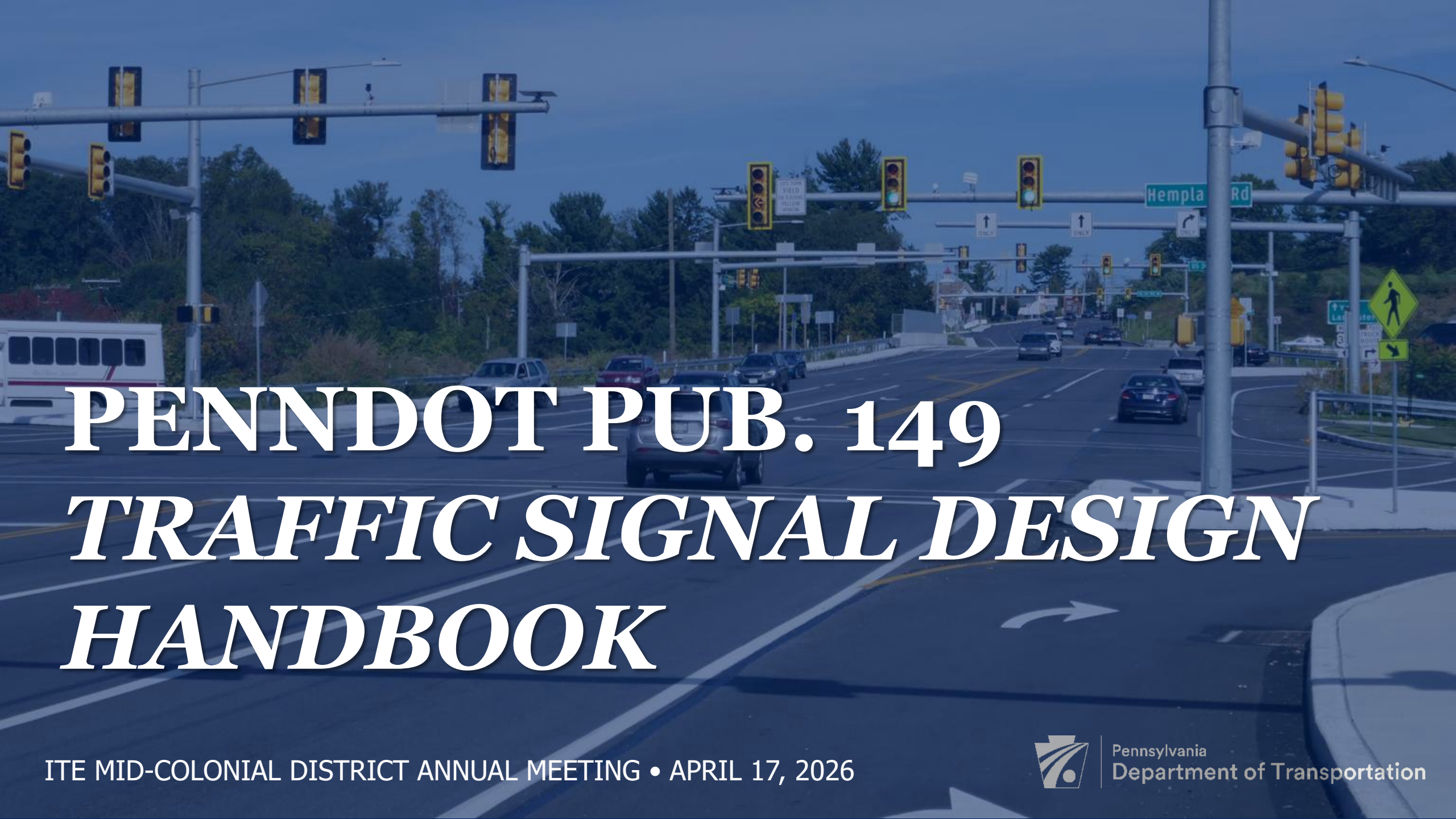


PENNDOT PUB. 149
TRAFFIC SIGNAL DESIGN HANDBOOK

ITE MID-COLONIAL DISTRICT ANNUAL MEETING • APRIL 17, 2026

Pennsylvania
Department of Transportation

SPEAKERS

Chris May

Project Manager – Traffic – Michael Baker International

Dan Fedio

Traffic Signals Supervisor – PennDOT District 11

Steve Gault

TSMO Arterials & Planning Section Chief – PennDOT Central Office

Draft Publication Disclaimer

- Content of Publication 149 is based on addressing comments for Clearance Transmittal Step 2 and submission to FHWA (4/2026)
- The final policy is still subject to change based on FHWA review.

Publication 149 Structure

- 6 parts, 36 chapters
- Part III, Chapters 12-18 align with Pub 408 signal sections (95x)
- Content Disposition Table
  - Content from Pubs 46, 149, 191 and Strike-off Letters
  - Lots of new content, too!

Part	Title	Chapters
I	General	1
II	Design Context – Traffic Control Signals	2-5
III	Design Elements/Criteria – Traffic Control Signals	6-22
IV	Special-Use Traffic Signals	23-29
V	Other Misc. Traffic Signals	30-32
VI	Plans, Specifications & Estimates (PS&E) / Bid Package	33-36

Major Policy Changes

- 6.2: Project Scope
- 8.2: Pedestrian Study
- 9: Bicycles
- 10.3.3: Left Turn Phasing
- 10.4.3: Pedestrian Intervals
- 10.5.3: Emergency Flash
- 16.2: Vehicular Signal Indications
- 18: Adaptive Signal Control Technology (ASCT) Systems
- 19.2: Pavement Markings
- 19.3: Signs
- 30: Flashing Warning Devices
- 33.4: Traffic Signal Plan Sheet Charts & Diagrams

PUBLICATION 149
SIGNING/PAVEMENT MARKINGS (CHAPTER 19)

CHRISTOPHER W. MAY, PE, PTOE – DECEMBER 2025

Pennsylvania
Department of Transportation

PURPOSE

- Why revise Publication 149?
- Where we are specific to signing and pavement markings.
- Where are we headed for signing & pavement markings?
- Key change highlights.

WHERE WE ARE

CHAPTER 13 - PAVEMENT MARKINGS AND SIGNS

13.1 Pavement Markings

Provide pavement markings (such as centerline, channelization, stop lines, crosswalk lines, and lane control markings) as may be required to properly direct and control the flow of vehicular and pedestrian traffic through the signalized intersection.

Pavement markings shall meet the provisions of Publication 35 (a.k.a. Bulletin 15), Publication 46, Publication 111 (TC-8600 Series), Publication 212, and Publication 408.

For additional information consult the MUTCD Part 3, Markings.

13.2 Signs

Signs provide proper direction and control the flow of vehicular and pedestrian traffic through the signalized intersection. Examples of such direction or control include turn prohibition, lane control, one-way, overhead street name, and pedestrian control. Refer to the MUTCD, Part 2, Signs for guidance on selection and placement of signs. All signs shall also meet the provisions of Publication 35 (a.k.a. Bulletin 15), Publication 46, Publication 111 (TC-8700 Series), Publication 212, Publication 236, and Publication 408. Note that the series numbers in Publication 236 supersede those of the MUTCD.

13.3 Illuminated Signs

Illuminated signs may be used where an engineering study shows that reflectorized signs will not provide effective performance or where extraneous light makes it difficult to read reflectorized signs.

The traffic control signal shall be given dominant position and brightness to assure its target priority in the overall display.

Changeable message or blank-out signs may be installed where the message is applicable at specific times.

Internally illuminated street name signs may be used as preferred by the local municipality. Please refer to Publication 408, sections 936 and 1103.

For more information consult the MUTCD, Section 2A.07, Retroreflectivity and Illumination.

WHERE WE ARE

NOTES:

LANE, EDGE AND CENTERLINES

1. MAKE ALL LANE LINES, EITHER SOLID OR BROKEN WHITE, 4" MINIMUM WIDE WHEN ADDITIONAL LANES ARE ADDED TO WHAT IS OTHERWISE A TWO-LANE, TWO-WAY HIGHWAY AND 6" WIDE ON ALL MULTI-LANE HIGHWAYS.
2. LANE LINES ON AN APPROACH TO A SIGNALIZED INTERSECTION SHALL BE SOLID WHITE FOR A DISTANCE OF 150' MEASURED FROM THE STOP BAR.
3. LANE LINES THAT DELINEATE THE EDGE OF A TURNING LANE ARE TO BE SOLID WHITE LINES WITH A LENGTH EQUAL 2X/3, BUT NOT LESS THAN 1/3 THE LENGTH OF THE TURN LANE, MEASURED FROM THE STOP BAR.
4. MAKE EDGE LINES SOLID WHITE LINES 4" WIDE, EXCEPT USE SOLID YELLOW LINES WHEN ADJACENT TO A MEDIAN WHICH SEPARATES OPPOSING DIRECTIONS OF VEHICULAR TRAFFIC FLOW.
5. ON TWO-LANE, TWO-WAY HIGHWAYS, THE CENTER LINES ARE YELLOW, 4" WIDE EITHER SOLID, BROKEN OR A COMBINATION THEREOF. A SOLID BARRIER LINE SHALL PRECEDE ALL CONTROLLED INTERSECTIONS BY THE MINIMUM DISTANCE NOTED IN TABLE A.
6. ON FOUR (4) OR MORE LANE UNDIVIDED HIGHWAYS, FOR CENTER LINES USE THE TWO-WAY BARRIER LINES.
7. "CENTER LANE LEFT TURN ONLY" MARKINGS ARE TWO (2) SETS OF ONE-WAY BARRIER LINES WITH BROKEN YELLOW LINES INSIDE OF THE SOLID YELLOW LINES.
8. EXTEND THE LANE LINES, EDGE LINES AND/OR CENTER LINES A DISTANCE OF 150' FROM THE STOP BAR ON MINOR APPROACHES, WHERE CONDITIONS PERMIT.

STOP LINE

9. STOP LINES ARE SOLID WHITE LINES THAT COMPLETELY TRAVERSE EACH TRAFFIC LANE. AT AN INTERSECTION WITH A STOP SIGN, THE STOP LINE SHOULD BE PLACED AT A LOCATION NO LESS THAN 4', OR MORE THAN 30' FROM THE NEAREST EDGE OF THE INTERSECTING ROADWAY TO ENSURE MAXIMUM SIGHT DISTANCE TO VEHICLES ON THE CROSSING ROUTE. WHEN USED ON MULTI-LANE APPROACH TO A SIGNALIZED INTERSECTION, THE STOP LINE MAY BE STAGGERED TO ASSIST TURNING VEHICLES AND TO IMPROVE SIGHT DISTANCE FOR MOTORIST DESIRING TO MAKE A TURN ON RED.
10. LOCATE STOP LINES AT A MINIMUM OF 4' IN ADVANCE OF AND PARALLEL TO THE CROSSWALK LINES UNLESS OTHERWISE NOTED.

YIELD LINE FOR DETAILS SEE SHEET 5.

11. YIELD LINES ARE TO CONSIST OF A ROW OF SOLID WHITE ISOSCELES TRIANGLES POINTING TOWARD APPROACHING VEHICLES EXTENDING ACROSS APPROACH LANES TO INDICATE THE POINT AT WHICH THE YIELD IS INTENDED OR REQUIRED TO BE MADE.

MEDIAN MARKINGS

12. TRANSVERSE MEDIAN MARKINGS ARE 24" WIDE YELLOW LINES SPACED AS INDICATED ON SHEET 4, WITHIN TWO (2) SETS OF TWO-WAY BARRIER LINES. USE TRANSVERSE LINES ONLY WHEN REQUIRED TO PROVIDE EMPHASIS IF THE SIGHT DISTANCE OR VISIBILITY IS RESTRICTED.

GORE MARKINGS

13. EDGE LINES ARE 4" SOLID WHITE LINES. USE TRANSVERSE OR DIAGONAL LINES ONLY WHEN REQUIRED TO PROVIDE ADDITIONAL EMPHASIS IF THE SIGHT DISTANCE OR VISIBILITY OF GORE IS RESTRICTED.

PAVEMENT LEGENDS

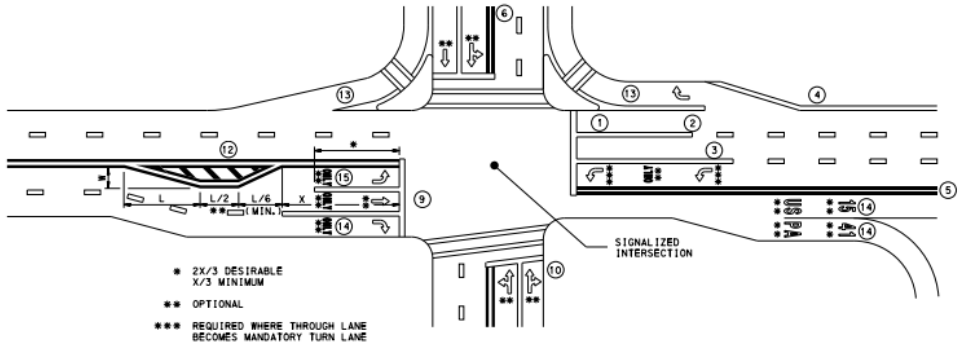
14. WORD AND SYMBOL MARKINGS SHOULD NOT EXCEED THREE LINES OF INFORMATION. IF A PAVEMENT MARKING WORD MESSAGE CONSISTS OF MORE THAN ONE LINE OF INFORMATION, IT SHOULD READ IN THE DIRECTION OF TRAVEL. THE FIRST WORD OF THE MESSAGE SHOULD BE NEAREST TO THE ROAD USER. THE LONGITUDINAL SPACE BETWEEN WORD OR SYMBOL MESSAGE MARKINGS, INCLUDING ARROW MARKINGS, SHOULD BE AT LEAST FOUR TIMES THE HEIGHT OF THE CHARACTERS FOR LOW-SPEED ROADS, BUT NOT MORE THAN TEN TIMES THE HEIGHT OF THE CHARACTERS UNDER ANY CONDITIONS. ON ALL APPROACHES, CENTER THE LEGENDS WITHIN THE LANE.
15. ALIGN THE LEGENDS TRANSVERSELY ACROSS EACH PAVEMENT. THE MINIMUM DISTANCE BETWEEN THE ARROW SYMBOL AND STOP BAR IS 20'.

DOTTED EXTENSION LINES

16. DOTTED EXTENSION LINES MAY BE USED TO DELINEATE TRAVEL PATHS FOR TURNING TRAFFIC MOVEMENTS AT OFFSET, SKEWED OR COMPLEX INTERSECTIONS AND FOR MULTIPLE TURN LANES.

LANE REDUCTION ARROW (LRA)

17. FOR DETAILS SEE SHEET 10.



PLAN

OFFSET TABLE

$L = \frac{WS^2}{60}$	FOR CONVENTIONAL ROADWAYS WHERE THE 85TH PERCENTILE SPEED IS 40 MPH OR LESS
$L = WS$	FOR CONVENTIONAL ROADWAYS WHERE THE 85TH PERCENTILE SPEED IS 45 MPH OR GREATER AND FOR ALL FREEWAYS AND EXPRESSWAYS
WHERE:	S = 85TH PERCENTILE SPEED (MPH) W = OFFSET

X = 25' PER 30 TURNING V.P.H. THE MINIMUM IS 75'

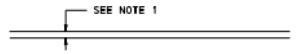
SPEED LIMIT OR 85TH PERCENTILE SPEED (MPH)	DISTANCE (FT)
35 OR LESS	300
40	350
45	400
50	450
55	500

TABLE A
(SEE NOTE 5)

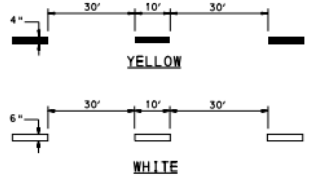
LEGEND

WHITE
YELLOW
DIRECTION OF TRAVEL
③ NOTE REFERENCE NUMBER

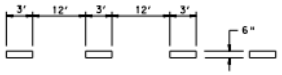
STOP LINE



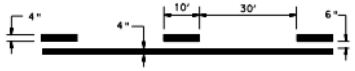
SOLID LANE LINE



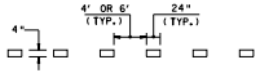
BROKEN LANE LINE



AUXILIARY LANE LINE



ONE-WAY BARRIER LINES
(SEE NOTE 5)



DOTTED EXTENSION LINE

TWO-WAY BARRIER LINES
(SEE NOTE 5)

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUREAU OF MAINTENANCE AND OPERATIONS

PAVEMENT MARKINGS

CONVENTIONAL

RECOMMENDED JUN. 13, 2013 CHIEF, TRAFFIC ENGINEERING AND PERMITS SECTION	RECOMMENDED JUN. 13, 2013 CHIEF, HIGHWAY SAFETY AND TRAFFIC OPERATIONS DIVISION	SHT. 3 OF 13 TC-8600

WHERE ARE WE HEADED

WHERE ARE WE HEADED

19.1 General

A traffic control signal design shall include the necessary pavement markings and signs as may be required to properly direct and control the flow of vehicular and pedestrian traffic through the signalized intersection.

Pavement markings and signing shall meet the provisions listed in the following references:

- ✓ *MUTCD*
  - Pavement Markings (PART 3 Markings)
  - Signs (PART 2 Signs)
- ✓ Publication 46
  - Pavement Markings (Chapter 3)
  - Signs (Chapter 2)
- ✓ Publication 111
  - Pavement Markings (TC-8600)
  - Signs (TC-8700C, TC-8701D & TC-8702 series)
- ✓ Publication 148
  - Signs on signal supports (TC-8801)
  - Ped signs on pedestal supports (TC-8803)
- ✓ Publication 212 (Official Traffic Control Devices)
- ✓ Publication 236 (Sign Handbook)

  Note, that the series numbers in Publication 236 supersede those of the MUTCD.
- ✓ Publication 408
  - Pavement Markings (Sections: 901, 960-965, 1103)
  - Signs (931, 935, 936, 971, 975, 976, & 1103)
- ✓ ECMS Master Items
  - Pavement Markings (0901, 0960, 0961, 0962, 0963, 0964, & 0965)
  - Signs (0931, 0935, 0936, 0971, 0975, & 0976)
- ✓ Publication 35 (Bulletin 15)
- ✓ Form TE-974

WHERE ARE WE HEADED

19.2 Typical Pavement Markings-Signalized Intersection

Pavement markings provide the motorist with guidance so that they remain in the appropriate lane as they approach and travel through an intersection.

The designer should consider the agency responsible for maintaining pavement markings as part of the signal design to avoid including optional markings which are unlikely to be maintained based on the agency's resources or logistics of refreshing the markings.

Traffic signal plans shall include the required pavement markings needed for the signalized intersection design and be shown for at least 150 feet from the stop line. Additional area should be included where auxiliary lanes for the signalized intersection extend further from the intersection.

Section 19.2 clarifies the application of pavement markings at signalized intersections when using the standards from Publication 111, TC-8600.

The typical pavement markings utilized at signalized intersections includes the following:

- ✓ Lane lines (lane, edge, and centerlines)
- ✓ Stop lines
- ✓ Dotted extension lines
- ✓ Crosswalk lines/markings
- ✓ Pavement legends (word & symbol markings)
- ✓ Median & gore transverse markings (when applicable)

The following two Exhibits show typical pavement marking configurations encountered at signalized intersections. **Exhibit 19-1** shows typical configurations for one approach lane and **Exhibit 19-2** shows typical configurations for two approach lanes.

WHERE ARE WE HEADED

19.3 Typical Signs-Signalized Intersection

Traffic control signal plans shall include the required signs needed for the signalized intersection design, which typically include the following (as described in the following sub-sections):

Section 19.3 clarifies the application of signs at signalized intersections when using the standards from Publication 236, Handbook of Approved Signs.

- ✓ Movement Prohibition & Intersection Lane Control Signs
- ✓ Traffic Signal Pedestrian and Bicycle Actuation
- ✓ Traffic Signal Signs *(Signs used to supplement traffic signal control)*
- ✓ No Turn on Red Signs
- ✓ Traffic Signal Warning Signs
- ✓ Pedestrian Signs
- ✓ Street Name Signs
- ✓ Advance Street Name Signs
- ✓ Illuminated Signs *(if needed, this is a special application which applies to one of the above typical signs)*
- ✓ Warning Signs

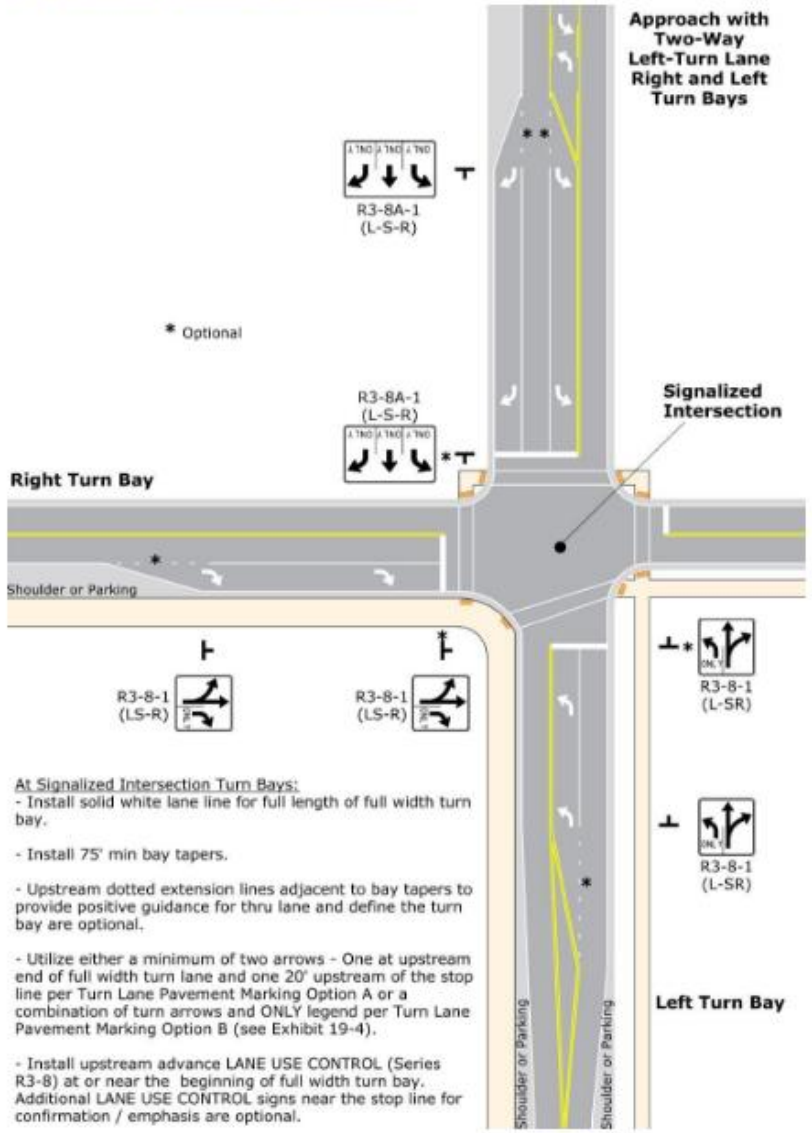
The signs should be the same on the traffic signal construction plan and traffic signal permit plan. Except for projects where the traffic signal is the primary work and no other plan sets are being prepared, other signs should be indicated on a signing and pavement marking plan and tabulated separately. Notes may be included to cross-reference other plan sets including signs in the vicinity of signalized intersections. See **Chapter 33** for more information on traffic signal plan requirements.

