



RIGHT TURN OVERLAP PHASE DESIGNATION:

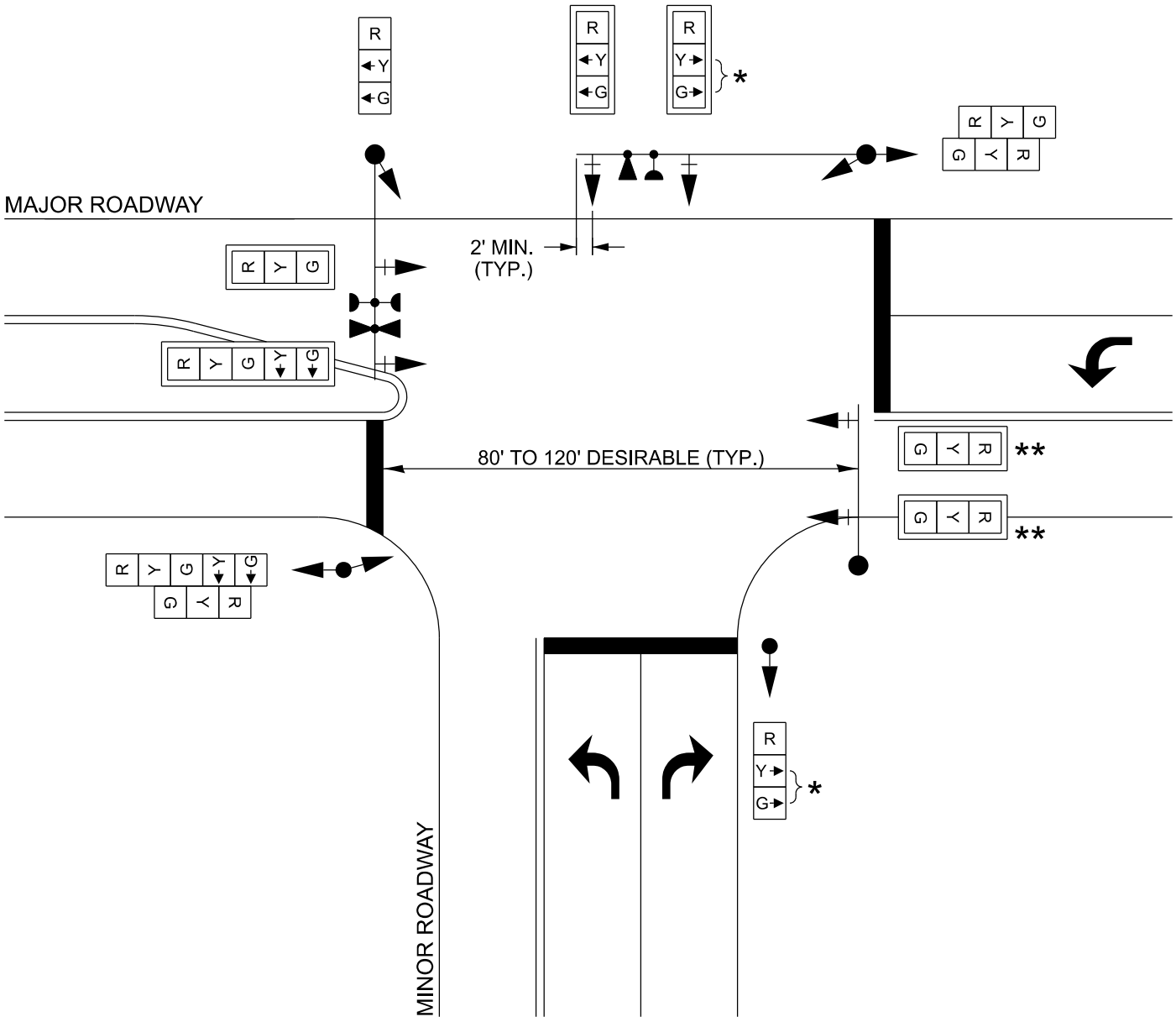
OVERLAP LETTER		PERMISSIVE PHASE		PROTECTED PHASE
A	=	2	+	8
D	=	8	+	1

EMERGENCY VEHICLE PREEMPTION PHASE DIAGRAM



EXAMPLE A–8

T-INTERSECTION
ONE APPROACH WITH SINGLE LANE AND NO RIGHT TURN LANE
NO PEDESTRIANS



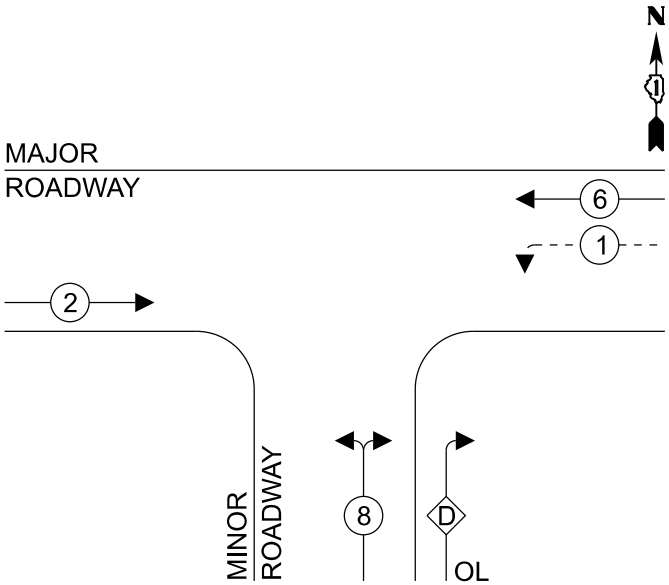
* RIGHT TURN OVERLAP ALLOWED PER THE APPROVED IDS