Signs at traffic control signals should be official traffic signs listed in Publication 236.

- ✓ The MUTCD contains additional signs which are not approved for use in Pennsylvania.
- ✓ In accordance with 67 Pa. Code §212.101, any custom sign message must be approved by the Chief of the Traffic Engineering & Permits Section in the Bureau of Operations. Custom signs may only include custom messages and may not create custom symbols.

KEY CHANGE HIGHLIGHTS

Exhibit 19-1 Pavement Markings for Signalized Intersection One Approach Lane – Typical Configurations Encountered

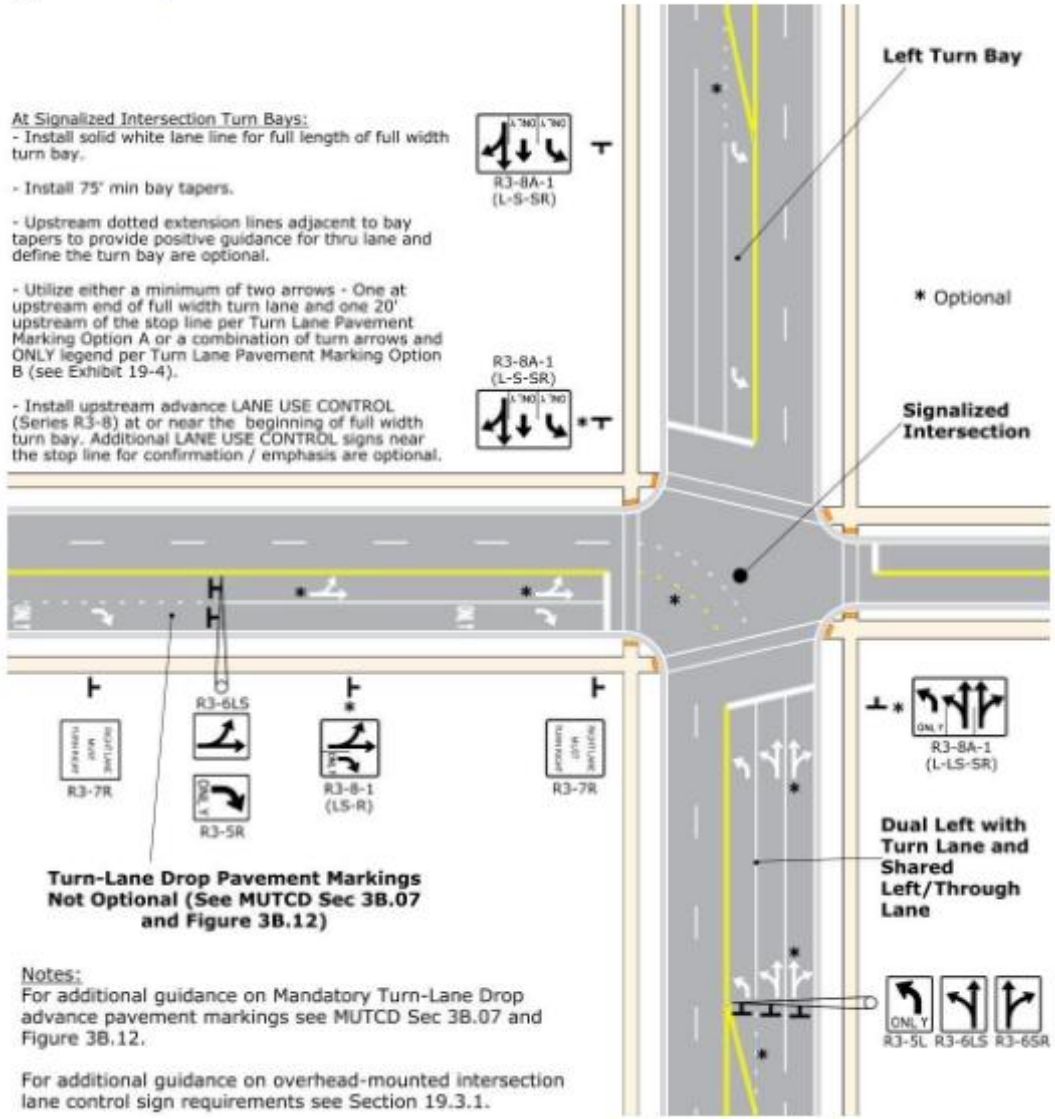


At Signalized Intersection Turn Bays:

- Install solid white lane line for full length of full width turn bay.
- Install 75' min bay tapers.
- Upstream dotted extension lines adjacent to bay tapers to provide positive guidance for thru lane and define the turn bay are optional.
- Utilize either a minimum of two arrows - One at upstream end of full width turn lane and one 20' upstream of the stop line per Turn Lane Pavement Marking Option A or a combination of turn arrows and ONLY legend per Turn Lane Pavement Marking Option B (see Exhibit 19-4).
- Install upstream advance LANE USE CONTROL (Series R3-8) at or near the beginning of full width turn bay. Additional LANE USE CONTROL signs near the stop line for confirmation / emphasis are optional.

KEY CHANGE HIGHLIGHTS

Exhibit 19-2 Pavement Markings for Signalized Intersection Two Approach Lanes – Typical Configurations Encountered



KEY CHANGE HIGHLIGHTS

Exhibit 19-3 Pavement Lines

Line			References	
Type	**Color**	**Minimum Width (in.)**	**Pub 111**	**MUTCD[1]**
Longitudinal Markings[2]				
Edge Line	White	4	TC-8600 Sheets 3 & 4	3B.09, 3B.12
Edge Line	Yellow	4		
Solid Lane Line	White	6		3B.06
Broken Lane Line	White	6		3B.06
Centerline (Two-way barrier lines)	Yellow	4		3B.01
Dotted Extension Line	White	6 (turn bay taper)		3B.06
Auxiliary Lane Line (Wide dotted lane line)	White	12		3B.07
Transverse Markings[3]				
Stop Line	White	24	TC-8600 Sheets 3 & 4	3B.19
Dotted Extension Line	White	6 (lane line)		3B.11
Dotted Extension Line	Yellow	4 (centerline)		

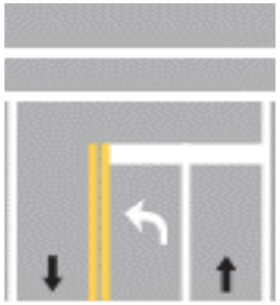
[1]MUTCD 3A.04 provides general information on the functions, widths and patterns of longitudinal pavement marking lines.
[2]Longitudinal markings run in the direction of travel.
[3]Transverse markings are those which run perpendicular to direction of travel. Dotted extension lines connecting lanes through the intersection are considered transverse markings since they are crossed by vehicles.

See the following sub-sections for further information on each line type.

KEY CHANGE HIGHLIGHTS

Stop Lines

Stop lines which are 24 inches wide shall be used to indicate the point behind which vehicles are required to stop in compliance with a traffic control signal. A stop line shall extend over the entire width of each lane on an approach.



Stop lines when used on a multi-lane approach to a signalized intersection may be staggered to assist turning vehicles and to improve sight distance for motorist desiring to make a turn on red.

The stop line shall be no less than 4 feet from the nearest edge of the intersecting roadway and any crosswalk markings.

If the right turn on red movement is allowed, the stop line should be no more than 30 feet from the nearest edge of the intersecting roadway to ensure maximum sight distance.

Stop lines should be placed considering turning paths of the largest expected design vehicle. The stop line may be located further from the intersecting roadway when necessary to accommodate large vehicle turning movements.

KEY CHANGE HIGHLIGHTS

Lane Use Arrows and ONLY Word Markings

Pavement legends approaching signalized intersections include lane-use arrow markings and ONLY word markings. In general, the number of markings should be the minimum necessary to provide positive guidance for lane control due to ongoing maintenance costs for the signal owner.

At exclusive turn lanes (bays), **Exhibit 19-4** provides two options (A or B) for installing required pavement markings; designers must select either Option A or B. Intersection lane control signs (see **Section 19.3.1)** shall accompany these pavement markings as shown in **Exhibit 19-4.**

- ✓ Option A (Arrows) – provides the minimum number of required lane-use arrows and distances for various turn bay lengths, or
- ✓ Option B (Arrow/ONLY combination) – provides the minimum number of arrow/ONLY combinations and distances for various turn bay lengths. The ONLY word pavement marking shall be located upstream of the lane-use arrow marking.

For lane drops, the ONLY word pavement marking shall be used (see **Section 19.4.4**).

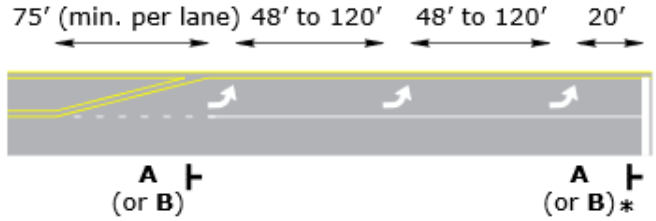
While use of lane-use arrow markings for straight through lanes is optional, they should be considered for through lanes adjacent to lane drops or other geometric conditions where additional direction may be beneficial to the driver. See **Section 19.4.4** for application of pavement markings at lane drops.

KEY CHANGE HIGHLIGHTS

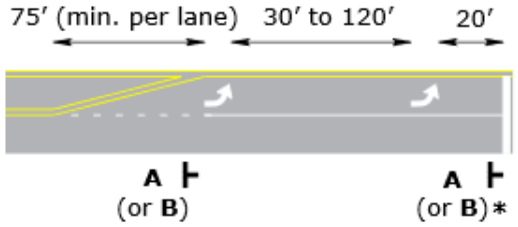
Exhibit 19-4 Lane Use Arrows and ONLY Word Markings for Various Turn Bay Lengths

Option A: Turn Lane Arrows

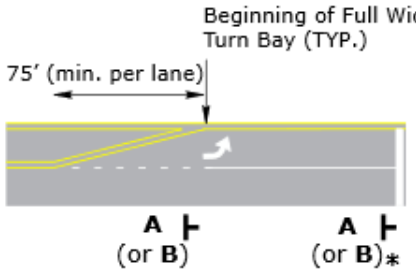
Turn Bay > 164 ft.
Minimum Three Arrows



Turn Bay 75 ft. – 164 ft.
Minimum Two Arrows

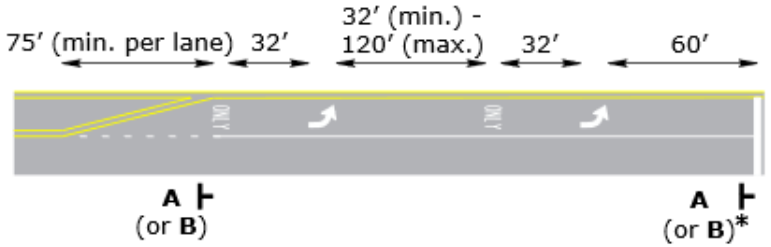


Turn Bay < 75 ft.
Minimum One Arrow

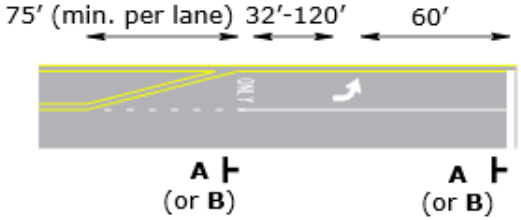


Option B: Arrow/Only Combinations

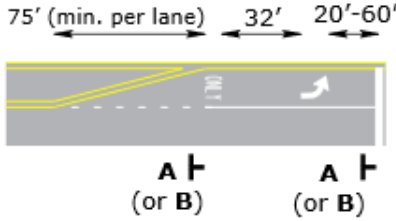
Turn Bay > 200 ft.
Minimum Two ONLY/ARROW Combination



Turn Bay 112 ft. – 200 ft.
One ONLY/ARROW Combination



Turn Bay < 112 ft.
One ONLY/ARROW Combination



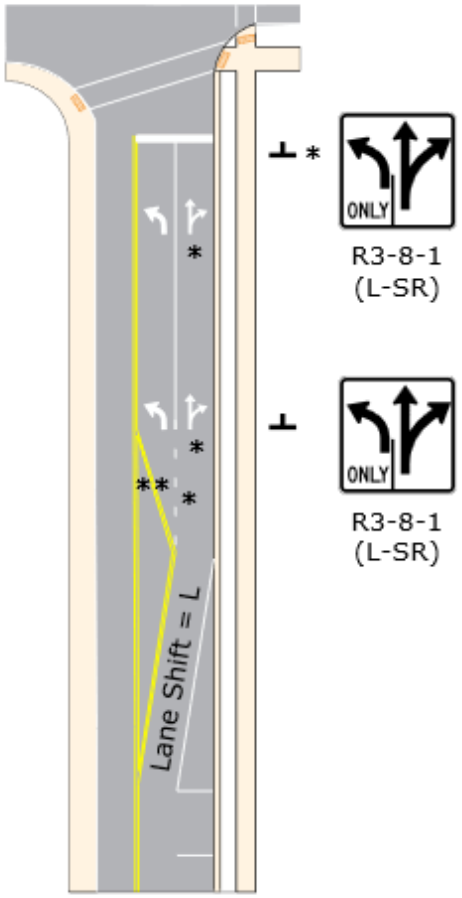
* Optional

⊢ Install R3-8-1 (**A**) or R3-8A-1 (**B**) lane use control sign matching actual lane configuration.

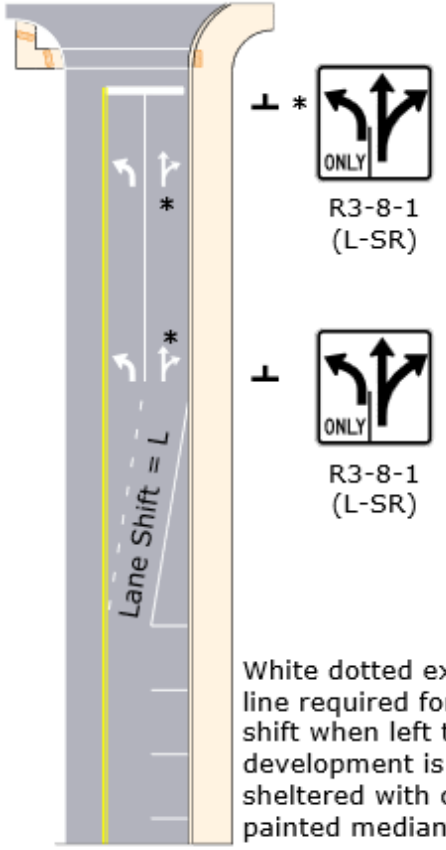
KEY CHANGE HIGHLIGHTS

Exhibit 19-25 Eliminating Parking for Auxiliary Lanes - Typical Applications

A – Elimination of Parking for Development of Fully Sheltered Left Turn Lane

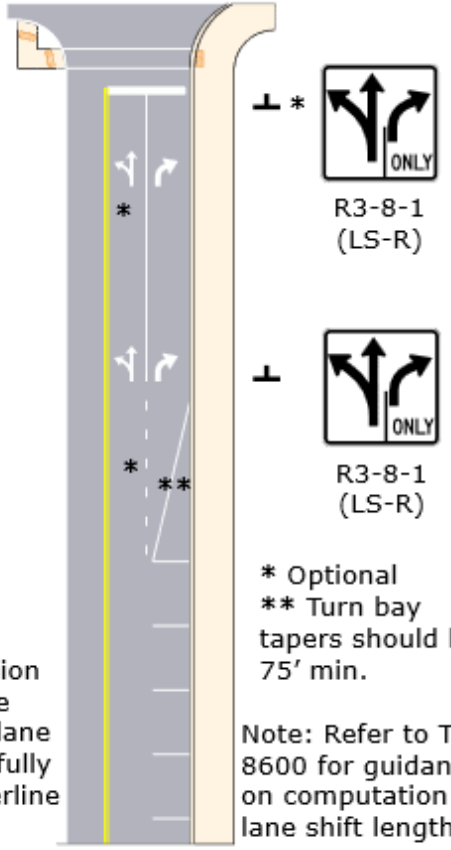


B – Elimination of Parking for Development of Unsheltered Left Turn Lane
(Urban ≤ 25 mph approaches with curbside parking only)



White dotted extension line required for lane shift when left turn lane development is not fully sheltered with centerline painted median.

C – Elimination of Parking for Development of Right Turn Lane

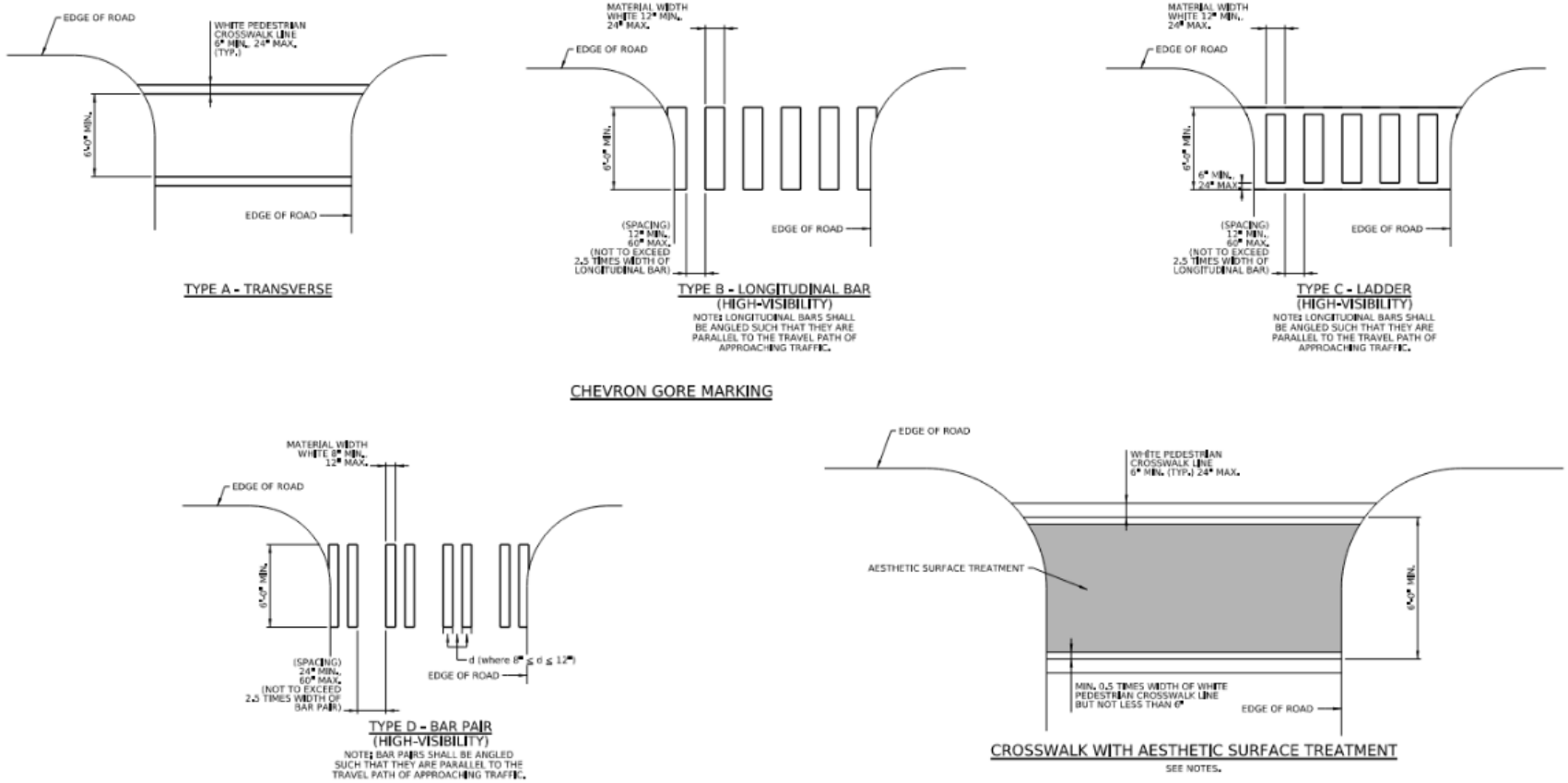


* Optional
** Turn bay tapers should be 75′ min.

Note: Refer to TC-8600 for guidance on computation of lane shift length L.

KEY CHANGE HIGHLIGHTS

Exhibit 19-5 Crosswalk Types



KEY CHANGE HIGHLIGHTS

Movement Prohibition Signs

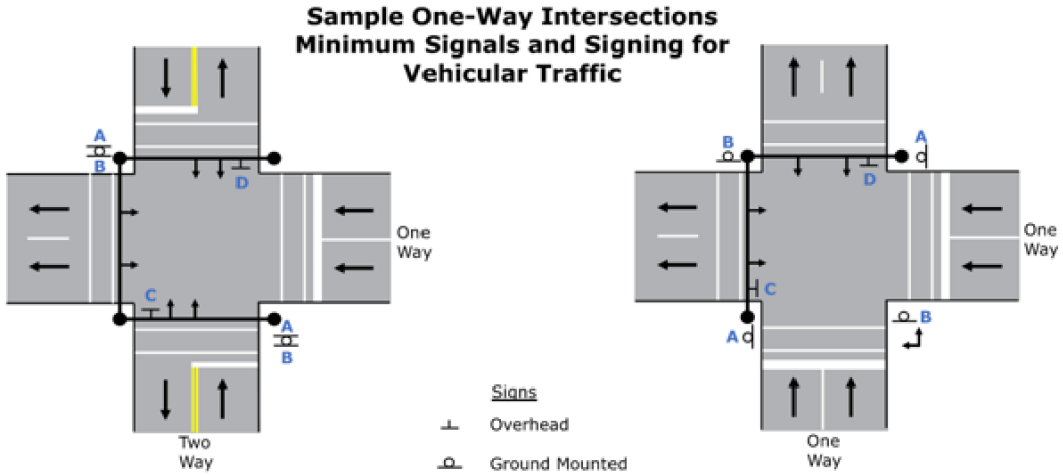
Where specific movements are prohibited, Movement Prohibition signs shall be installed, except No Left Turn and No Right Turn signs may be omitted where ONE WAY signs are mounted overhead near the appropriate signal faces.

When used with overhead traffic signals, No Right Turn (R3-1), No Left Turn (R3-2), and No U-Turn (R3-4) signs, should be installed adjacent to the overhead signal face closest to the direction of the prohibited movement. A second No Right Turn (R3-1) or No Left Turn (R3-2) sign shall also be installed (post mounted) at the near right-hand corner of the intersection. Additional post-mounted signs may be installed to reinforce the movement prohibition.

An auxiliary sign with the same turn prohibition message may be used in advance of the intersection.

See **Exhibit 19-6** for sample one-way intersections with minimum number of signals and signing for vehicular traffic.

Exhibit 19-6 Sample One-Way Intersections Minimum Signals & Signing for Vehicular Traffic



Sign A	Sign B	Sign C	Sign D
R6-1R or R6-2R	R6-1L or R6-2L	R6-2R	R6-2L
ONE WAY or ONE WAY	ONE WAY or ONE WAY	ONE WAY	ONE WAY

KEY CHANGE HIGHLIGHTS

Turn-Related Signs

The following turn-related signal signs in **Exhibit 19-11** may be installed as indicated in this section.

Exhibit 19-11 Turn-Related Signal Signs

R10-12 R10-12A R10-10L

A Left Turn Yield On Green (R10-12) sign shall be installed adjacent to a shared signal face used for protected/permissive left turn phase operation where permissive left-turn movements occur during the display of a circular green (see **Exhibit 16-14 B** and **C**).

A Left Turn Yield on Flashing Yellow Arrow (R10-12A) sign may be installed adjacent to a signal face which includes a flashing yellow arrow (FYA) display (see **Exhibit 16-14A**).

The Left Turn Signal (R10-10L) sign should not be used when the separate left-turn signal face contains all left arrow indications.

Prior to the 2009 MUTCD, a circular red indication was allowed for separate left-turn signal faces. These installations should be upgraded to comply with the current MUTCD by replacing the circular red indication with a red arrow indication. Where the circular red indication from a pre-2009 installation remains in use in a separate left-turn signal face, the Left Turn Signal (R10-10L) sign shall be used on approaches where other signal faces may display green or yellow indications while the circular red indication is illuminated for the left turning movement.

The Right Turn Signal (R10-10R) sign shall not be used. Existing Right Turn Signal signs should be removed whenever signal permits are revised. The Right Turn Signal sign is only used in cases where the right turn signal face would display a circular red at the same time when the adjacent through signal faces would not display circular red. A red arrow indication should be used instead. It is noted that right turn on red is allowed in Pennsylvania when a red arrow indication is used.

KEY CHANGE HIGHLIGHTS

19.3.6 Illuminated Signs

Illuminated signs may be used where an engineering study shows that reflectorized signs will not provide effective performance or where extraneous light makes it difficult to read reflectorized signs. Therefore, an illuminated sign is a special application to a typically required sign at a signalized intersection.

Designers should be aware that use of internally illuminated signs carry additional maintenance requirements and costs to keep these type signs operating and functioning properly. Since illuminated signs are not retroreflective and cannot be seen if the internal illumination fails, prompt maintenance of the illumination is necessary. While such signs are allowed, the traffic signal permittee should be made aware of the additional maintenance requirements, and potential liability, if internally illuminated signs are not maintained on a timely schedule per Publication 191. In most situations, a retroreflective sign is sufficient and has both lower installation and maintenance costs.

The sign display message character color, dimensions, and layout must be in accordance with Publication 236 and the MUTCD.

The traffic control signal shall be given dominant position and brightness to assure its target priority in the overall display.

Internally Illuminated signs are referenced in Publication 408, Section 1103.03(g).

Exhibit 19-19 Illuminated Street Name Sign

KEY CHANGE HIGHLIGHTS

19.3.7 Blank Out Signs

A "blank-out" sign is a sign that displays a single predetermined message only when activated. When not activated, the sign legend is not visible.

As such, the size of a blank-out sign's legend elements, overall sign size, and sign placement should comply with the applicable provisions for the conventional version of the sign in Publication 236 and the MUTCD.

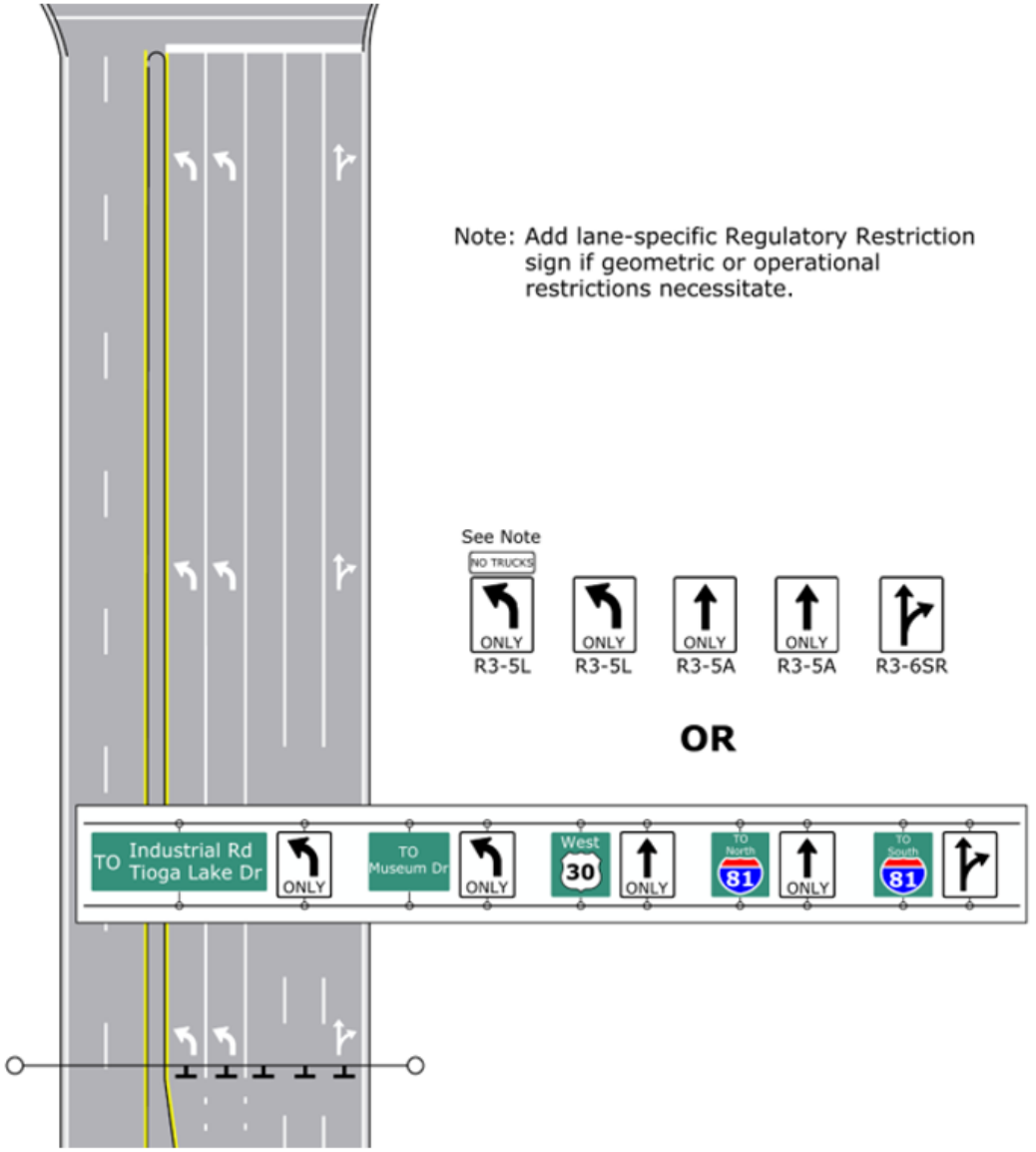
Blank-out signs used as part of a traffic signal design must operate in coordination with the signal controller so that the sign is only ON (illuminated) when the specific condition for the sign message applies.

Examples of where blank-out signs may be applicable and beneficial with respect to traffic signals are:

- ✓ Light Rail Transit Approaching (W-10-7 activated blank-out sign) (MUTCD Section 8B.17).
- ✓ Preemption of highway traffic signals at or near grade crossings (MUTCD Section 8D.09).
- ✓ Movement prohibitions during preemption (R3-1a & R3-2a activated blank-out signs) (MUTCD Section 8D.10).
- ✓ Movement prohibitions during specific traffic signal phases (MUTCD Sections 2B.26 & 2B.60).
- ✓ Traffic signal signs (MUTCD Sections 2B.59 & 2C.44).
- ✓ Advance warning on approaches to traffic signals with restricted line-of-sight, sight distance (MUTCD Section 2C.35). See **Section 19.3.8** and **Chapter 22**.

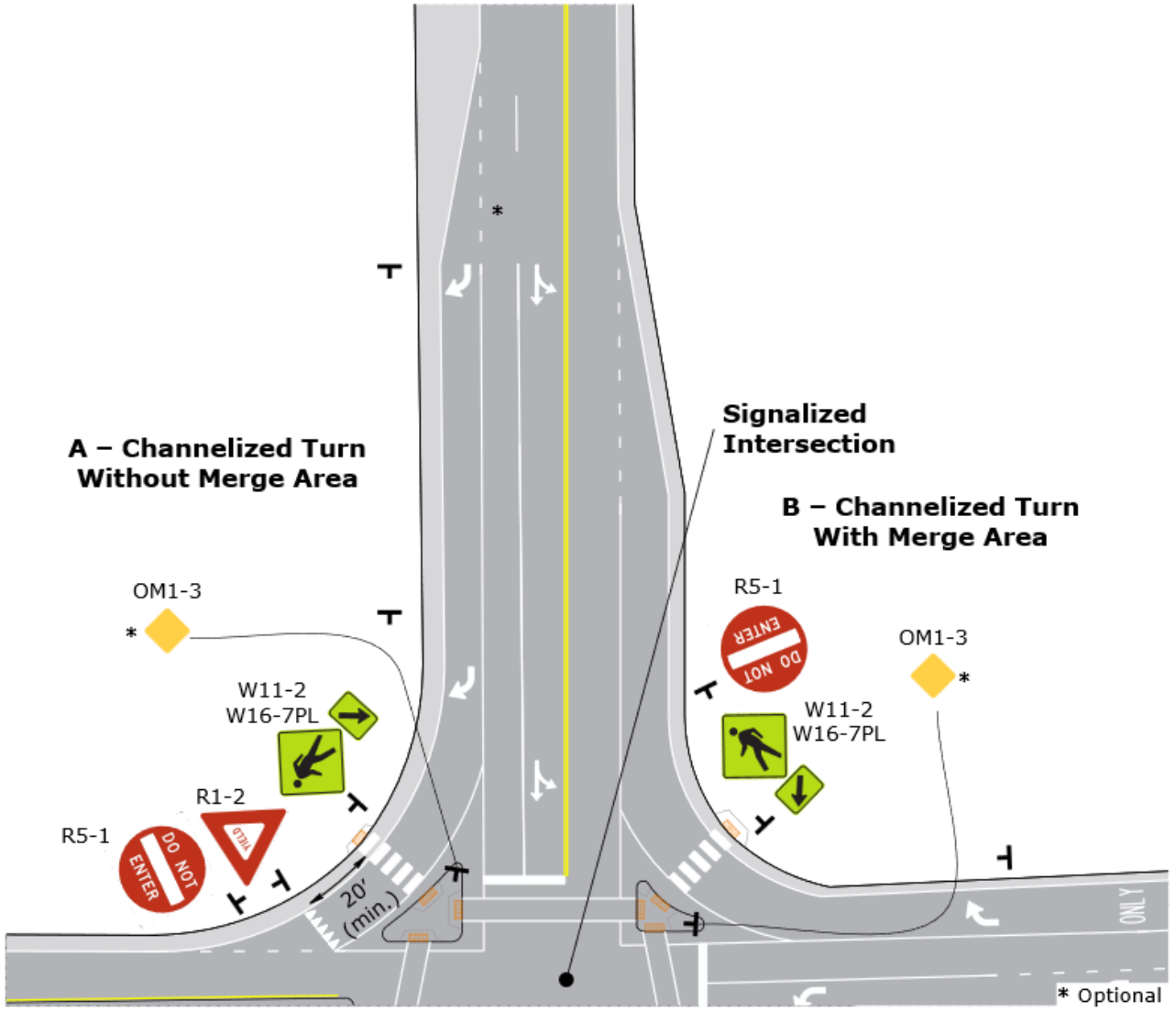
KEY CHANGE HIGHLIGHTS

Exhibit 19-21 Overhead Lane Control Sign Options & Typical Applications



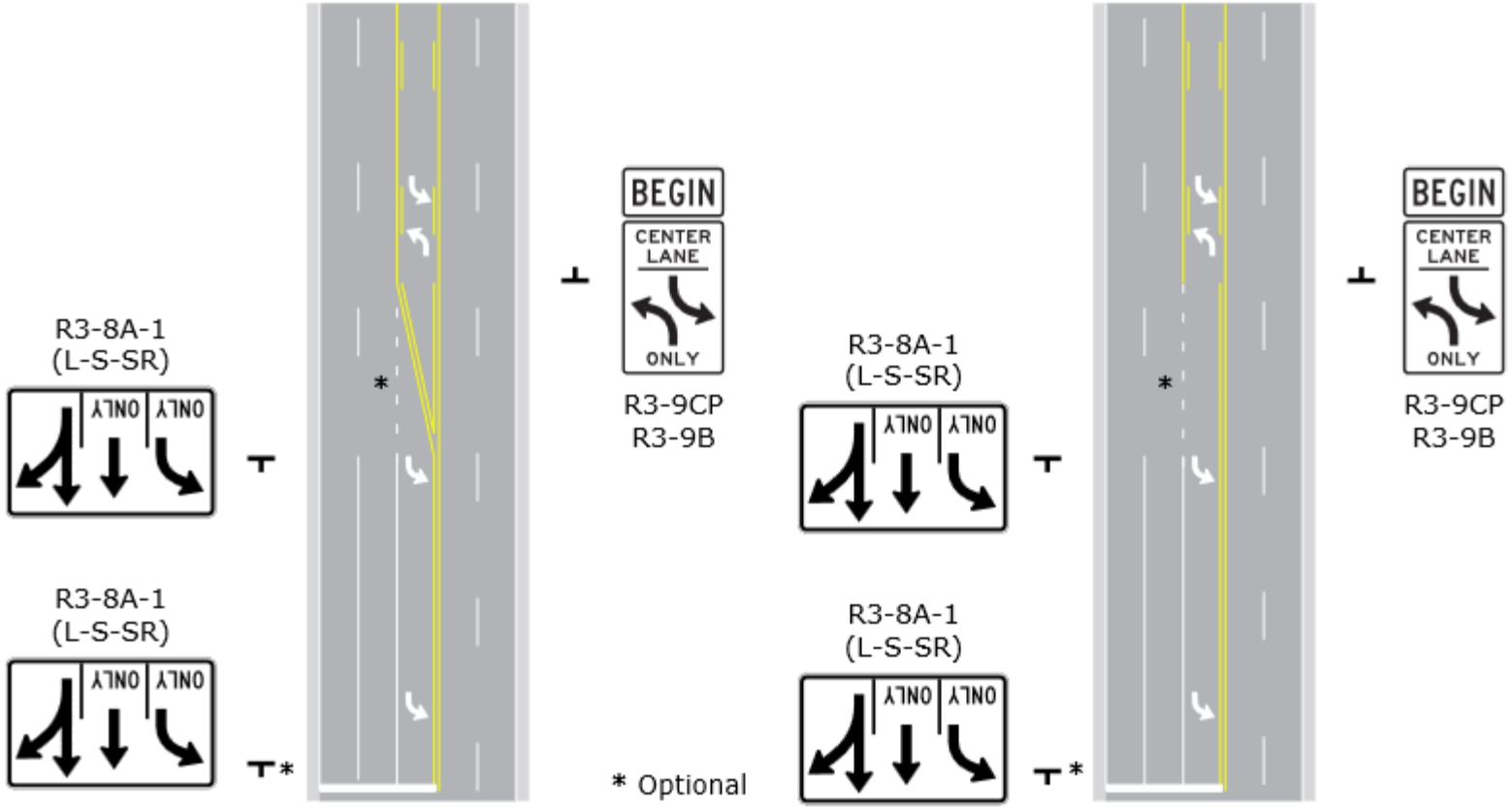
KEY CHANGE HIGHLIGHTS

Exhibit 19-22 Channelized Right-Turn Yield Typical Applications



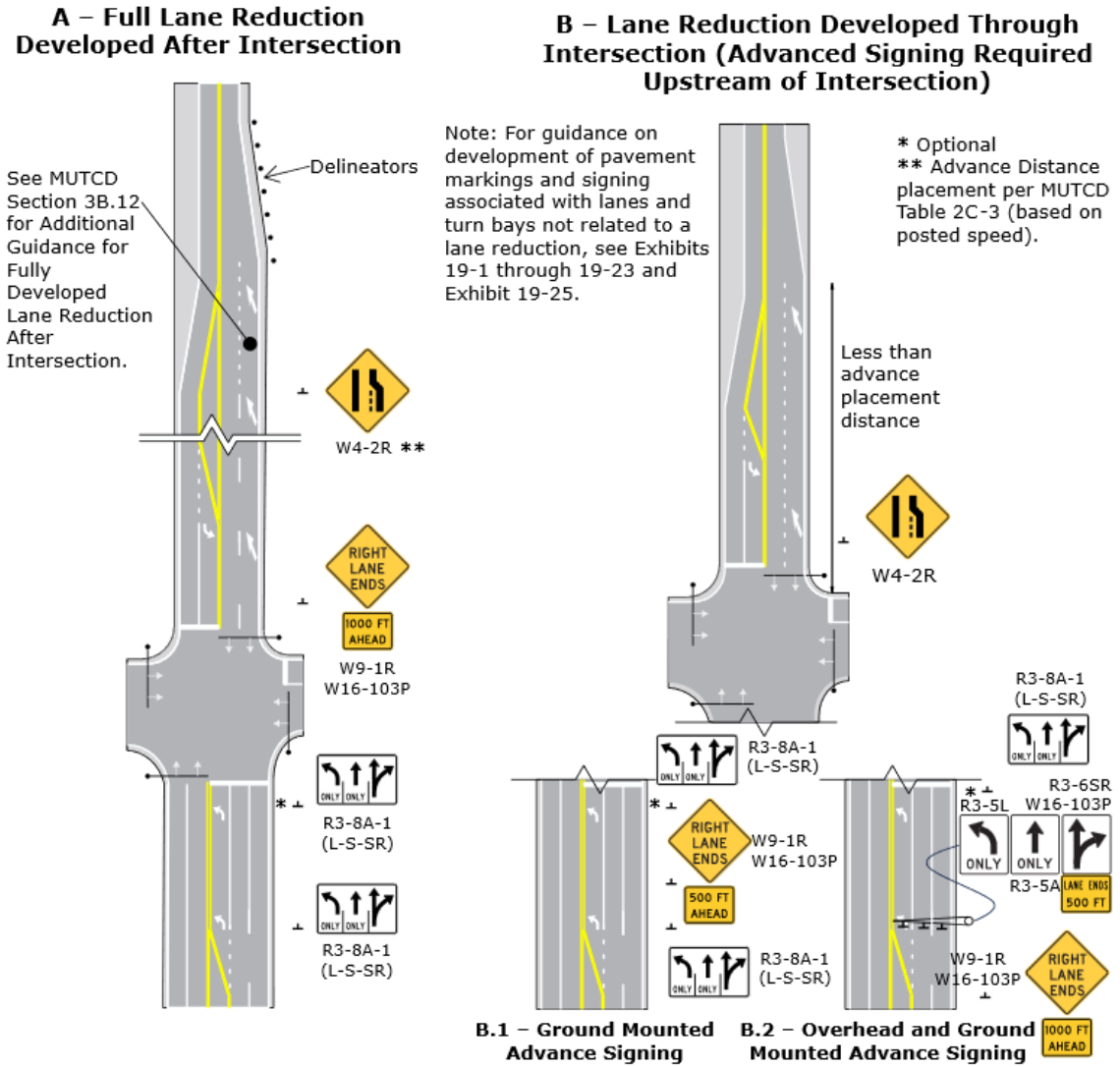
KEY CHANGE HIGHLIGHTS

Exhibit 19-23 Transition from Two-Way Center Left Turn Lane to Exclusive Turn Lane Typical Applications



KEY CHANGE HIGHLIGHTS

Exhibit 19-24 Lane Reductions Typical Applications



QUESTIONS?

MST CHART CHANGES

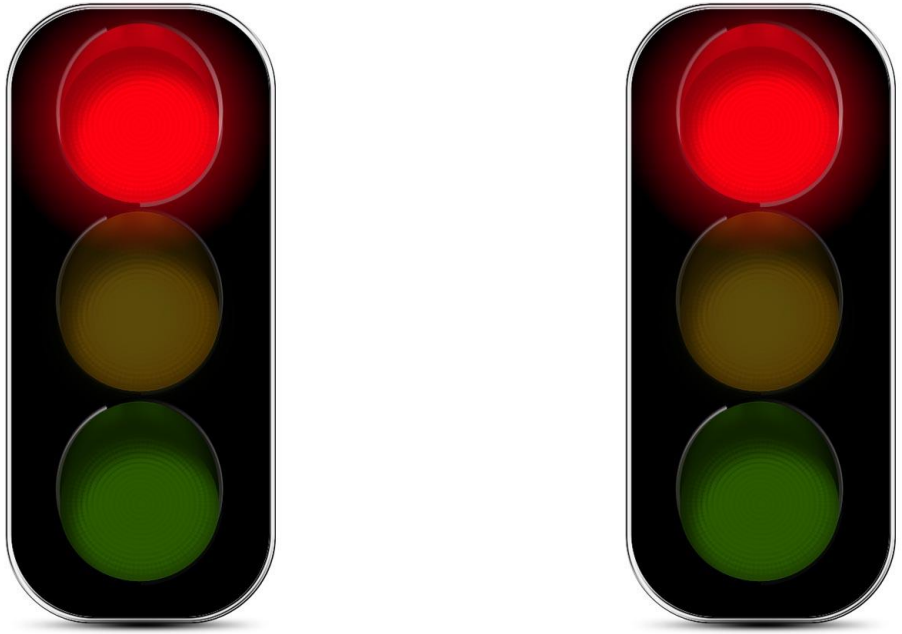
(MOVEMENT, SEQUENCE, AND TIMING)
FOR TRAFFIC SIGNALS

DAN FEDIO
PENNDOT D-11
TRAFFIC SIGNAL SUPERVISOR

Pennsylvania
Department of Transportation

What is an MST Chart?