** THE SIGNAL HEADS SHALL BE ALIGNED WITH THE LANE LINES WHEN THERE IS A SINGLE LANE.

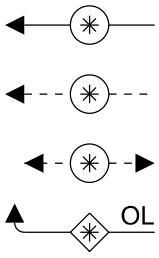
EXAMPLE A–8

T-INTERSECTION
ONE APPROACH WITH SINGLE LANE AND NO RIGHT TURN LANE
NO PEDESTRIANS

CONTROLLER PHASE DIAGRAM



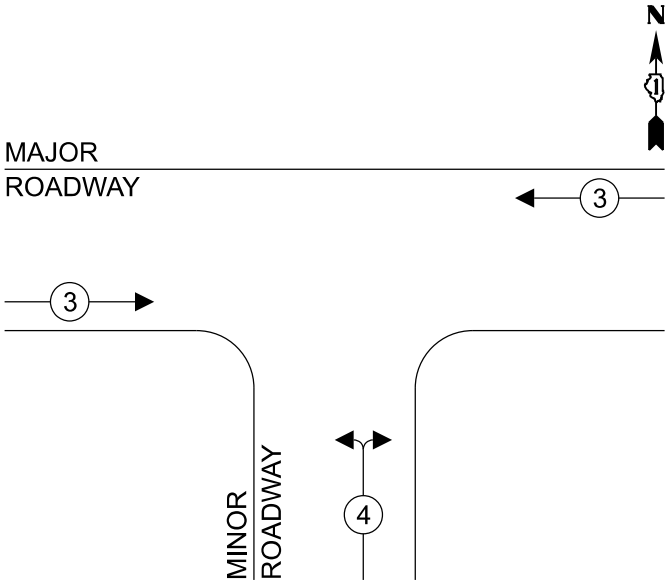
LEGEND:



RIGHT TURN OVERLAP PHASE DESIGNATION:

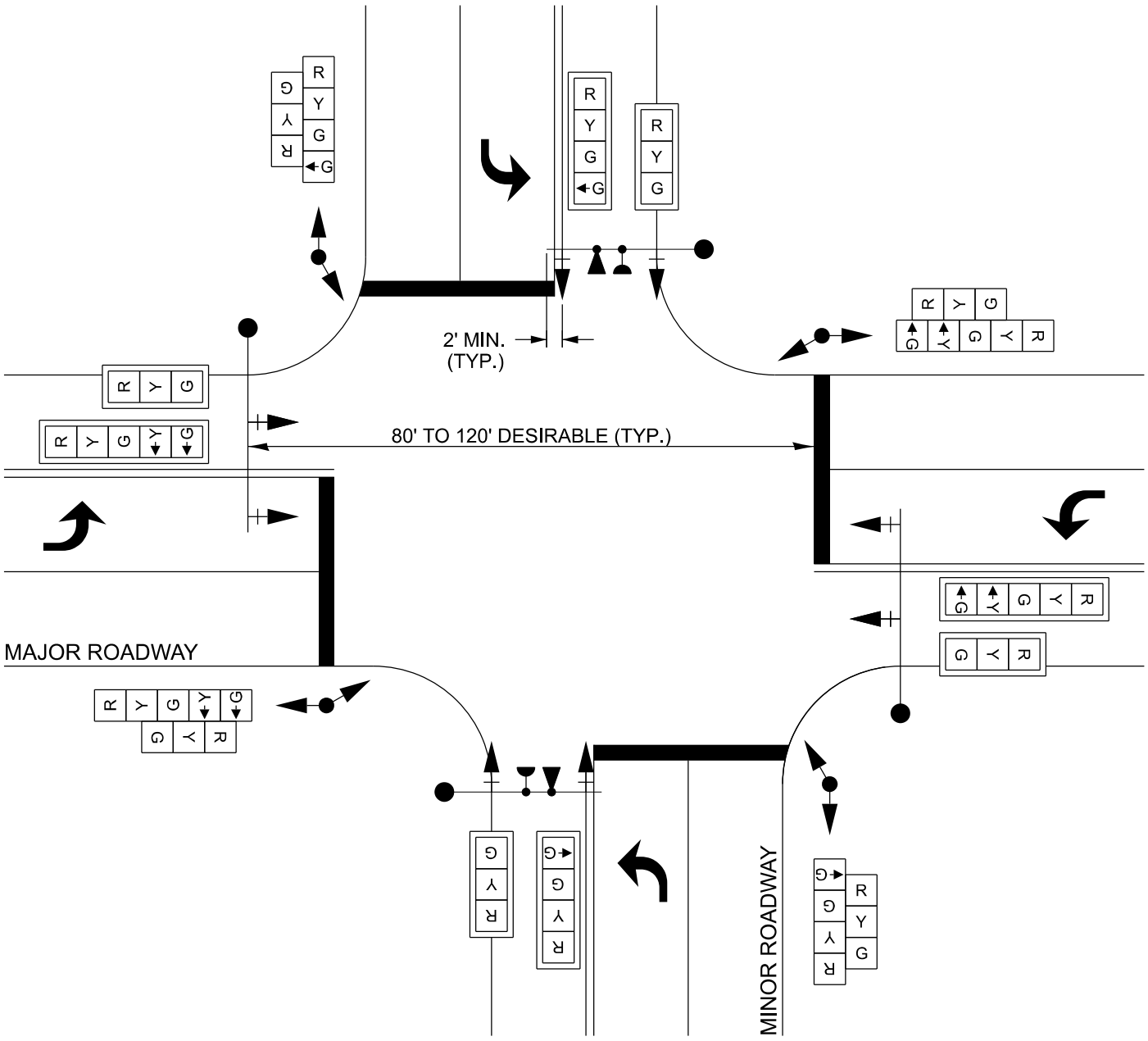
OVERLAP LETTER		PERMISSIVE PHASE		PROTECTED PHASE
D	=	8	+	1

EMERGENCY VEHICLE PREEMPTION PHASE DIAGRAM



EXAMPLE A–9

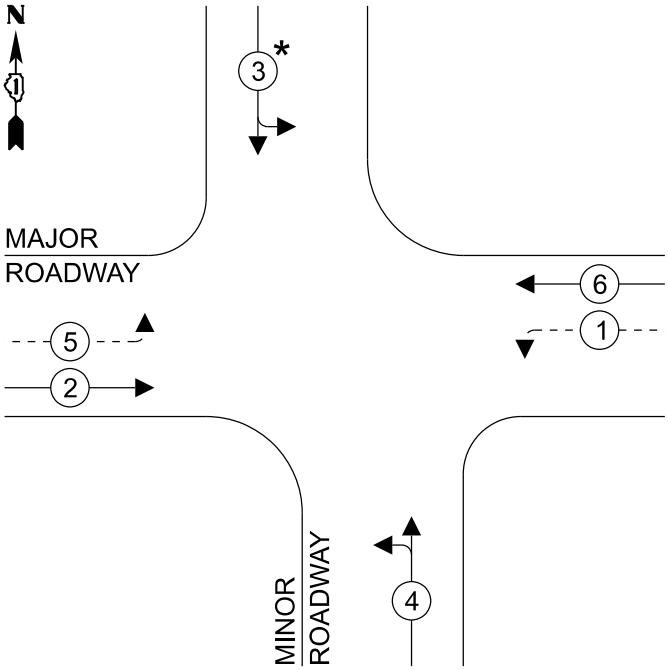
SPLIT PHASING ON MINOR ROADWAY



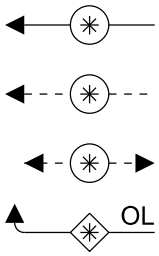
EXAMPLE A–9

SPLIT PHASING ON MINOR ROADWAY

CONTROLLER PHASE DIAGRAM



LEGEND:



PROTECTED PHASE

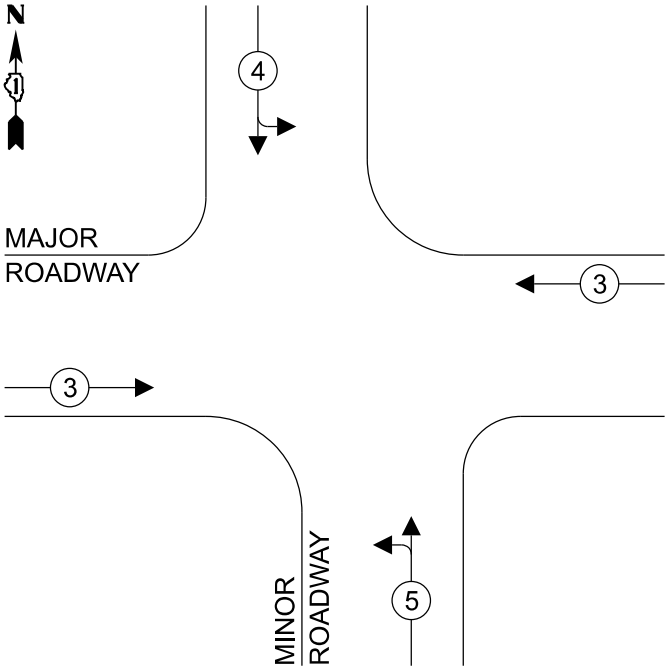
PROTECTED/PERMISSIVE PHASE

PEDESTRIAN PHASE

OVERLAP

* THE SMALLER PHASE NUMBER SHALL BE ASSIGNED TO THE LEG WITH LOWER VOLUME IN MOST CASES

EMERGENCY VEHICLE PREEMPTION PHASE DIAGRAM

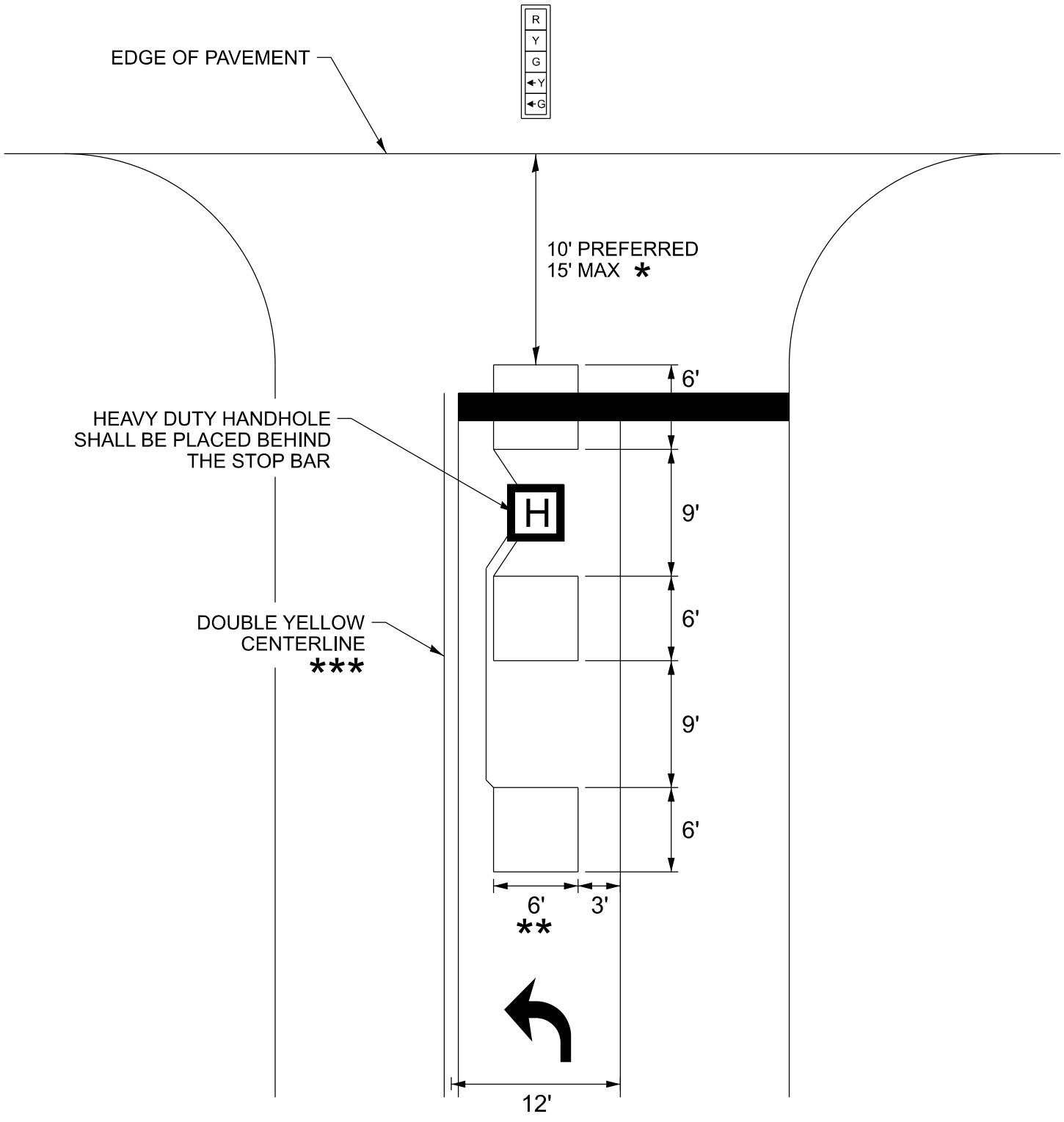


APPENDIX B

Typical Detection Placement

EXAMPLE B–1

LEFT TURN LANE DETECTOR LOOP LAYOUT
FOR PROTECTED-PERMISSIVE LEFT TURN PHASING



* THE FIRST DETECTOR LOOP SHALL BE NO MORE THAN 15' FROM THE EDGE OF PAVEMENT. IF THE EDGE OF PAVEMENT IS LESS THAN 15', CENTER THE FIRST LOOP ON THE STOP BAR.