Shows how a Traffic Signal operates.



MST CHART

Current
Format

Current
Issues

Proposed
Format

MST CHART

Current
Format

Current
Issues

Proposed
Format

MST CHART

Current
Format

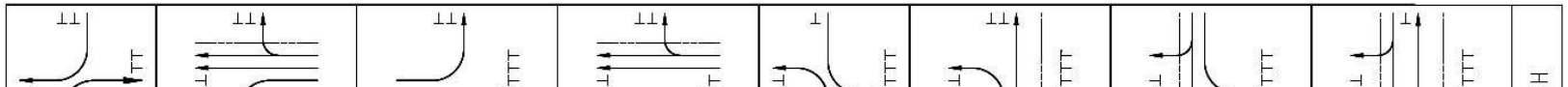
Current
Issues

Proposed
Format

MST CHART CURRENT FORMAT

Example:

MOVEMENT, SEQUENCE, AND TIMING DIAGRAM



PHASE	1+5			1+6				2+5				2+6				3+7			3+8				4+7				4+8				FLASH
INTERVAL / SIGNAL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1	G	Y(1)	R(1)	G	G	Y	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
2,3	R	R	R	G	G	Y(2)	R(2)	R	R	R	R	G	G	Y(7)	R(7)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Y
4	G	Y(3)	R(3)	R	R	R	R	G	G	Y	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
5,6	R	R	R	R	R	R	R	G	G	Y(2)	R(2)	G	G	Y(8)	R(8)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Y
7	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	Y(4)	R(4)	G	G	Y	R	R	R	R	R	R	R	R	R	R
8,9	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	G	Y(5)	R(5)	R	R	R	R	G	G	Y	R	R
10	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	Y(6)	R(6)	R	R	R	R	G	G	Y	R	R	R	R	R	R
11,12	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	G	Y(5)	R(5)	G	G	Y	R	R
13,14	H	H	H	M	FH(9)	H(9)	H(9)	H	H	H	H	M	FH	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	OFF
15,16	H	H	H	H	H	H	H	M	FH(9)	H(9)	H(9)	M	FH	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	OFF
17,18	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	M	FH(10)	H(10)	H(10)	M	FH	H	H	OFF
19,20	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	M	FH(10)	H(10)	H(10)	H	H	H	H	M	FH	H	H	OFF

FIXED		3	3			4	2			4	2			4	2		3	4			4	3			4	3			4	3
MINIMUM	3			3				3				15				3			3				3				3				
SEC / ACT												1.5																			
MAX INITIAL												24																			
PASSAGE	3			3				3				1**				3			3				3				3				
MAX 1	12			12				12				29				11			11				11				22				
MAX 2																															
PEDESTRIAN *				(11)				(11)				7	16						(12)				(12)				7	20			
MEMORY	NL			NL				NL				MN				NL			NL				NL				NL				

MST CHART CURRENT FORMAT

What does it show?

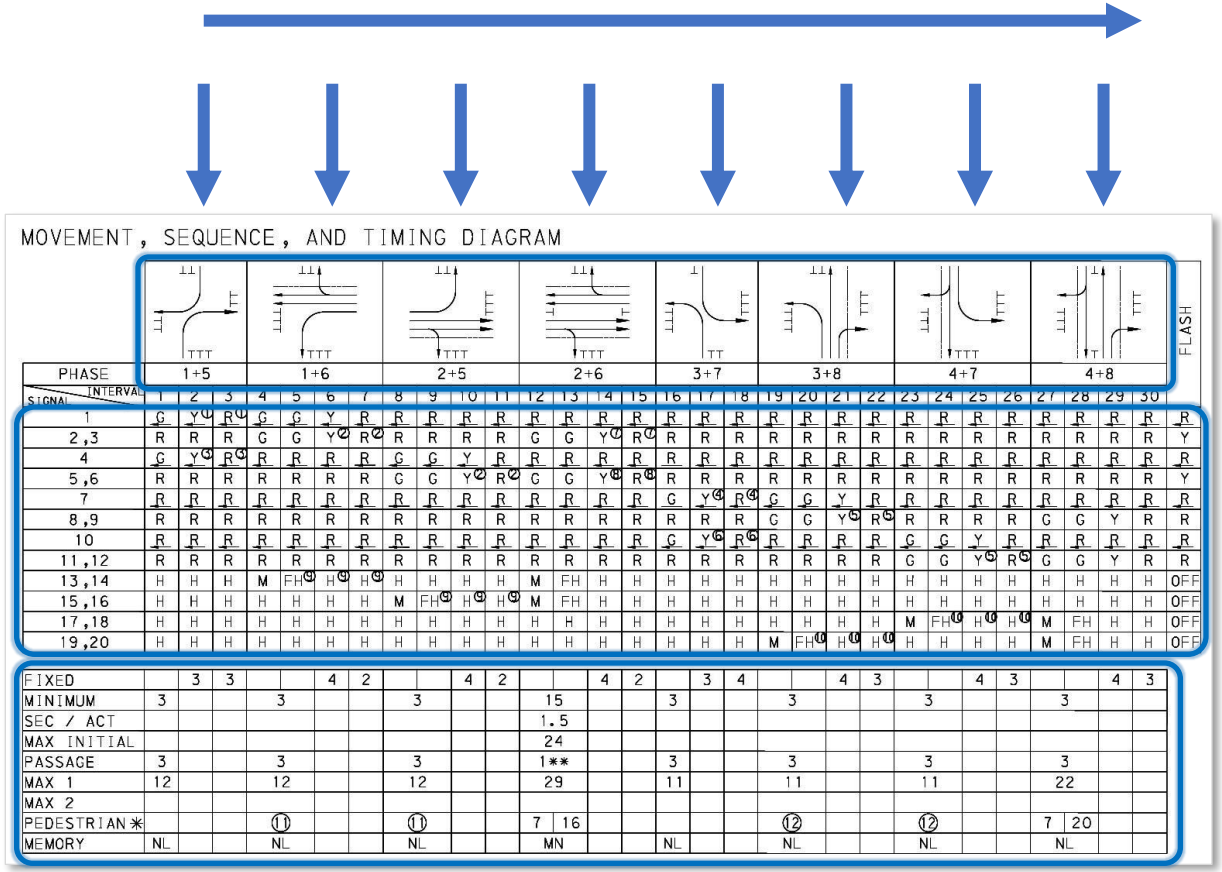
Vehicular and Pedestrian Movements and Phases.

All possible phase combinations.

Order of the phase combinations.

Signal indications
for each combination of phases.

Timings and phase settings
for each combination of phases.



In use for 50+ years.

MST CHART CURRENT FORMAT

MST CHART ISSUES

Signal Timings:

Phase Settings:

Format Compatibility:

MST CHART ISSUES

Signal Timings:

Not all timings are shown.
Overlaps, Preemption, & Railroad.

Cannot show *individual* phase timings.

Phase Settings:

Timings can be misinterpreted.

Does not show what each signal indication is controlled by.
Phase or Overlap.

Format Compatibility:

Incorrectly shows the YELLOW and RED times of left turns.

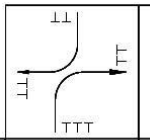
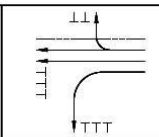
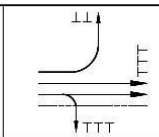
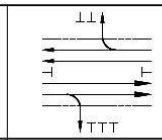
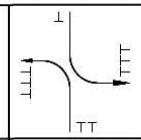
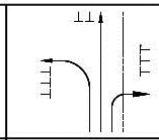
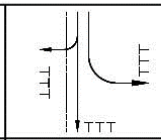
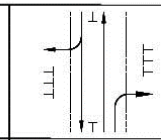
MST CHART ISSUES

Signal Timings:

Phase Settings:

Format Compatibility:

MOVEMENT, SEQUENCE, AND TIMING DIAGRAM

PHASE	1+5			1+6				2+5				2+6				3+7			3+8				4+7				4+8				FLASH
INTERVAL / SIGNAL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1	G	Y①	R①	G	G	Y	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
2,3	R	R	R	G	G	Y②	R②	R	R	R	R	G	G	Y⑦	R⑦	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Y
4	G	Y③	R③	R	R	R	R	G	G	Y	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
5,6	R	R	R	R	R	R	R	G	G	Y②	R②	G	G	Y⑧	R⑧	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	Y
7	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	Y④	R④	G	G	Y	R	R	R	R	R	R	R	R	R	R
8,9	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	G	Y⑤	R⑤	R	R	R	R	G	G	Y	R	R
10	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	Y⑥	R⑥	R	R	R	R	G	G	Y	R	R	R	R	R	R
11,12	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	G	Y⑤	R⑤	G	G	Y	R	R
13,14	H	H	H	M	FH⑨	H⑨	H⑨	H	H	H	H	M	FH	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	OFF
15,16	H	H	H	H	H	H	H	M	FH⑨	H⑨	H⑨	M	FH	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	OFF
17,18	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	M	FH⑩	H⑩	H⑩	M	FH	H	H	OFF
19,20	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	M	FH⑩	H⑩	H⑩	H	H	H	H	M	FH	H	H	OFF

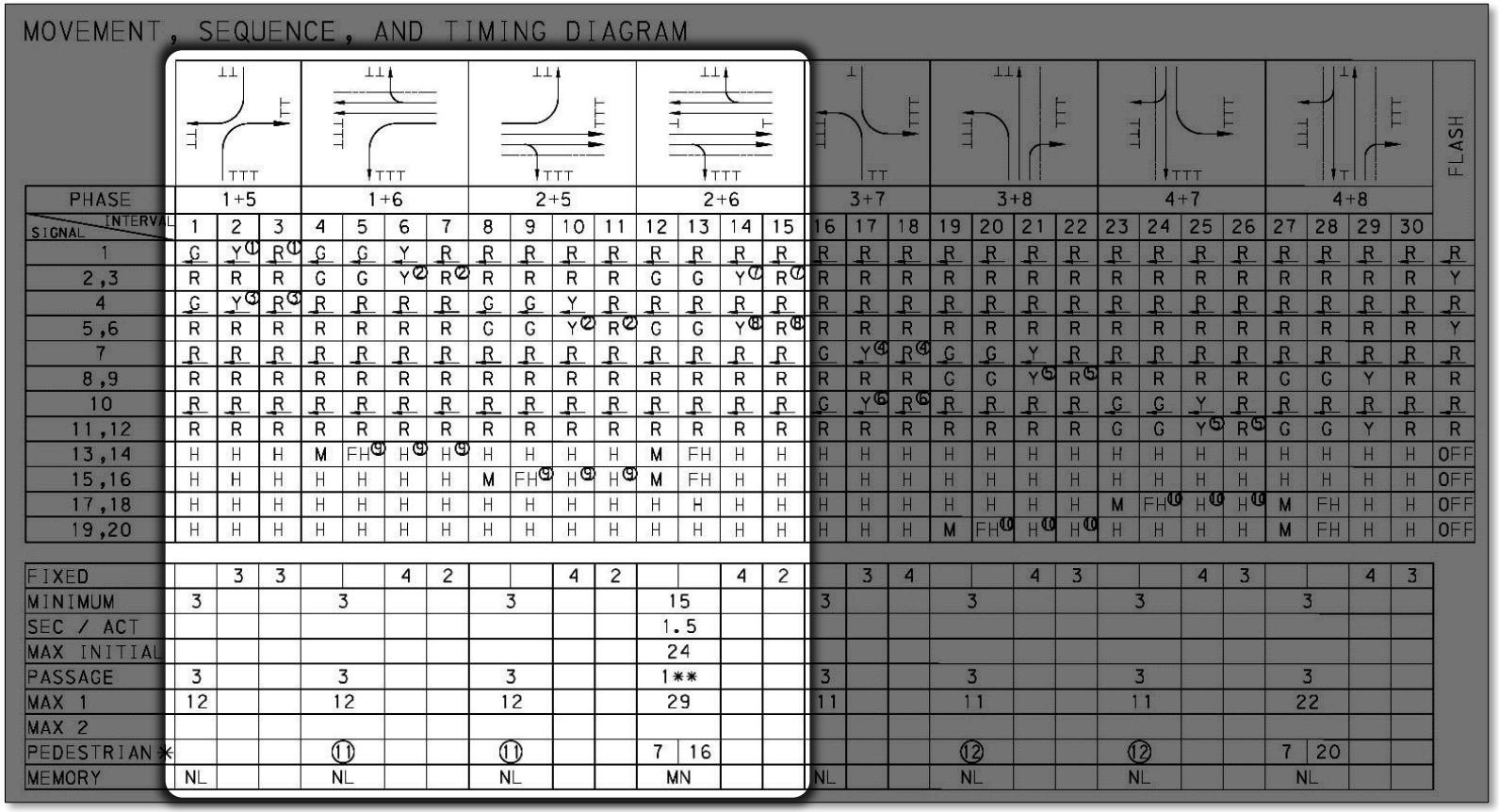
FIXED		3	3			4	2			4	2			4	2		3	4			4	3			4	3			4	3
MINIMUM	3			3				3				15				3			3				3				3				
SEC / ACT												1.5																			
MAX INITIAL												24																			
PASSAGE	3			3				3				1**				3			3				3				3				
MAX 1	12			12				12				29				11			11				11				22				
MAX 2																															
PEDESTRIAN ✳				⑪				⑪				7	16						⑫				⑫				7	20			
MEMORY	NL			NL				NL				MN				NL			NL				NL				NL				

MST CHART ISSUES

Signal Timings:

Phase Settings:

Format Compatibility:



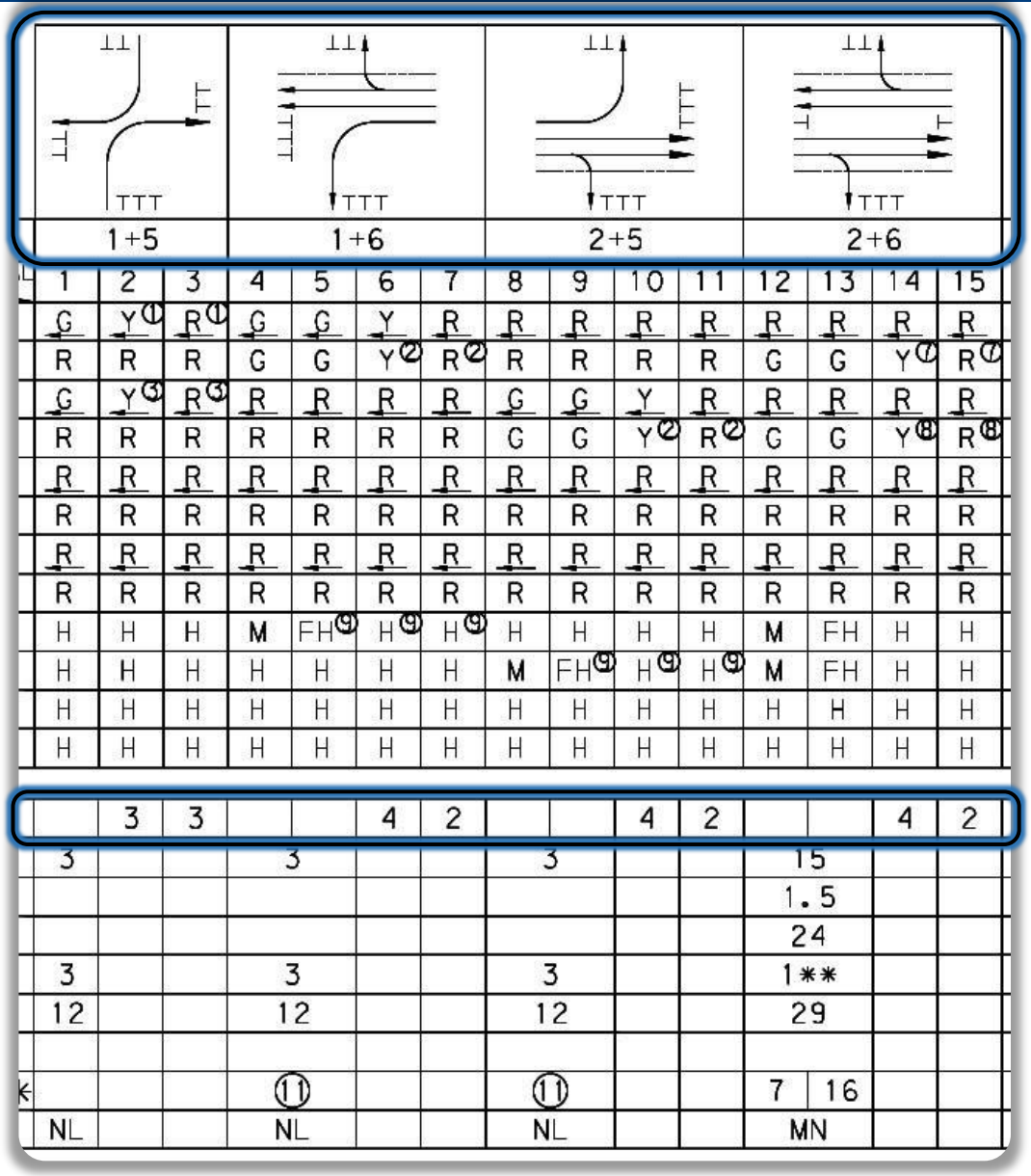
MST CHART ISSUES

Signal Timings:

Phase Settings:

Format Compatibility:

YELLOW / RED



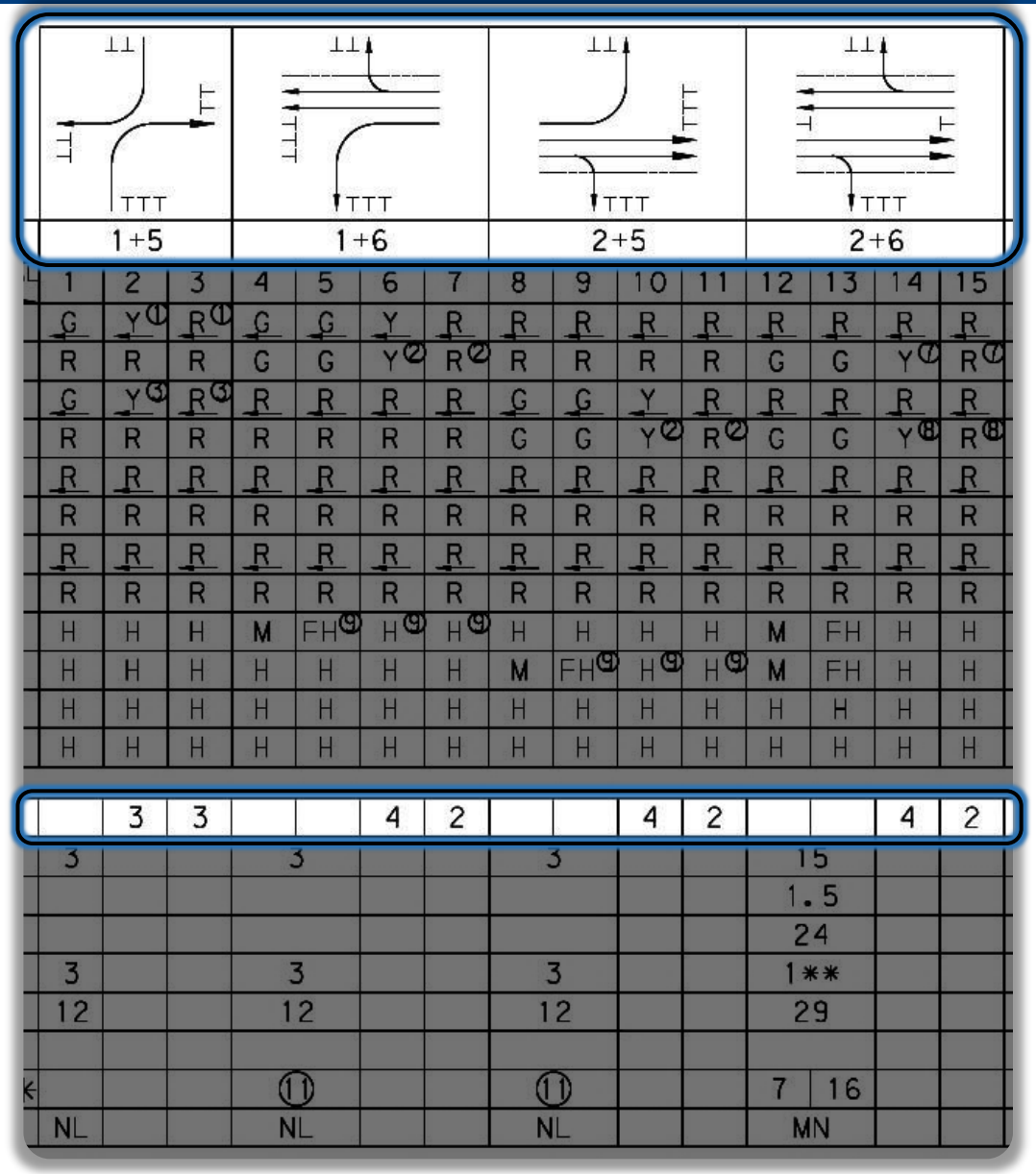
MST CHART ISSUES

Signal Timings:

Phase Settings:

Format Compatibility:

YELLOW / RED

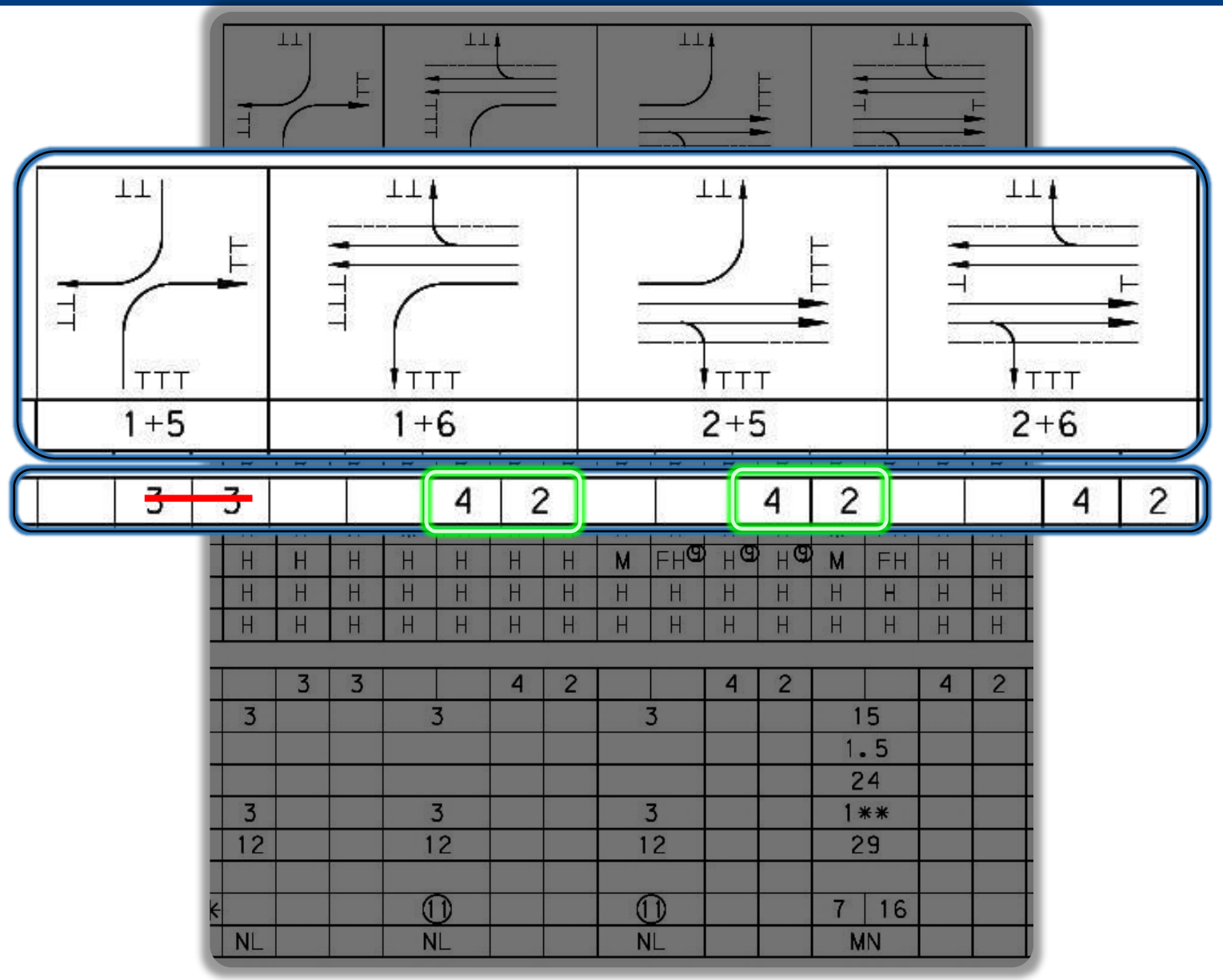


MST CHART ISSUES

Signal Timings:

Phase Settings:

Format Compatibility:

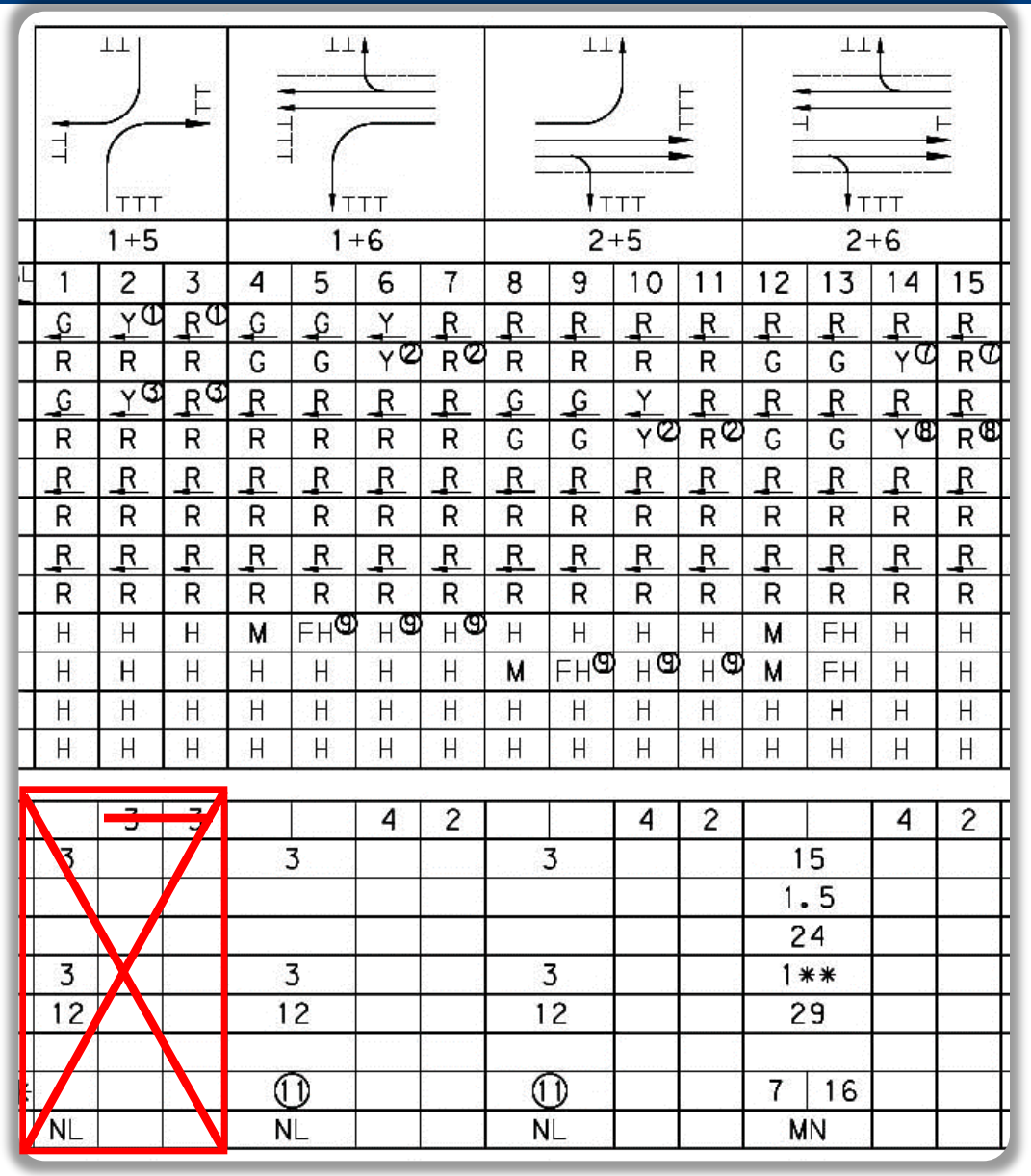


MST CHART ISSUES

Signal Timings:

Phase Settings:

Format Compatibility:



MST CHART ISSUES

Signal Timings:

Not all necessary settings are shown.

Recall, Dual Entry, Detector Memory

Phase Settings:

Cannot show *individual* phase settings.

Ex. Different recalls or detector memory.

Format Compatibility:

Does not show overlap configuration.

MST CHART ISSUES

Signal Timings:

Originally designed for mechanical controllers.

1970s

Phase Settings:

Designed for interval-based controllers.

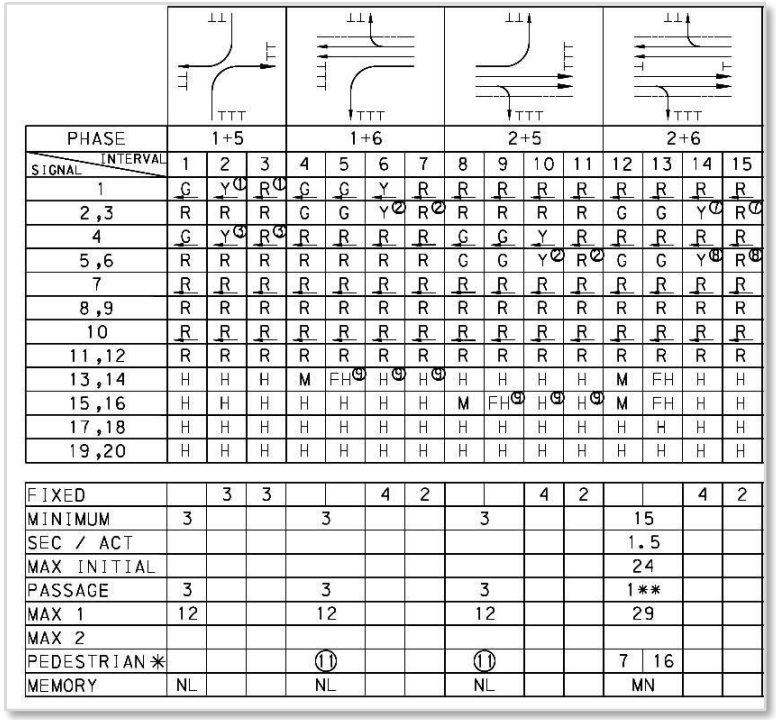
Modern controllers are phase-based.

Format Compatibility:

Does not translate to modern controller computer format.

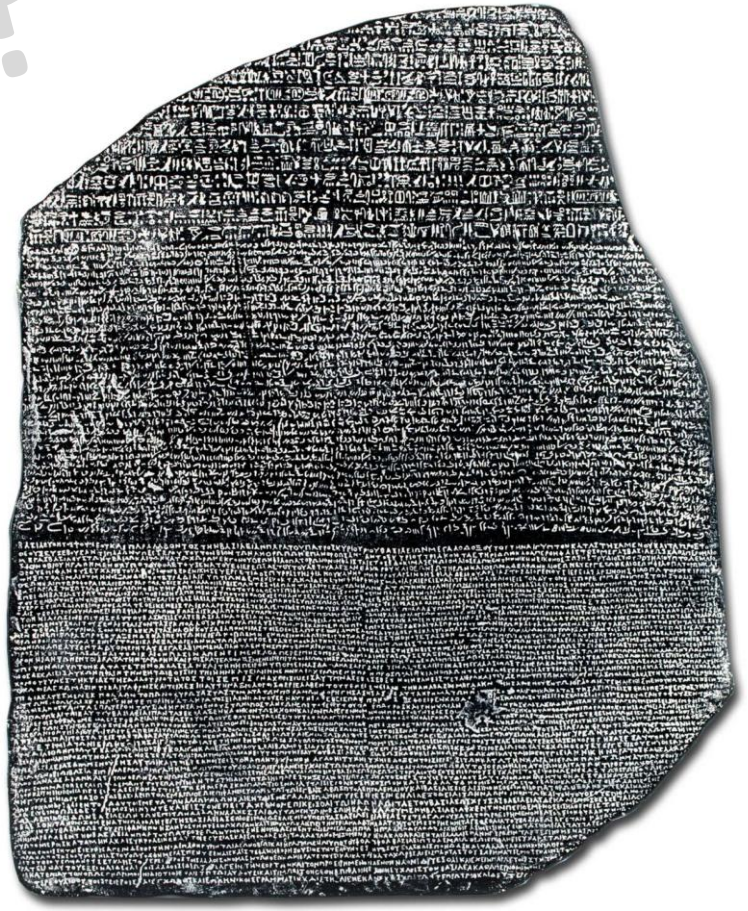
Settings and timings are in Table Format

MST CHART TRANSLATION

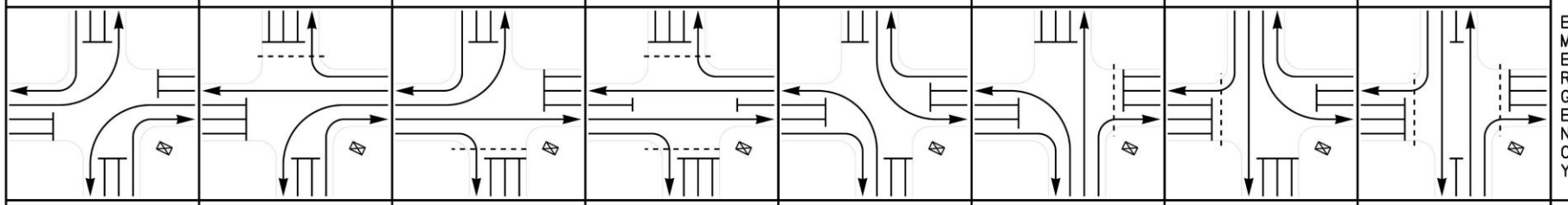


PHASE	1+5			1+6				2+5				2+6			
INTERVAL / SIGNAL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	G	Y①	R①	G	G	Y	R	R	R	R	R	R	R	R	R
2,3	R	R	R	G	G	Y②	R②	R	R	R	R	G	G	Y⑦	R⑦
4	G	Y④	R④	R	R	R	R	G	G	Y	R	R	R	R	R
5,6	R	R	R	R	R	R	R	G	G	Y②	R②	G	G	Y⑧	R⑧
7	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
8,9	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
10	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
11,12	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
13,14	H	H	H	M	FH⑨	H	H⑨	H	H	H	H	M	FH	H	H
15,16	H	H	H	H	H	H	H	M	FH⑨	H⑨	H⑨	M	FH	H	H
17,18	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
19,20	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

FIXED		3	3			4	2			4	2			4	2
MINIMUM	3			3				3				15			
SEC / ACT												1.5			
MAX INITIAL												24			
PASSAGE	3			3				3				1**			
MAX 1	12			12				12				29			
MAX 2															
PEDESTRIAN ✳				⑪				⑪				7	16		
MEMORY	NL			NL				NL				MN			



MST CHART – PROPOSED CHANGES



	SIGNALS	INTERVALS 1	2	3	4	INTERVALS 1	2	3	4	INTERVALS 1	2	3	4	INTERVALS 1	2	3	4	INTERVALS 1	2	3	4	INTERVALS 1	2	3	4	INTERVALS 1	2	3	4	INTERVALS 1	2	3	4	
	1	←G–	←Y ①	←R ①		←R–	←R–	←R–	←R–	←G–	←G–	←Y ⑤	←R ⑤	←R–	←R–	←R–	←R–	←R–	←R–	←R–		←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–
	2	R	R	R		R	R	R	R	G	G	Y ⑥	R ⑥	G	G	Y ⑧	R ⑧	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R
	3	R	R	R		R	R	R	R	G	G	Y ⑥	R ⑥	G	G	Y ⑧	R ⑧	R –G→	R –Y→	R ⑩		R –G→	R –G→	R –Y→	R	R	R	R	R	R	R	R	R	R	R
	4	←G–	←Y ②	←R ②		←G–	←G–	←Y ⑤	←R ⑤	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–		←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–
	5	R	R	R		G	G	Y ⑥	R ⑥	R	R	R	R	G	G	Y ⑨	R ⑨	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R
	6	R	R	R		G	G	Y ⑥	R ⑥	R	R	R	R	G	G	Y ⑨	R ⑨	R –G→	R –Y→	R ⑪		R	R	R	R	R –G→	R –G→	R –Y→	R	R	R	R	R	R
	7	←R–	←R–	←R–		←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←G–	←Y ⑫	←R ⑫		←R–	←R–	←R–	←R–	←G–	←G–	←Y–	←R–	←R–	←R–	←R–	←R–	←R–
	8	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		R	R	R	R	G	G	Y ⑭	R ⑭	G	G	Y	R	R
	9	R –G→	R –Y→ ③	R ③		R	R	R	R	R –G→	R –G→	R –Y→ ⑦	R ⑦	R	R	R	R	R	R	R		R	R	R	R	G	G	Y ⑭	R ⑭	G	G	Y	R	R
	10	←R–	←R–	←R–		←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←G–	←Y ⑬	←R ⑬		←G–	←G–	←Y–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–	←R–
	11	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		G	G	Y ⑭	R ⑭	R	R	R	R	G	G	Y	R	R
	12	R –G→	R –Y→ ④	R ④		R –G→	R –G→	R –Y→ ⑦	R ⑦	R	R	R	R	R	R	R	R	R	R	R		G	G	Y ⑭	R ⑭	R	R	R	R	G	G	Y	R	R
*	13,14	DW	DW	DW		DW	DW	DW	DW	W	FD	DW	DW	W	FD	DW	DW	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	OFF
*	15,16	DW	DW	DW		W	FD	DW	DW	DW	DW	DW	DW	W	FD	DW	DW	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	OFF
*	17,18	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW		DW	DW	DW	DW	W	FD	DW	DW	W	FD	DW	DW	OFF
*	19,20	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW		W	FD	DW	DW	DW	DW	DW	DW	W	FD	DW	DW	OFF
	FIXED		3	3			4	3			4	3			5	2			3	3			4	3			4	3			4	4		
	MINIMUM	5				5				5				5				5				5				5				5				
	PASSAGE	2				2				2				2				2				2				2				2				
	MAX 1	15				25				20				60				15				25				20				60				
	MAX 2	15				25				20				60				15				25				20				60				
	PEDESTRIAN					⑮				⑮				7	18							⑯				⑯				7	15			
	MEMORY	L				NL				NL				MN				L				L				NL				NL				

* UPON PEDESTRIAN ACTUATION ONLY, OTHERWISE DON'T WALK AT ALL TIMES

MST CHART – PROPOSED CHANGES

Phasing Diagram

	PHASE 1+5				PHASE 1+6				PHASE 2+5				PHASE 2+6				PHASE 3+7				PHASE 3+8				PHASE 4+7				PHASE 4+8				EMERGENCY	FLASHING
	INTERVALS				INTERVALS				INTERVALS				INTERVALS				INTERVALS				INTERVALS				INTERVALS				INTERVALS					
SIGNALS	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4		
1	←G-	←Y①	←R①		←R-	←R-	←R-	←R-	←G-	←G-	←Y⑤	←R⑤	←R-	←R-	←R-	←R-	←R-	←R-	←R-		←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-
2	R	R	R		R	R	R	R	G	G	Y⑥	R⑥	G	G	Y⑧	R⑧	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R
3	R	R	R		R	R	R	R	G	G	Y⑥	R⑥	G	G	Y⑧	R⑧	R →G	R →Y	R⑩		R →G	R →G	R →Y	R	R	R	R	R	R	R	R	R	R	R
4	←G-	←Y②	←R②		←G-	←G-	←Y⑤	←R⑤	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-		←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-
5	R	R	R		G	G	Y⑥	R⑥	R	R	R	R	G	G	Y⑨	R⑨	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R
6	R	R	R		G	G	Y⑥	R⑥	R	R	R	R	G	G	Y⑨	R⑨	R →G	R① →Y	R⑪		R	R	R	R	R →G	R →G	R →Y	R	R	R	R	R	R	R
7	←R-	←R-	←R-		←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←G-	←Y⑫	←R⑫		←R-	←R-	←R-	←R-	←G-	←G-	←Y-	←R-	←R-	←R-	←R-	←R-	←R-	←R-
8	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		R	R	R	R	G	G	Y⑭	R⑭	G	G	Y	R	R	R
9	R →G	R③ →Y	R③		R	R	R	R	R →G	R →G	R⑦ →Y	R⑦	R	R	R	R	R	R	R		R	R	R	R	G	G	Y⑭	R⑭	G	G	Y	R	R	R
10	←R-	←R-	←R-		←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←G-	←Y⑬	←R⑬		←G-	←G-	←Y-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-
11	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		G	G	Y⑭	R⑭	R	R	R	R	G	G	Y	R	R	R
12	R →G	R④ →Y	R④		R →G	R →G	R⑦ →Y	R⑦	R	R	R	R	R	R	R	R	R	R	R		G	G	Y⑭	R⑭	R	R	R	R	G	G	Y	R	R	R
* 13,14	DW	DW	DW		DW	DW	DW	DW	W	FD	DW	DW	W	FD	DW	DW	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	OFF
* 15,16	DW	DW	DW		W	FD	DW	DW	DW	DW	DW	DW	W	FD	DW	DW	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	OFF
* 17,18	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW		DW	DW	DW	DW	W	FD	DW	DW	W	FD	DW	DW	OFF
* 19,20	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW		W	FD	DW	DW	DW	DW	DW	DW	W	FD	DW	DW	OFF

Programming Tables

FIXED		3	3			4	3		4	3		5	2		3	3			4	3		4	3		4	4	
MINIMUM	5				5			5			5			5				5			5			5			
PASSAGE	2				2			2			2			2				2			2			2			
MAX 1	15				25			20			60			15				25			20			60			
MAX 2	15				25			20			60			15				25			20			60			
PEDESTRIAN					⑮			⑮			7 18							⑯			⑯			7 15			
MEMORY	L				NL			NL			MN			L				L			NL			NL			

* UPON PEDESTRIAN ACTUATION ONLY, OTHERWISE DON'T WALK AT ALL TIMES

MST CHART – PROPOSED CHANGES

Phasing Diagram

- Ring & Barrier
- Signal Heads
- Movement Diagram

		PHASE 1+5				PHASE 1+6				PHASE 2+5				PHASE 2+6				PHASE 3+7				PHASE 3+8				PHASE 4+7				PHASE 4+8				EMERGENCY	FLASHING
		INTERVALS				INTERVALS				INTERVALS				INTERVALS				INTERVALS				INTERVALS				INTERVALS				INTERVALS					
	SIGNALS	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4		
	1	←G-	←Y①	←R①		←R-	←R-	←R-	←R-	←G-	←G-	←Y⑤	←R⑤	←R-	←R-	←R-	←R-	←R-	←R-	←R-		←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-
	2	R	R	R		R	R	R	R	G	G	Y⑥	R⑥	G	G	Y⑧	R⑧	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R
	3	R	R	R		R	R	R	R	G	G	Y⑥	R⑥	G	G	Y⑧	R⑧	R -G→	R⑩ -Y→	R⑩		R -G→	R -G→	R -Y→	R	R	R	R	R	R	R	R	R	R	R
	4	←G-	←Y②	←R②		←G-	←G-	←Y⑤	←R⑤	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-		←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-
	5	R	R	R		G	G	Y⑥	R⑥	R	R	R	R	G	G	Y⑨	R⑨	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R
	6	R	R	R		G	G	Y⑥	R⑥	R	R	R	R	G	G	Y⑨	R⑨	R -G→	R⑪ -Y→	R⑪		R	R	R	R	R -G→	R -G→	R -Y→	R	R	R	R	R	R	R
	7	←R-	←R-	←R-		←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←G-	←Y⑫	←R⑫		←R-	←R-	←R-	←R-	←G-	←G-	←Y-	←R-	←R-	←R-	←R-	←R-	←R-	←R-
	8	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		R	R	R	R	G	G	Y⑭	R⑭	G	G	Y	R	R	R
	9	R -G→	R⑬ -Y→	R③		R	R	R	R	R -G→	R -G→	R⑦ -Y→	R⑦	R	R	R	R	R	R	R		R	R	R	R	G	G	Y⑭	R⑭	G	G	Y	R	R	R
	10	←R-	←R-	←R-		←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←G-	←Y⑮	←R⑮		←G-	←G-	←Y-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-	←R-
	11	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		G	G	Y⑭	R⑭	R	R	R	R	G	G	Y	R	R	R
	12	R -G→	R④ -Y→	R④		R -G→	R -G→	R⑦ -Y→	R⑦	R	R	R	R	R	R	R	R	R	R	R		G	G	Y⑭	R⑭	R	R	R	R	G	G	Y	R	R	R
*	13,14	DW	DW	DW		DW	DW	DW	DW	W	FD	DW	DW	W	FD	DW	DW	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	OFF	
*	15,16	DW	DW	DW		W	FD	DW	DW	DW	DW	DW	DW	W	FD	DW	DW	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	OFF	
*	17,18	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW		DW	DW	DW	DW	W	FD	DW	DW	W	FD	DW	DW	OFF	
*	19,20	DW	DW	DW		DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW		W	FD	DW	DW	DW	DW	DW	DW	W	FD	DW	DW	OFF	