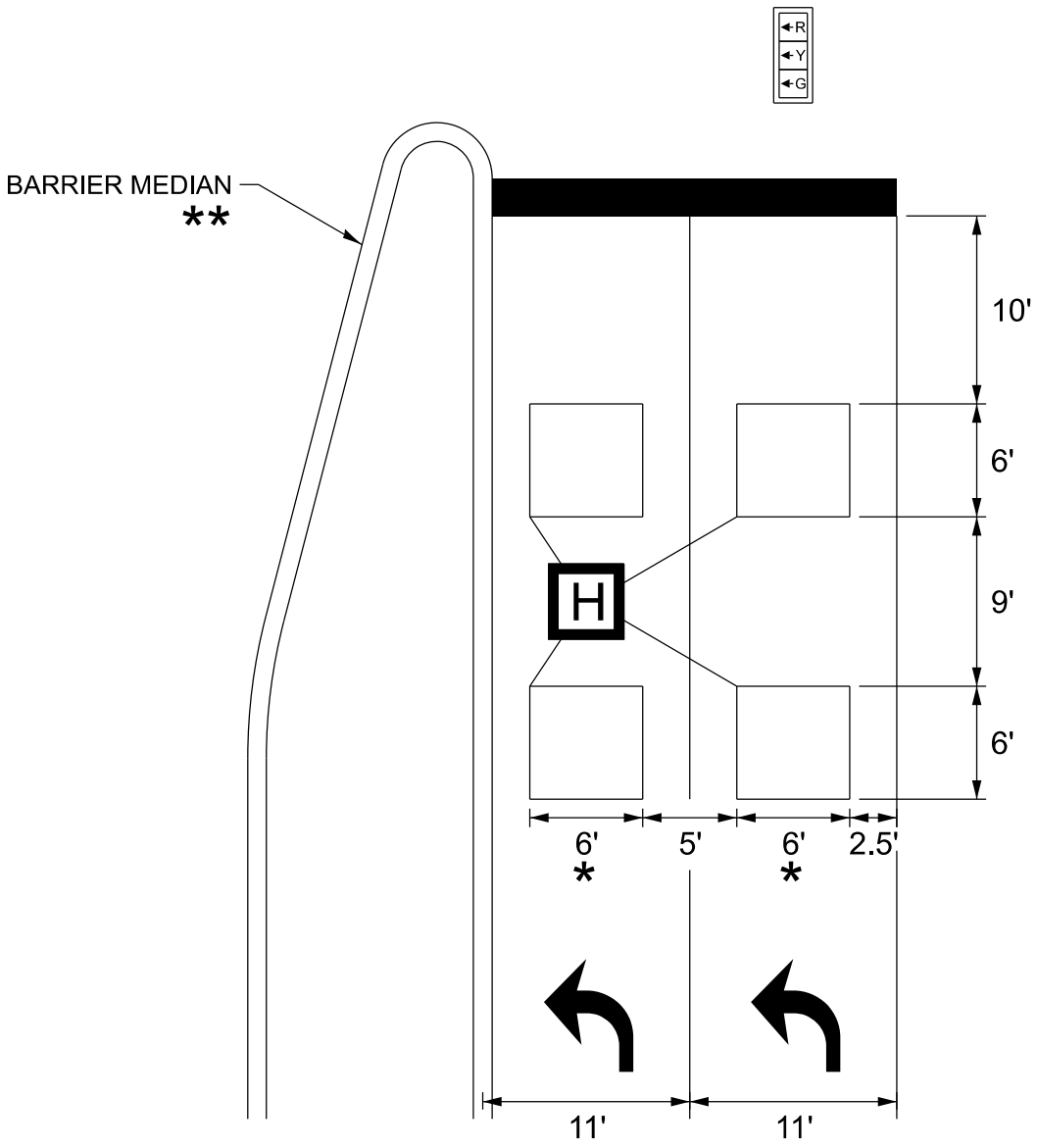
** DETECTOR LOOPS SHALL BE A MINIMUM 6' WIDTH REGARDLESS OF LANE WIDTH.

*** THE DETECTOR LOOP LAYOUT REMAINS THE SAME WITH A BARRIER MEDIAN.

NOTE: THERE SHALL BE A MINIMUM OF 2 FULL DETECTOR LOOPS BEHIND THE STOP BAR.

EXAMPLE B–2

LEFT TURN LANE DETECTOR LOOP LAYOUT
FOR PROTECTED ONLY LEFT TURN PHASING



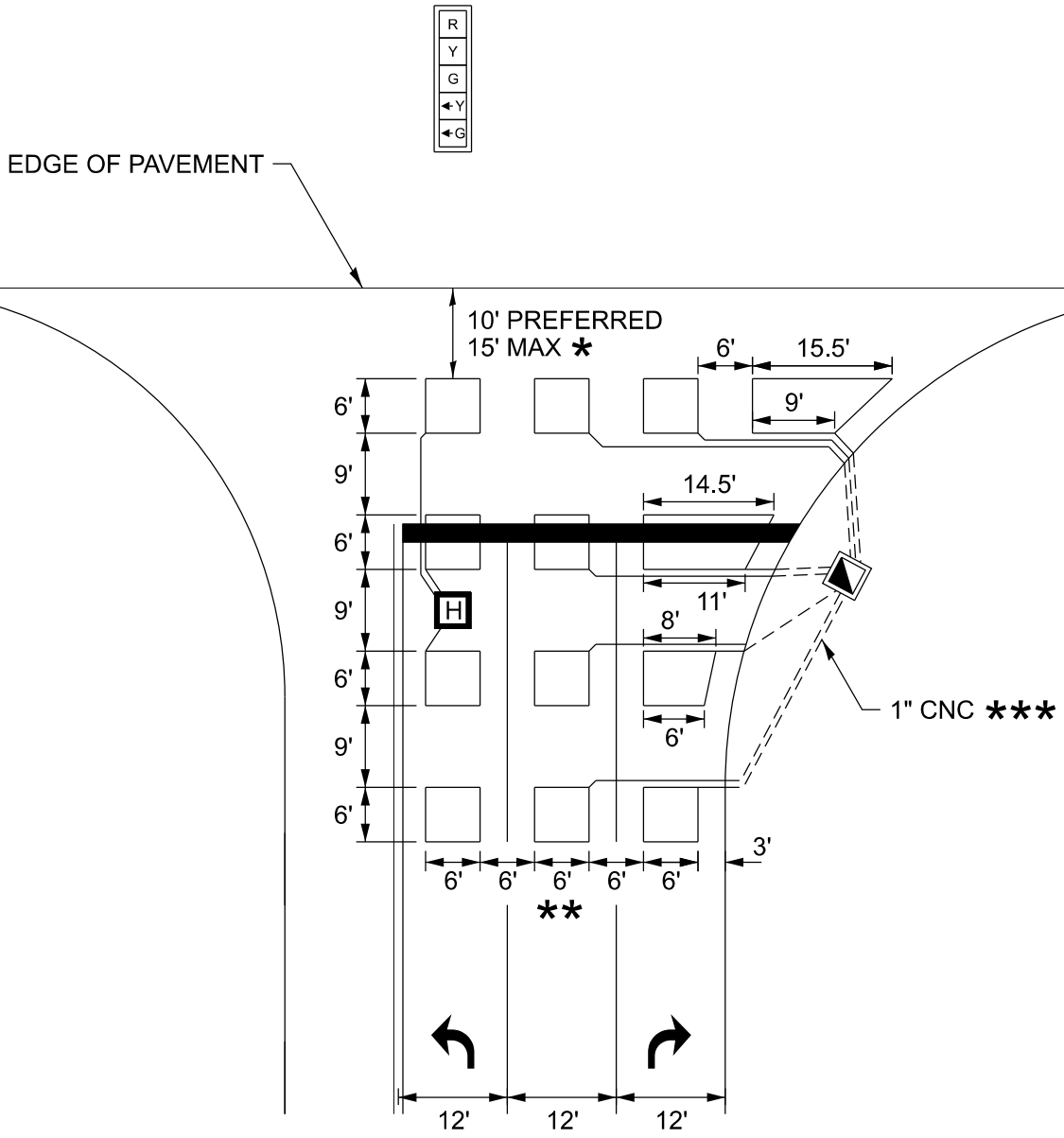
* DETECTOR LOOPS SHALL BE A MINIMUM 6' WIDTH REGARDLESS OF LANE WIDTH.