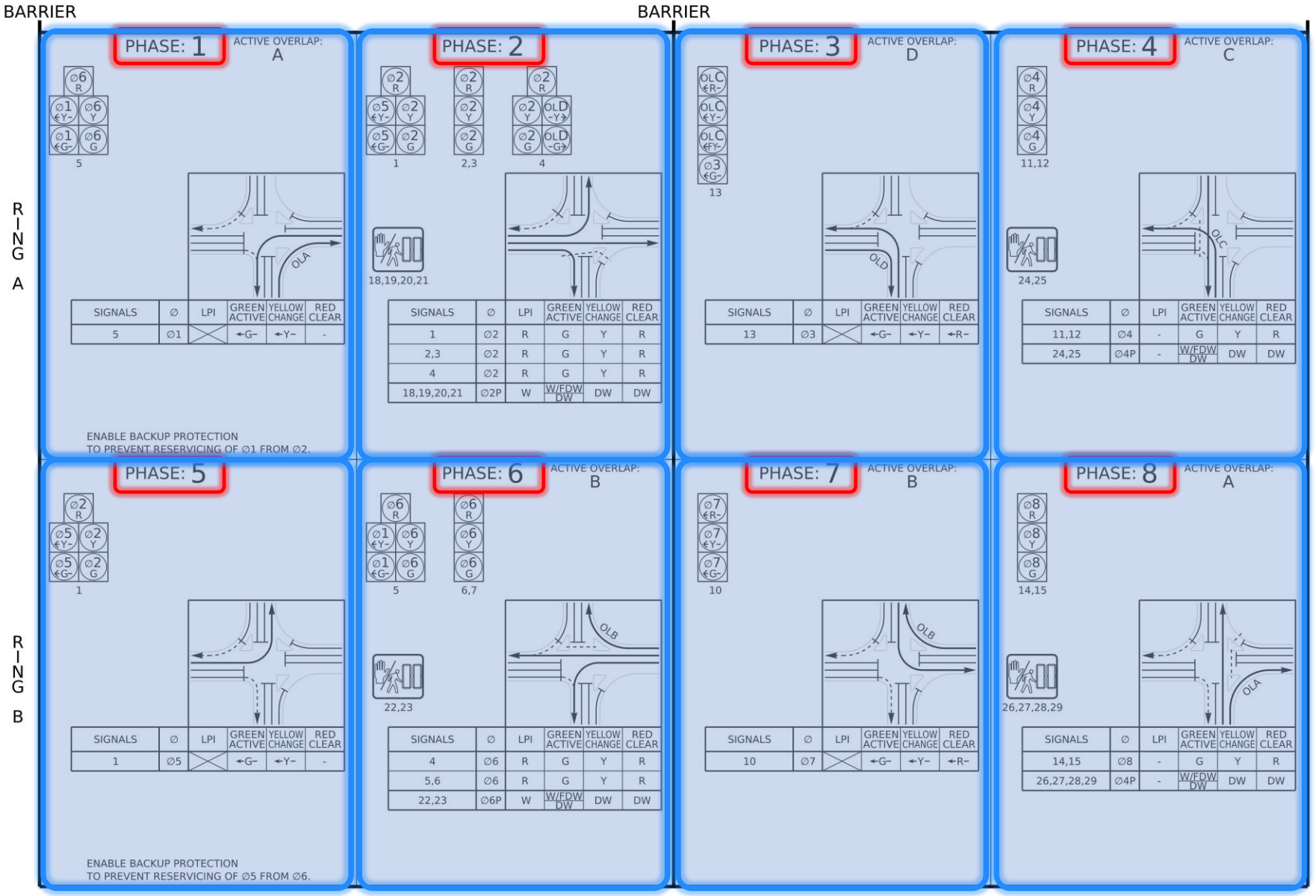
MST CHART – PHASING DIAGRAM

Ring & Barrier

Phase Assignments

Signal Heads

Movement Diagram



SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
5	∅1		←G–	←Y–	-

SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
1	∅2	R	G	Y	R
2,3	∅2	R	G	Y	R
4	∅2	R	G	Y	R
18,19,20,21	∅2P	W	W/FDW DW	DW	DW

SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
13	∅3		←G–	←Y–	←R–

SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
11,12	∅4	-	G	Y	R
24,25	∅4P	-	W/FDW DW	DW	DW

SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
1	∅5		←G–	←Y–	-

SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
4	∅6	R	G	Y	R
5,6	∅6	R	G	Y	R
22,23	∅6P	W	W/FDW DW	DW	DW

SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
10	∅7		←G–	←Y–	←R–

SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
14,15	∅8	-	G	Y	R
26,27,28,29	∅4P	-	W/FDW DW	DW	DW

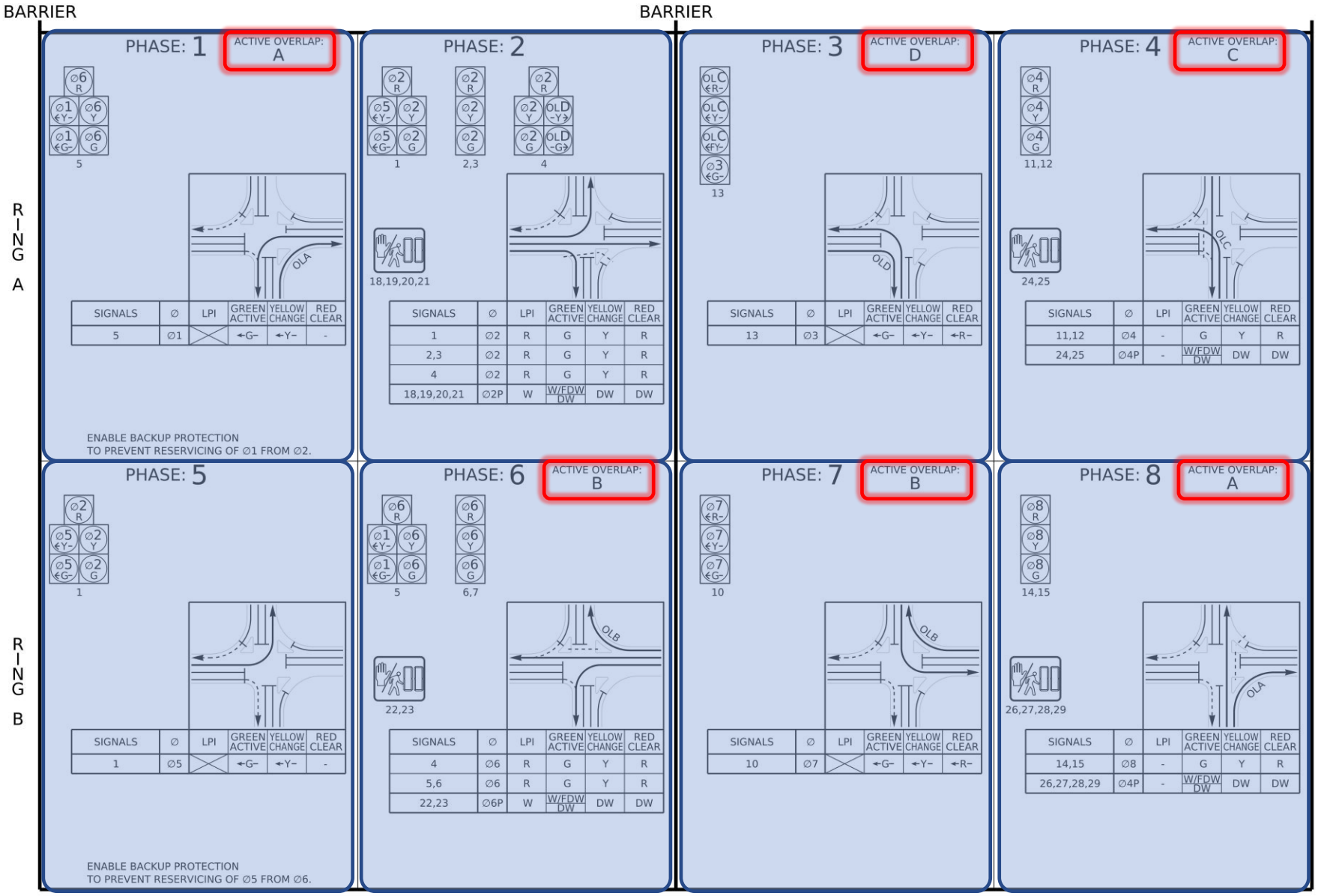
MST CHART – PHASING DIAGRAM

Ring & Barrier

- Phase Assignments
- Active Overlaps

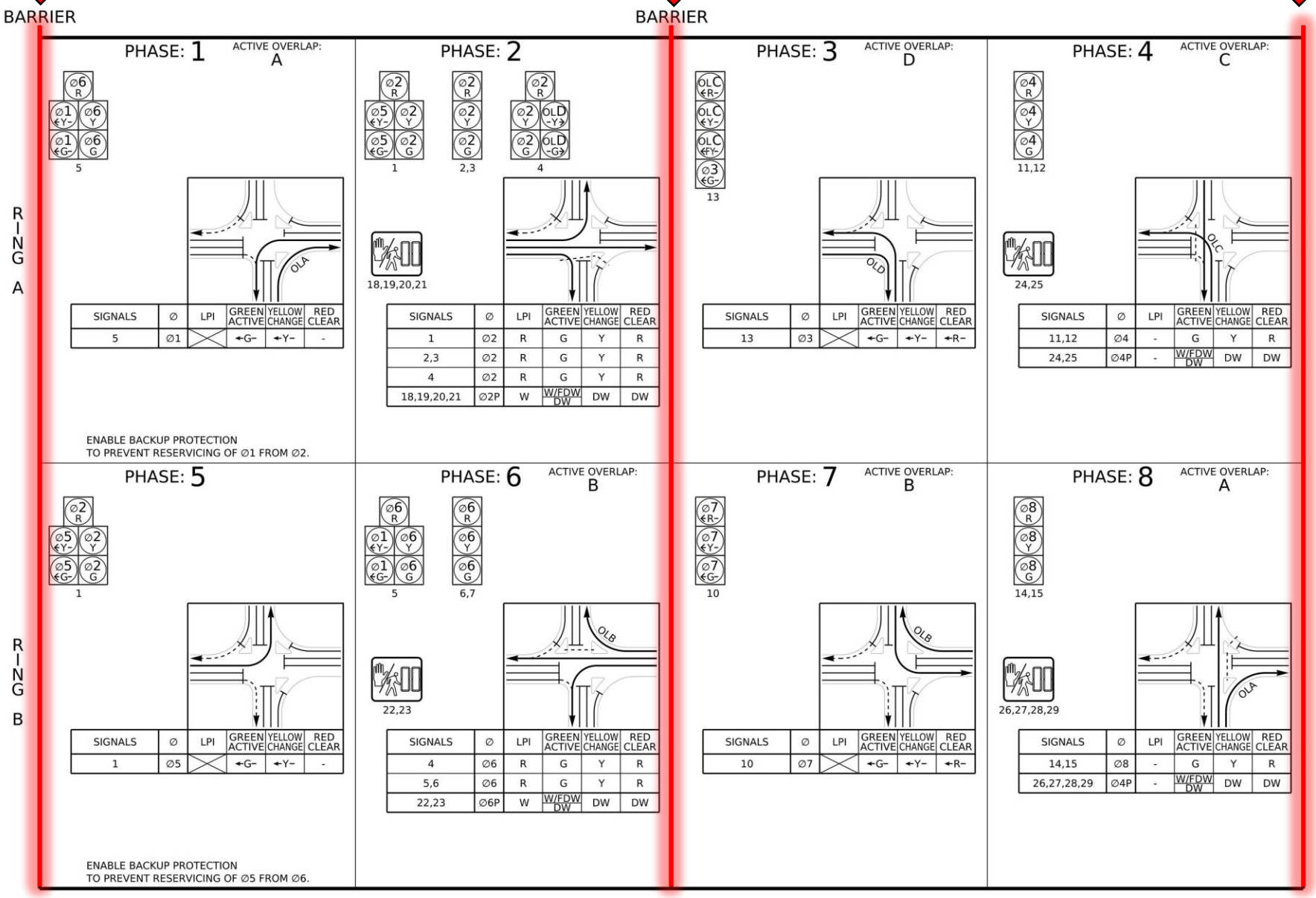
Signal Heads

Movement Diagram



MST CHART – PHASING DIAGRAM

- Ring & Barrier
- Phase Assignments
- Active Overlaps
- Barriers
- Signal Heads
- Movement Diagram



MST CHART – PHASING DIAGRAM

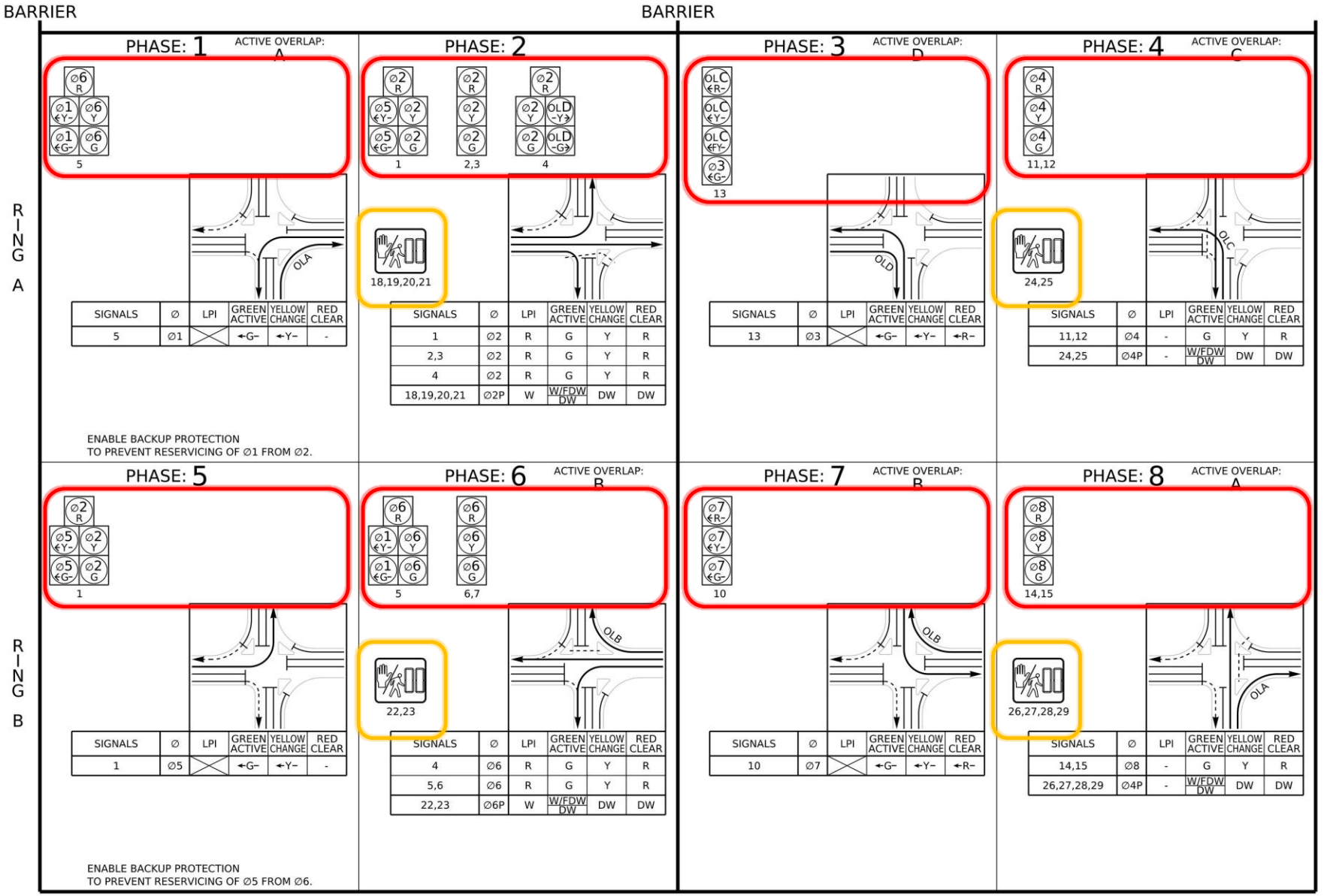
Ring & Barrier

- Phase Assignments
- Active Overlaps
- Barriers

Signal Heads

- **Wired to Phase**

Movement Diagram



SIGNALS	Ø	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
5	Ø1		←G–	←Y–	-

SIGNALS	Ø	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
1	Ø2	R	G	Y	R
2,3	Ø2	R	G	Y	R
4	Ø2	R	G	Y	R
18,19,20,21	Ø2P	W	W/FDW DW	DW	DW

SIGNALS	Ø	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
13	Ø3		←G–	←Y–	←R–

SIGNALS	Ø	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
11,12	Ø4	-	G	Y	R
24,25	Ø4P	-	W/FDW DW	DW	DW

SIGNALS	Ø	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
1	Ø5		←G–	←Y–	-

SIGNALS	Ø	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
4	Ø6	R	G	Y	R
5,6	Ø6	R	G	Y	R
22,23	Ø6P	W	W/FDW DW	DW	DW

SIGNALS	Ø	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
10	Ø7		←G–	←Y–	←R–

SIGNALS	Ø	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
14,15	Ø8	-	G	Y	R
26,27,28,29	Ø4P	-	W/FDW DW	DW	DW