** THE DETECTOR LOOP LAYOUT REMAINS THE SAME WITH A DOUBLE YELLOW CENTERLINE.

NOTE: THE DETECTOR LOOP LAYOUT FOR PROTECTED ONLY PHASING WITH A SINGLE LEFT TURN LANE FOLLOWS THE SAME LAYOUT AS THE OUTSIDE LEFT TURN LANE IN THIS EXAMPLE.

EXAMPLE B–3

UP-TIGHT DETECTION
WITH PROTECTED-PERMISSIVE LEFT TURN PHASING



* THE FIRST DETECTOR LOOP SHALL BE NO MORE THAN 15' FROM THE EDGE OF PAVEMENT. IF THE EDGE OF PAVEMENT IS LESS THAN 15', CENTER THE FIRST LOOP ON THE STOP BAR.

** DETECTOR LOOPS SHALL BE A MINIMUM 6' WIDTH REGARDLESS OF LANE WIDTH.

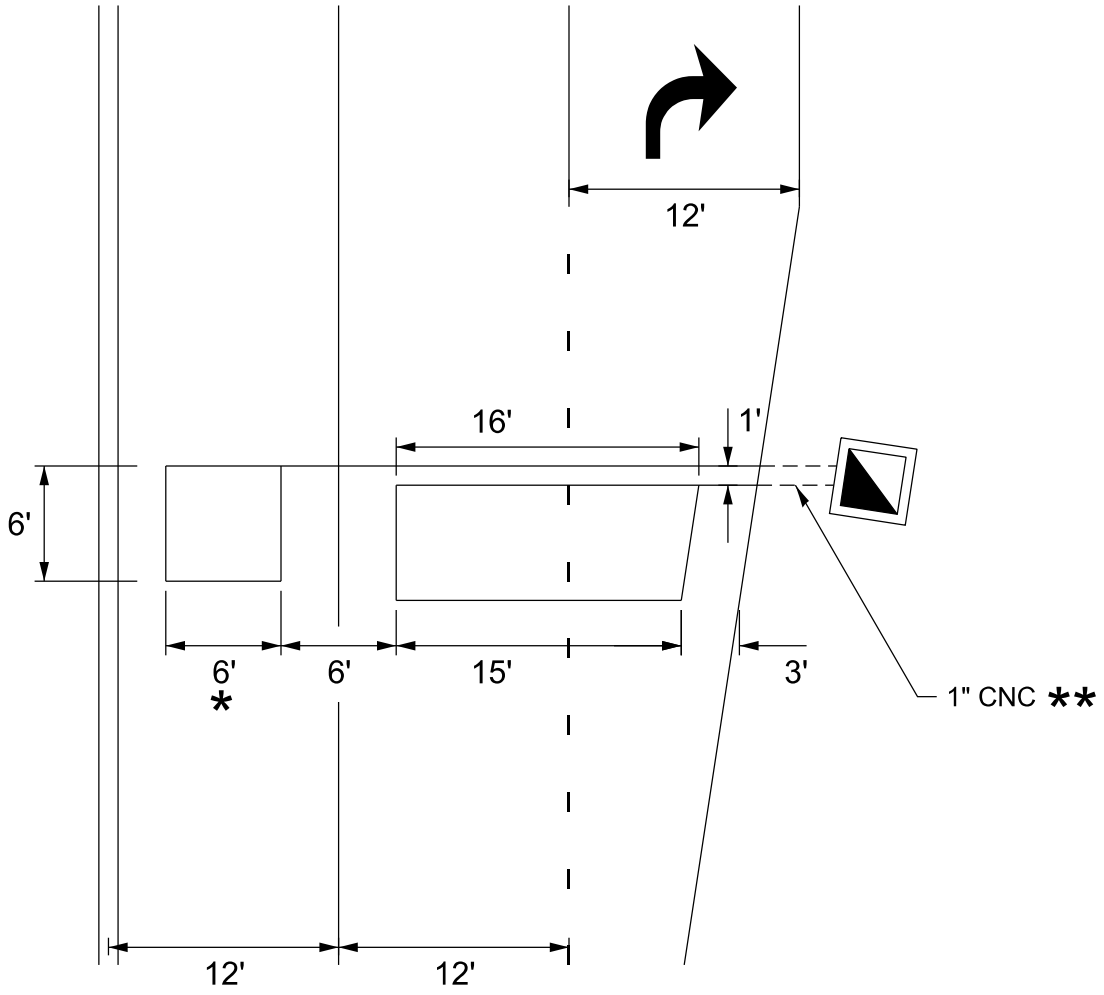
*** EACH DETECTOR LOOP SHALL HAVE ITS OWN 1" COILABLE NON-METALLIC CONDUIT BETWEEN THE EDGE OF PAVEMENT AND THE ADJACENT HANDHOLE. COILLABLE NON-METALLIC CONDUIT IS TO BE SHOWN ON THE PLAN SHEETS BUT NOT INCLUDED IN THE PAY ITEMS.