MST CHART – PHASING DIAGRAM

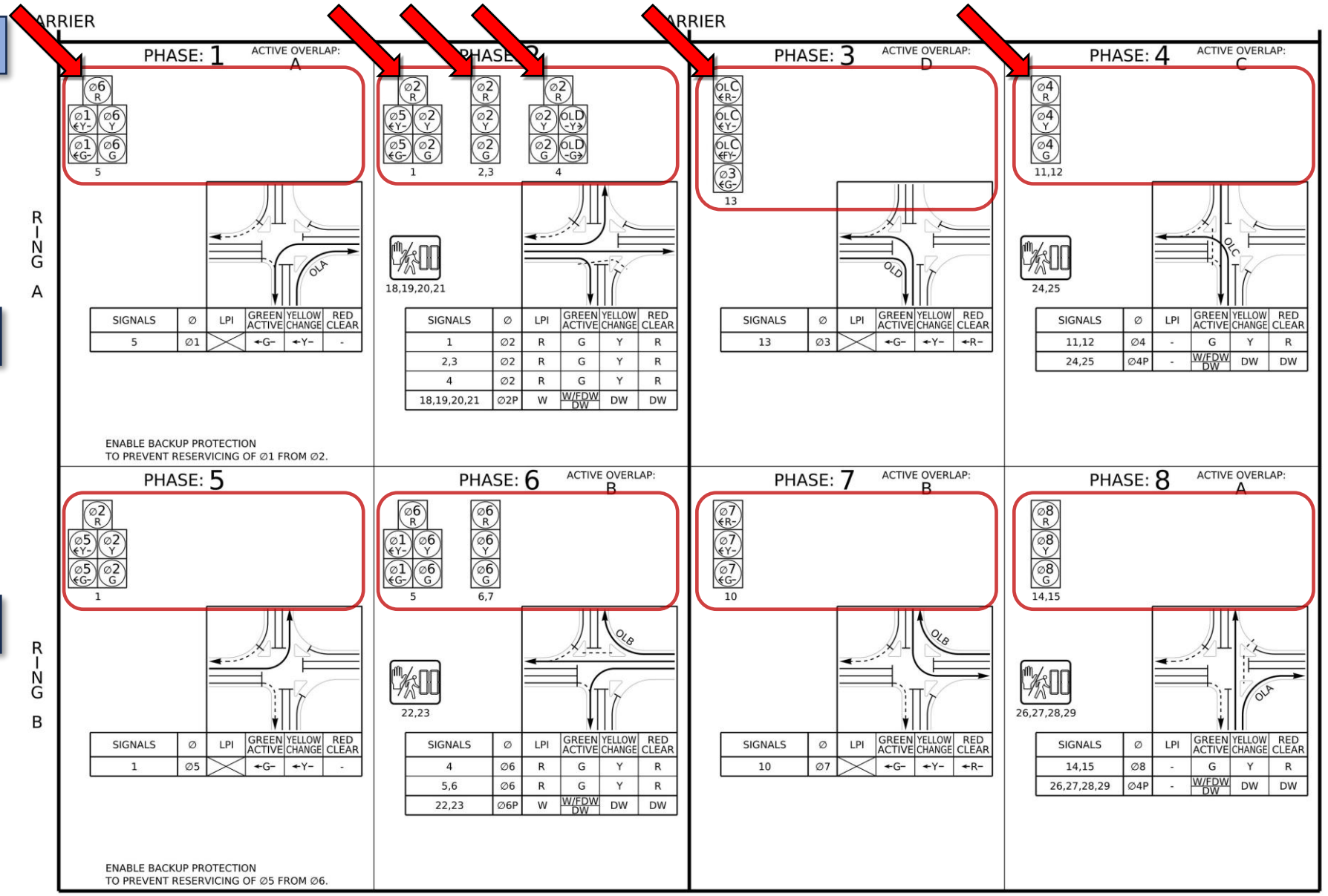
Ring & Barrier

- Phase Assignments
- Active Overlaps
- Barriers

Signal Heads

- **Wired to Phase**
- **Type**

Movement Diagram



MST CHART – PHASING DIAGRAM

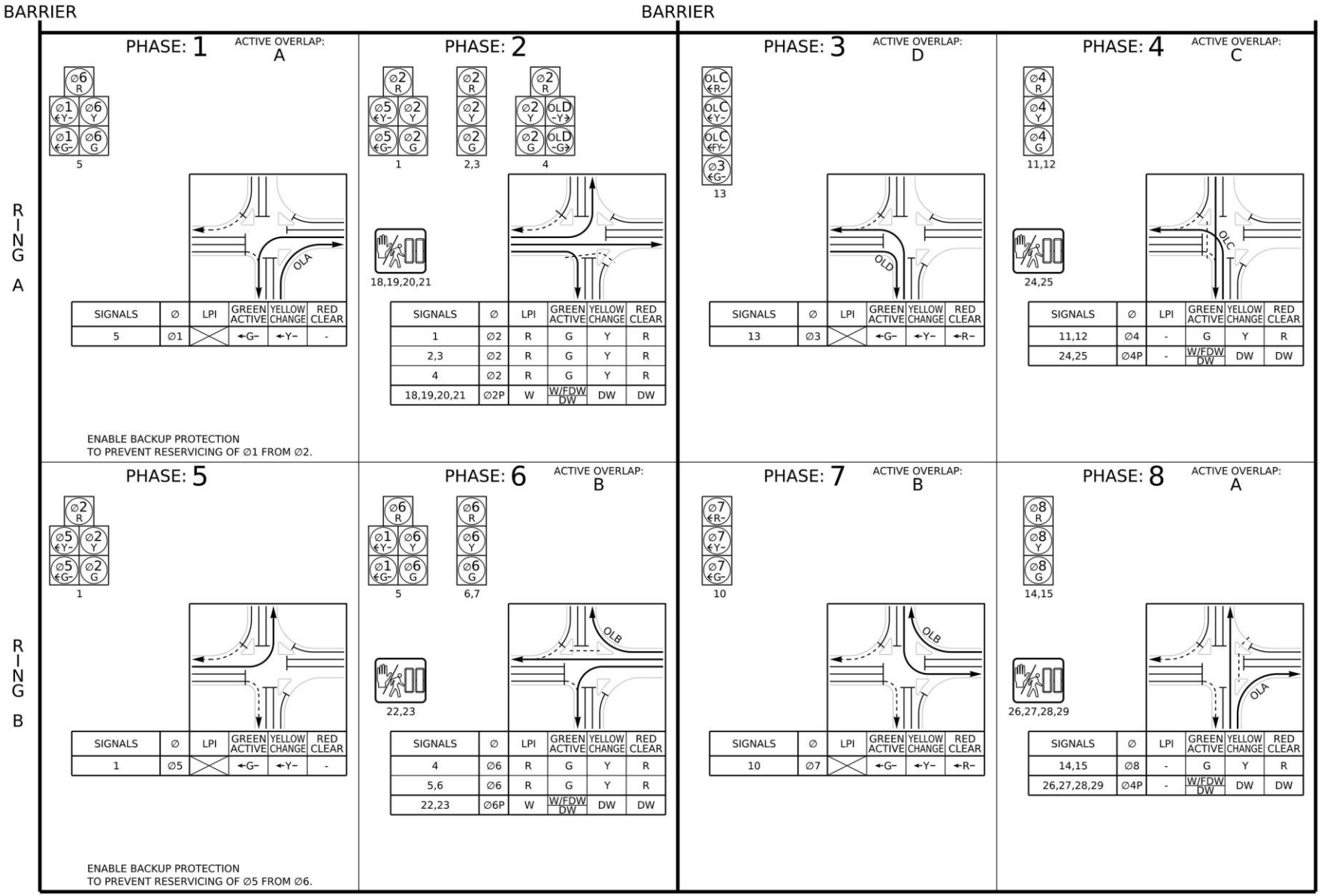
Ring & Barrier

- Phase Assignments
- Active Overlaps
- Barriers

Signal Heads

- **Wired to Phase**
- **Type**
- **Indications**

Movement Diagram



MST CHART – PHASING DIAGRAM

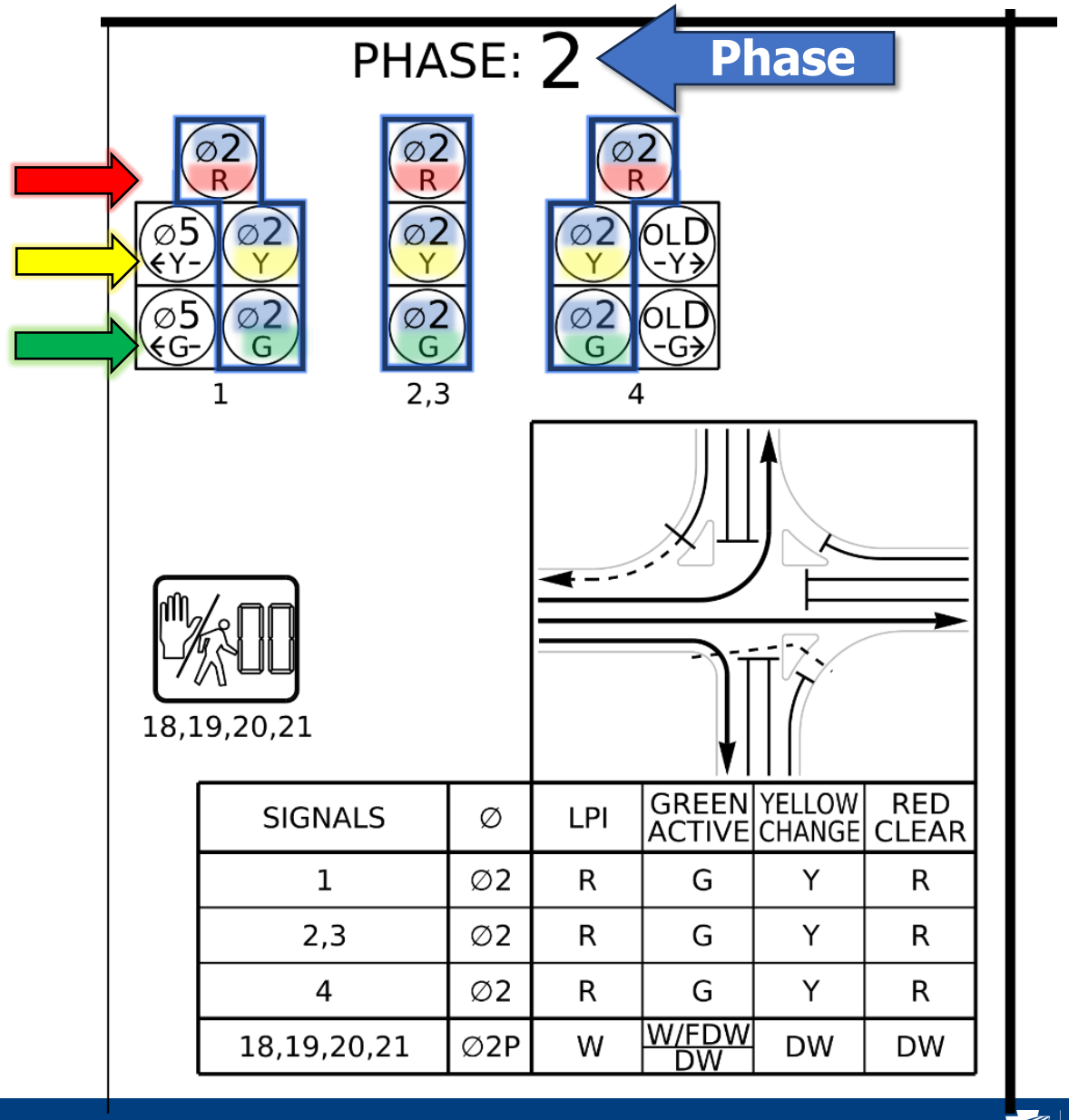
Ring & Barrier

- Phase Assignments
- Active Overlaps
- Barriers

Signal Heads

- **Wired to Phase**
- **Type**
- **Indications**

Movement Diagram



SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
1	∅2	R	G	Y	R
2,3	∅2	R	G	Y	R
4	∅2	R	G	Y	R
18,19,20,21	∅2P	W	W/FDW DW	DW	DW

MST CHART – PHASING DIAGRAM

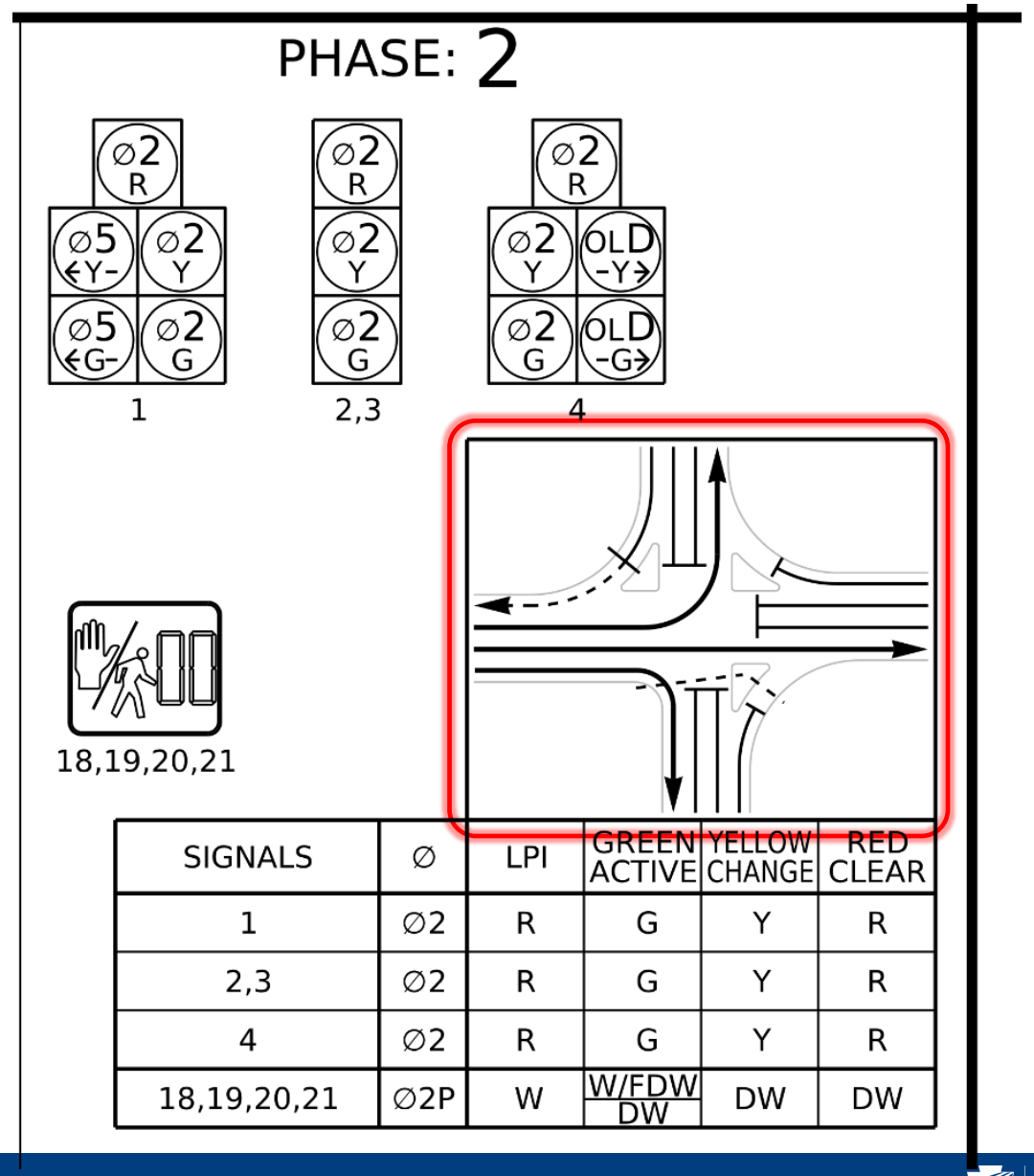
Ring & Barrier

- Phase Assignments
- Active Overlaps
- Barriers

Signal Heads

- Wired to Phase
- Type
- Indications

Movement Diagram



SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
1	∅2	R	G	Y	R
2,3	∅2	R	G	Y	R
4	∅2	R	G	Y	R
18,19,20,21	∅2P	W	W/FDW DW	DW	DW

MST CHART – PHASING DIAGRAM

Ring & Barrier

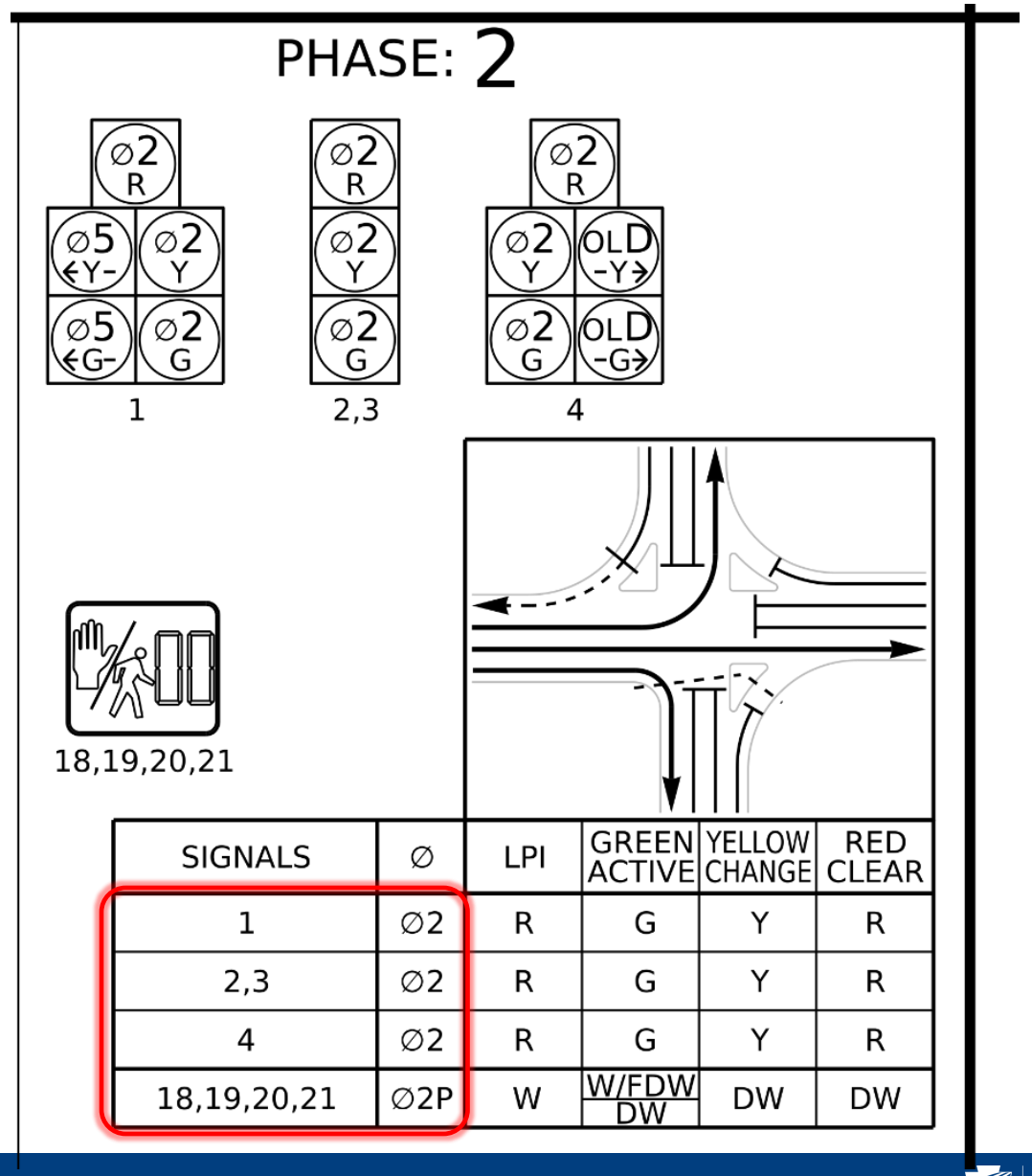
- Phase Assignments
- Active Overlaps
- Barriers

Signal Heads

- Wired to Phase
- Type
- Indications

Movement Diagram

Signal Assignments



SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
1	∅2	R	G	Y	R
2,3	∅2	R	G	Y	R
4	∅2	R	G	Y	R
18,19,20,21	∅2P	W	W/FDW DW	DW	DW

MST CHART – PHASING DIAGRAM

Ring & Barrier

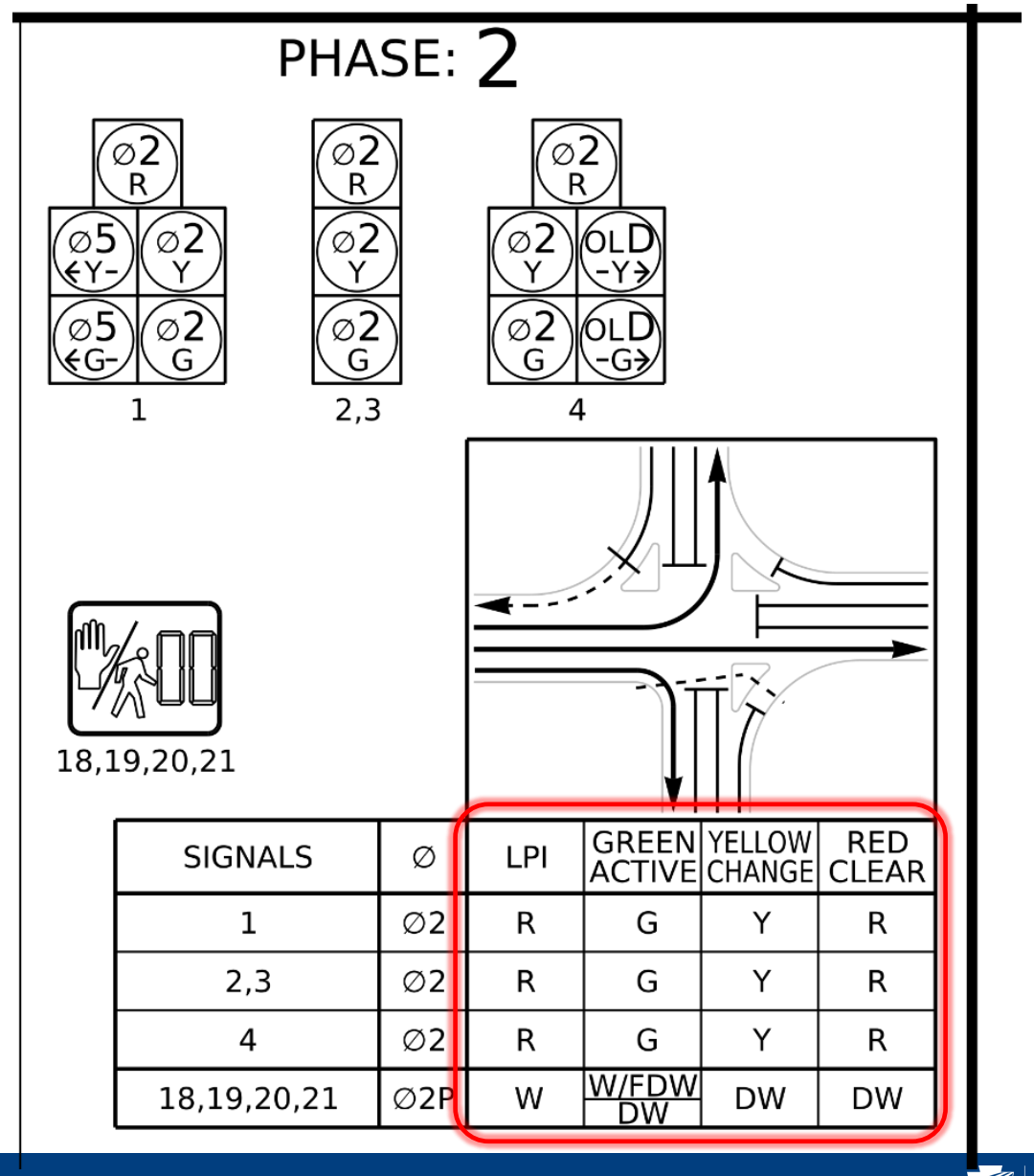
- Phase Assignments
- Active Overlaps
- Barriers

Signal Heads

- Wired to Phase
- Type
- Indications

Movement Diagram

- **Signal Assignments**
- **Simplified Intervals**



SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
1	∅2	R	G	Y	R
2,3	∅2	R	G	Y	R
4	∅2	R	G	Y	R
18,19,20,21	∅2P	W	W/FDW DW	DW	DW