NOTE: FOR PROTECTED ONLY LEFT TURN PHASING, FOLLOW THE LEFT TURN LANE DETECTOR LOOP LAYOUT SHOWN IN EXAMPLE D-2.

NOTE: THERE SHALL BE A MINIMUM OF 2 FULL DETECTOR LOOPS BEHIND THE STOP BAR.

EXAMPLE B–4

FAR BACK DETECTOR LOOPS WITH RIGHT TURN LANE TAPER

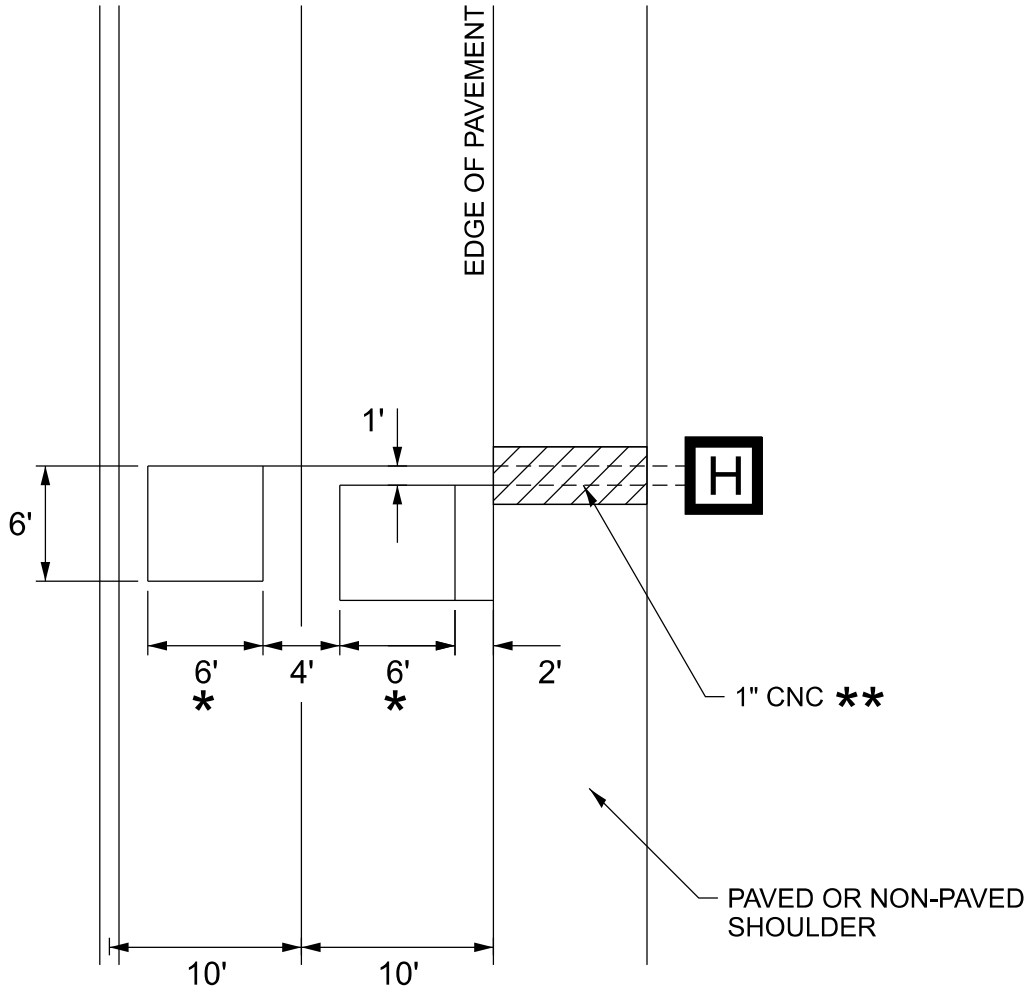


* DETECTOR LOOPS SHALL BE A MINIMUM 6' WIDTH REGARDLESS OF LANE WIDTH.

** EACH DETECTOR LOOP SHALL HAVE ITS OWN 1" COILABLE NON-METALLIC CONDUIT BETWEEN THE EDGE OF PAVEMENT AND THE ADJACENT HANDHOLE. COILLABLE NON-METALLIC CONDUIT IS TO BE SHOWN ON THE PLAN SHEETS BUT NOT INCLUDED IN THE PAY ITEMS.

EXAMPLE B–5

FAR BACK DETECTOR LOOPS NEXT TO SHOULDER

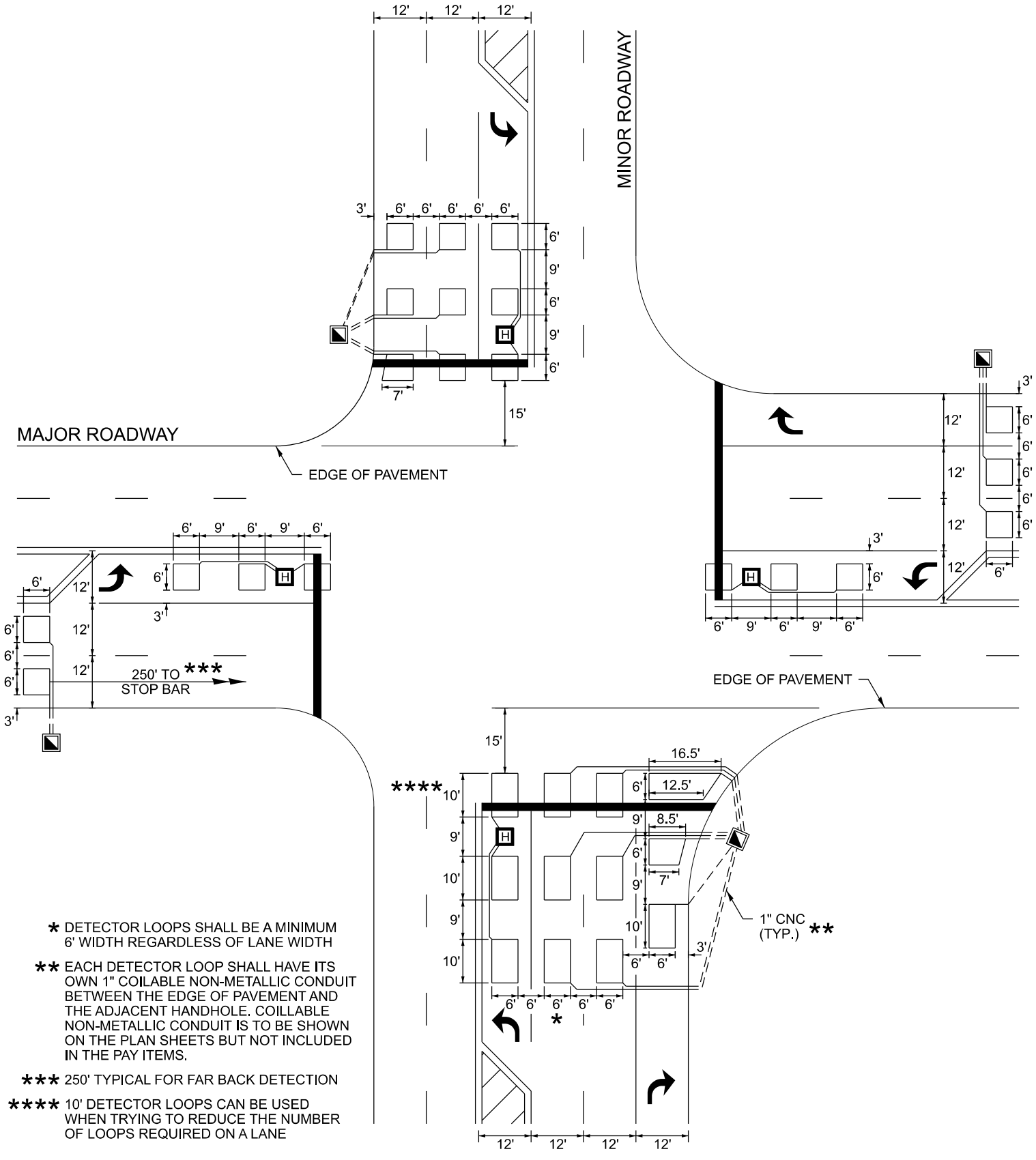


* DETECTOR LOOPS SHALL BE A MINIMUM 6' WIDTH REGARDLESS OF LANE WIDTH.

** EACH DETECTOR LOOP SHALL HAVE ITS OWN 1" COILABLE NON-METALLIC CONDUIT BETWEEN THE EDGE OF PAVEMENT AND THE ADJACENT HANDHOLE. COILLABLE NON-METALLIC CONDUIT IS TO BE SHOWN ON THE PLAN SHEETS BUT NOT INCLUDED IN THE PAY ITEMS.

EXAMPLE B–6

FAR BACK DETECTION ON MAJOR ROADWAY AND
UP-TIGHT DETECTION ON MINOR ROADWAY
PROTECTED-PERMISSIVE LEFT TURN PHASING FOR BOTH ROADWAYS



* DETECTOR LOOPS SHALL BE A MINIMUM 6' WIDTH REGARDLESS OF LANE WIDTH

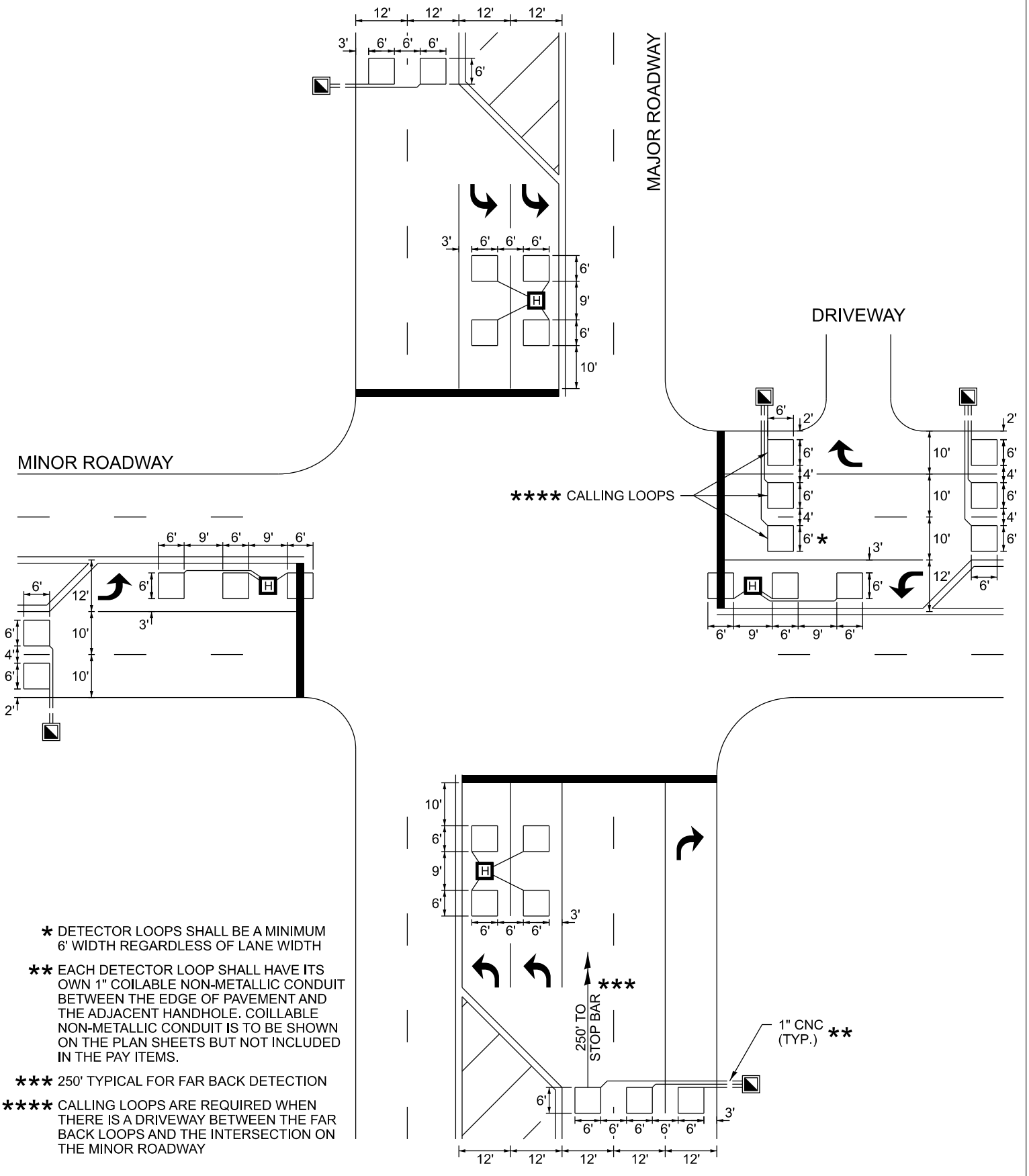
** EACH DETECTOR LOOP SHALL HAVE ITS OWN 1" COILABLE NON-METALLIC CONDUIT BETWEEN THE EDGE OF PAVEMENT AND THE ADJACENT HANDHOLE. COILLABLE NON-METALLIC CONDUIT IS TO BE SHOWN ON THE PLAN SHEETS BUT NOT INCLUDED IN THE PAY ITEMS.

*** 250' TYPICAL FOR FAR BACK DETECTION

**** 10' DETECTOR LOOPS CAN BE USED WHEN TRYING TO REDUCE THE NUMBER OF LOOPS REQUIRED ON A LANE

EXAMPLE B–7

FAR BACK DETECTION ON BOTH ROADWAYS
PROTECTED ONLY LEFT TURN PHASING FOR MAJOR ROADWAY AND
PROTECTED-PERMISSIVE LEFT TURN PHASING FOR MINOR ROADWAY



* DETECTOR LOOPS SHALL BE A MINIMUM 6' WIDTH REGARDLESS OF LANE WIDTH

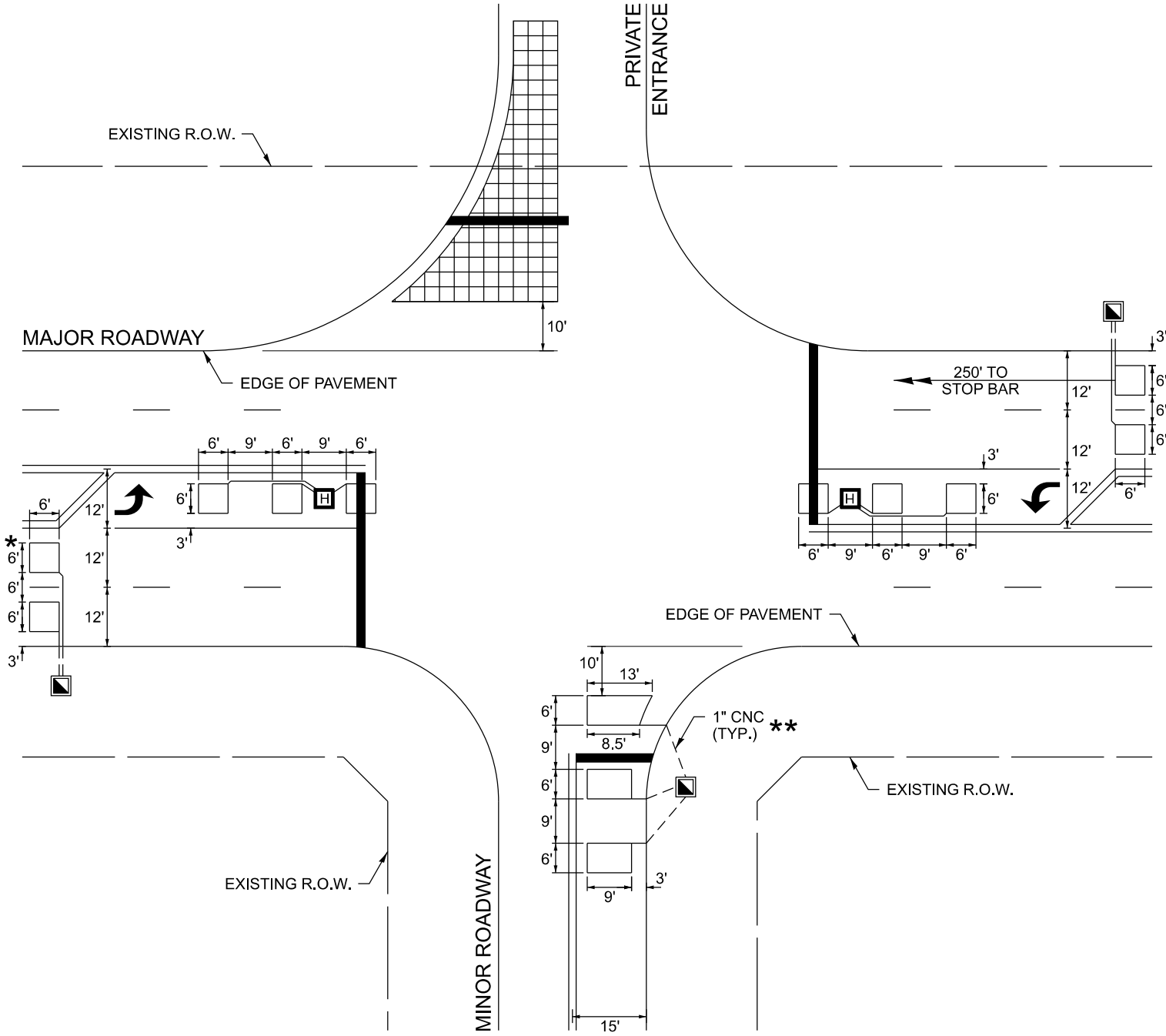
** EACH DETECTOR LOOP SHALL HAVE ITS OWN 1" COILABLE NON-METALLIC CONDUIT BETWEEN THE EDGE OF PAVEMENT AND THE ADJACENT HANDHOLE. COILLABLE NON-METALLIC CONDUIT IS TO BE SHOWN ON THE PLAN SHEETS BUT NOT INCLUDED IN THE PAY ITEMS.

*** 250' TYPICAL FOR FAR BACK DETECTION

**** CALLING LOOPS ARE REQUIRED WHEN THERE IS A DRIVEWAY BETWEEN THE FAR BACK LOOPS AND THE INTERSECTION ON THE MINOR ROADWAY

EXAMPLE B–8

PRIVATE ENTRANCE WITH VIDEO DETECTION



* DETECTOR LOOPS SHALL BE A MINIMUM 6' WIDTH REGARDLESS OF LANE WIDTH

** EACH DETECTOR LOOP SHALL HAVE ITS OWN 1" COILABLE NON-METALLIC CONDUIT BETWEEN THE EDGE OF PAVEMENT AND THE ADJACENT HANDHOLE. COILLABLE NON-METALLIC CONDUIT IS TO BE SHOWN ON THE PLAN SHEETS BUT NOT INCLUDED IN THE PAY ITEMS.