MST CHART – PHASING DIAGRAM

Ring & Barrier

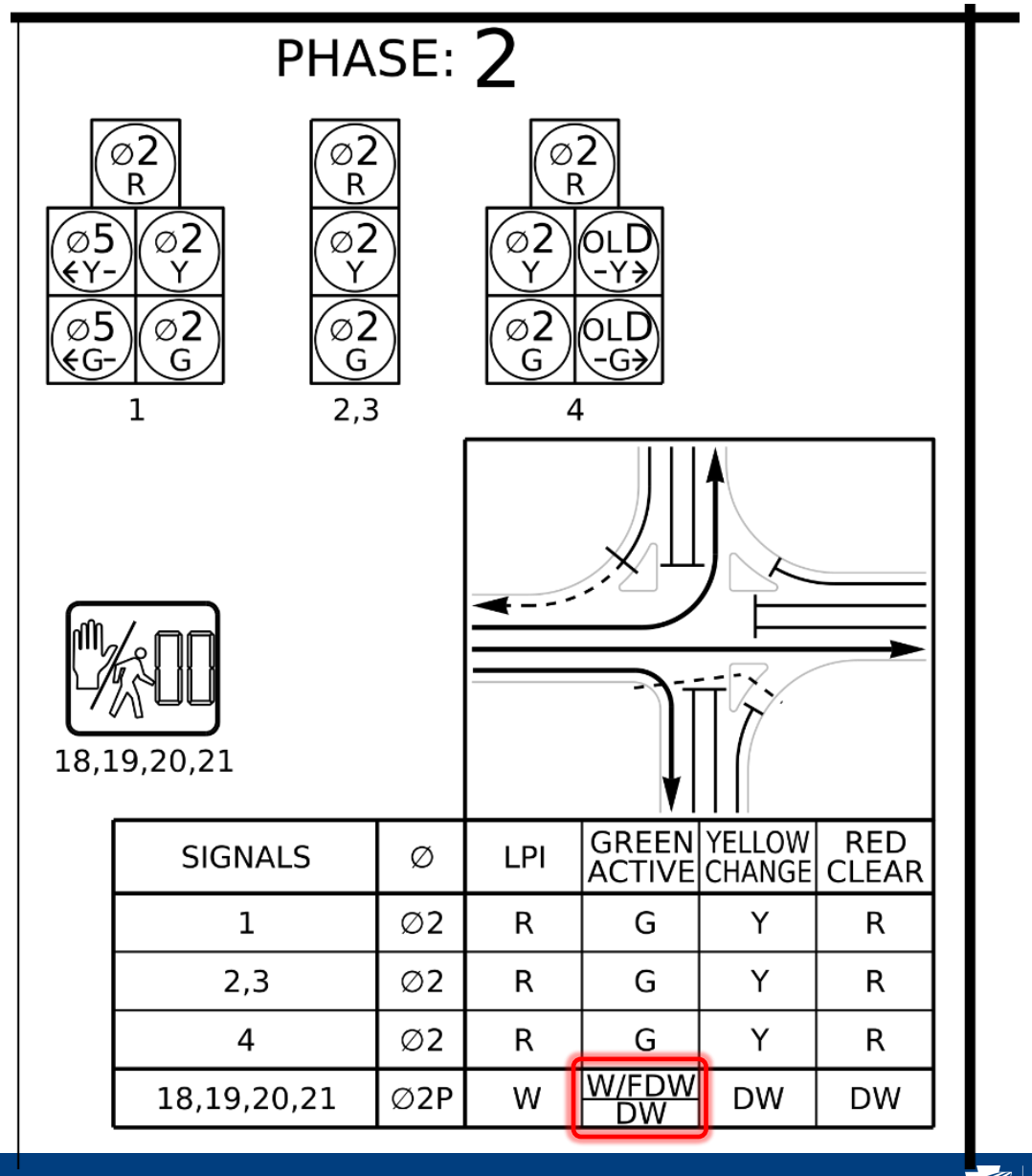
- Phase Assignments
- Active Overlaps
- Barriers

Signal Heads

- Wired to Phase
- Type
- Indications

Movement Diagram

- **Signal Assignments**
- **Simplified Intervals**



SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
1	∅2	R	G	Y	R
2,3	∅2	R	G	Y	R
4	∅2	R	G	Y	R
18,19,20,21	∅2P	W	W/FDW DW	DW	DW

MST CHART – PHASING DIAGRAM

Ring & Barrier

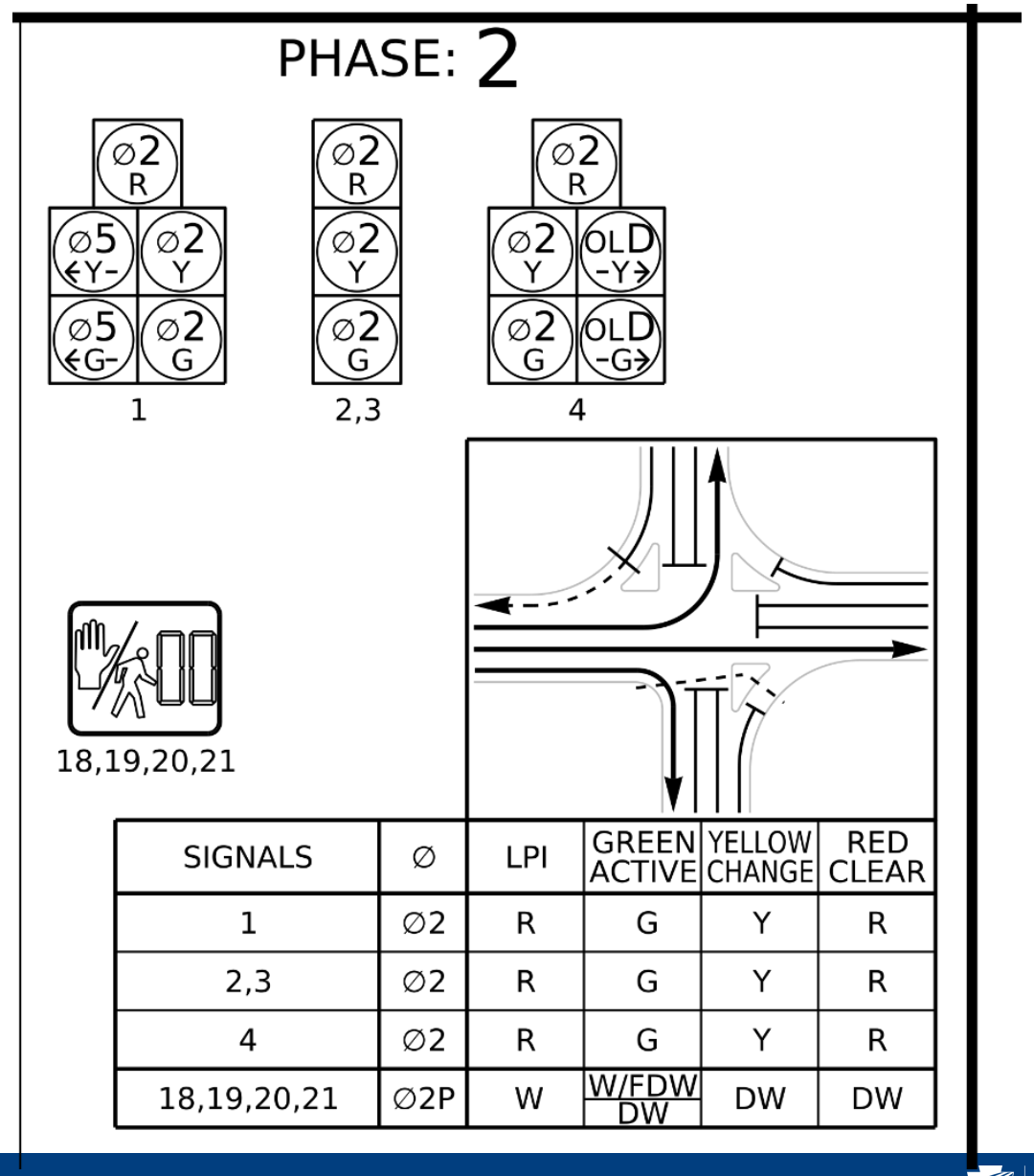
- Phase Assignments
- Active Overlaps
- Barriers

Signal Heads

- Wired to Phase
- Type
- Indications

Movement Diagram

- **Signal Assignments**
- **Simplified Intervals**
- **Minimal Notes**

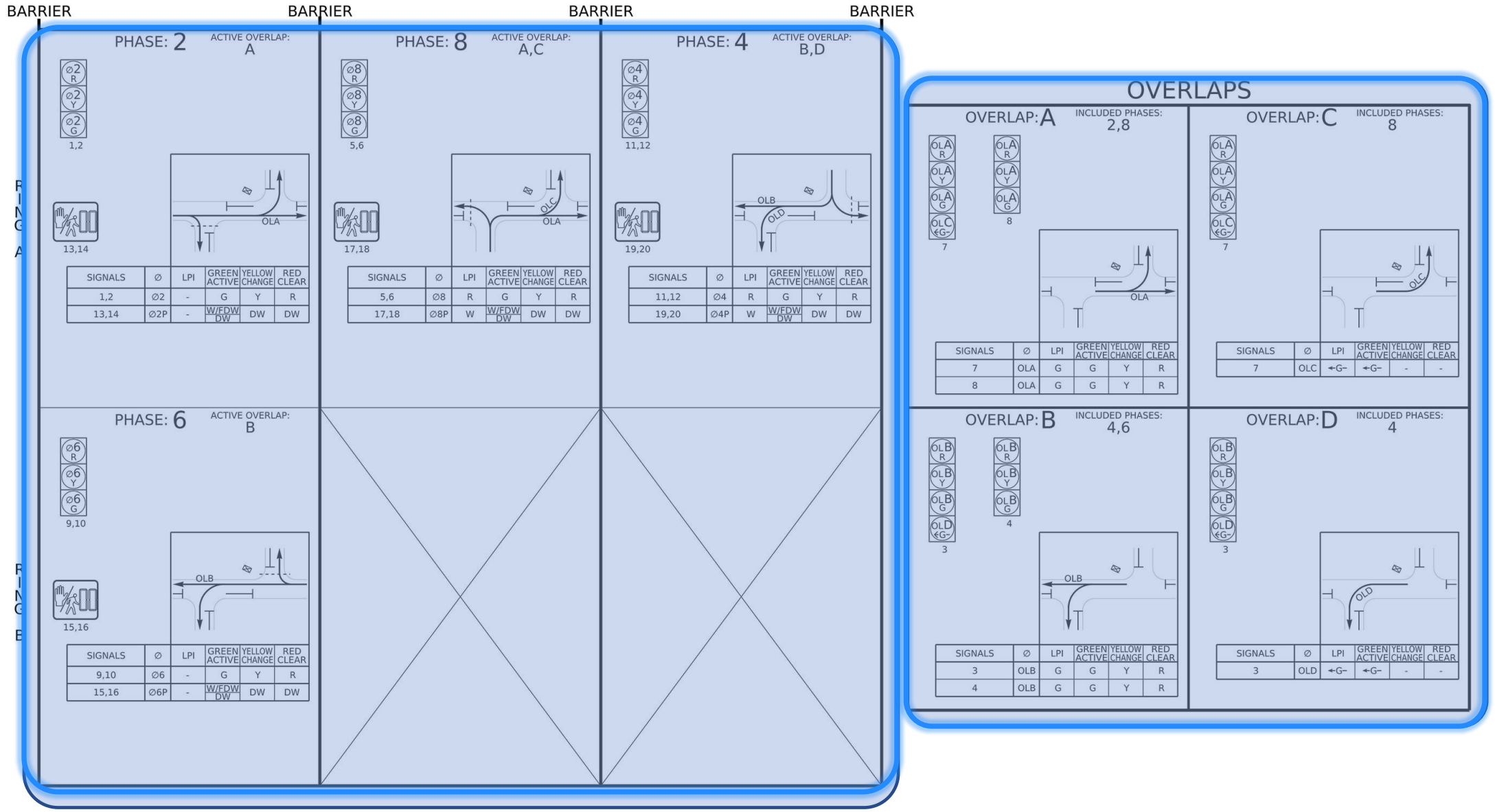


SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
1	∅2	R	G	Y	R
2,3	∅2	R	G	Y	R
4	∅2	R	G	Y	R
18,19,20,21	∅2P	W	W/FDW DW	DW	DW

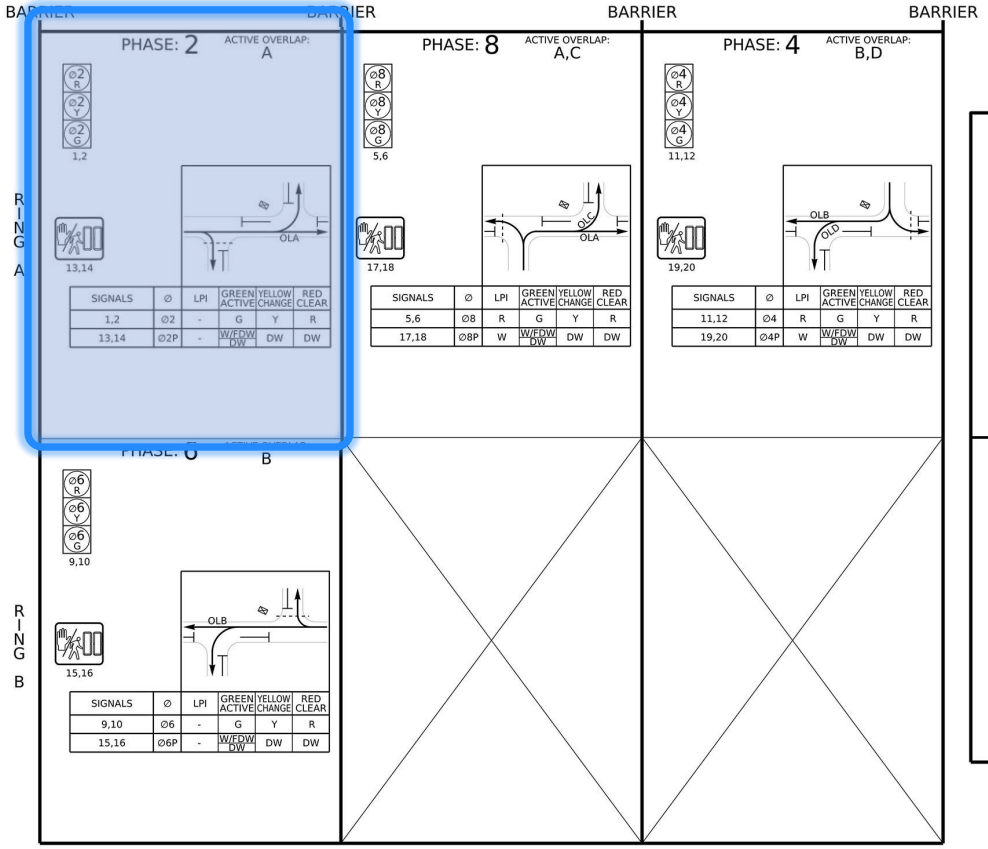
Double Intersection Example

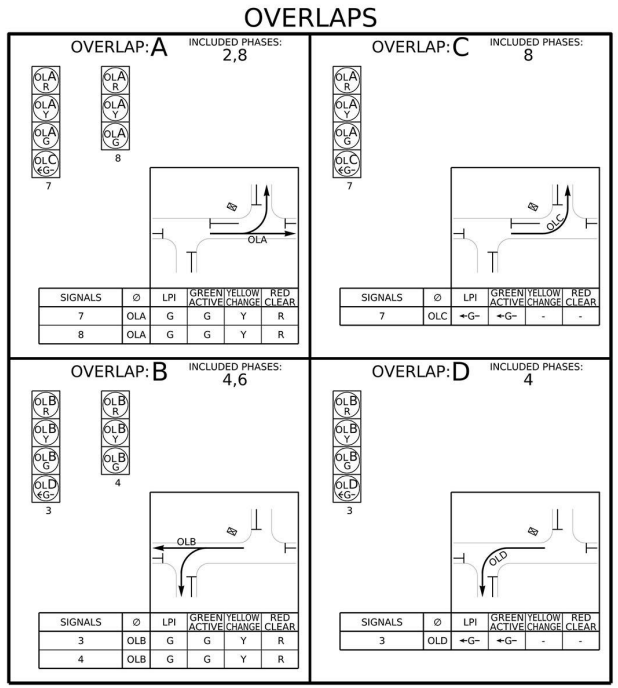
With Overlaps (Parent/Child Phases)

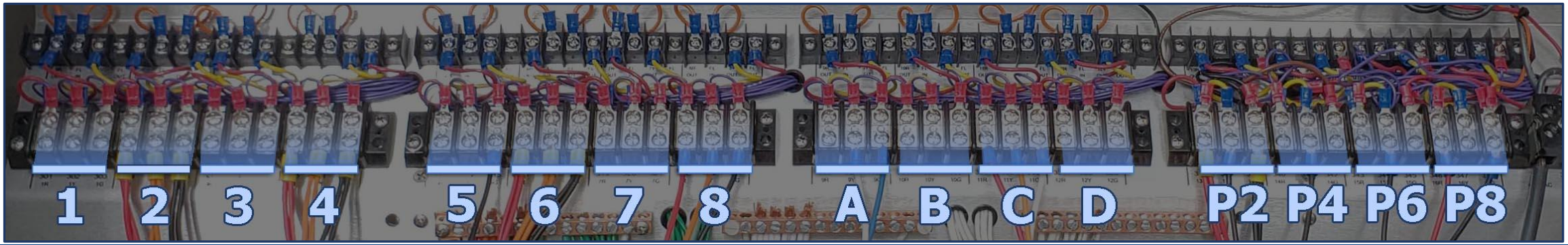
MST CHART – PHASING DIAGRAM



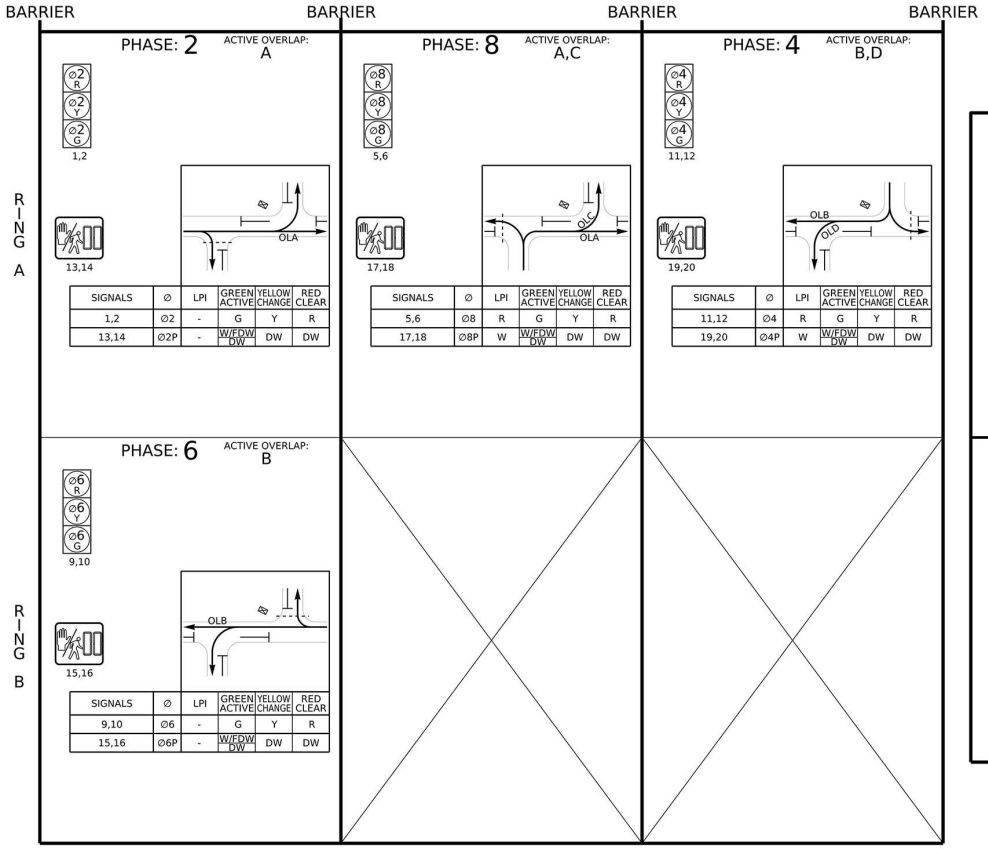
MST CHART – PHASING DIAGRAM







MST CHART – PHASING DIAGRAM



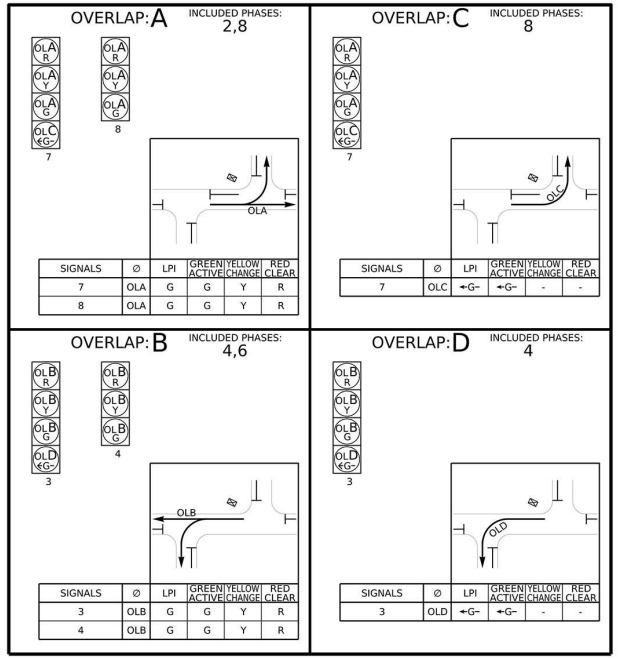
SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
1,2	∅2	-	G	Y	R
13,14	∅2P	-	W/FDW DW	DW	DW

SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
5,6	∅8	R	G	Y	R
17,18	∅8P	W	W/FDW DW	DW	DW

SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
11,12	∅4	R	G	Y	R
19,20	∅4P	W	W/FDW DW	DW	DW

SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
9,10	∅6	-	G	Y	R
15,16	∅6P	-	W/FDW DW	DW	DW

OVERLAPS

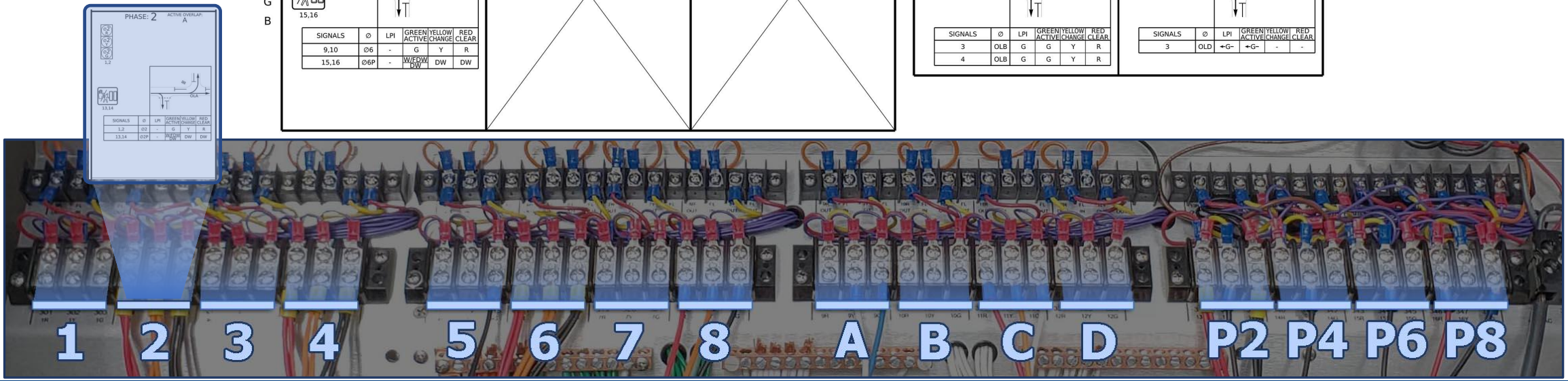


SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
7	OLA	G	G	Y	R
8	OLA	G	G	Y	R

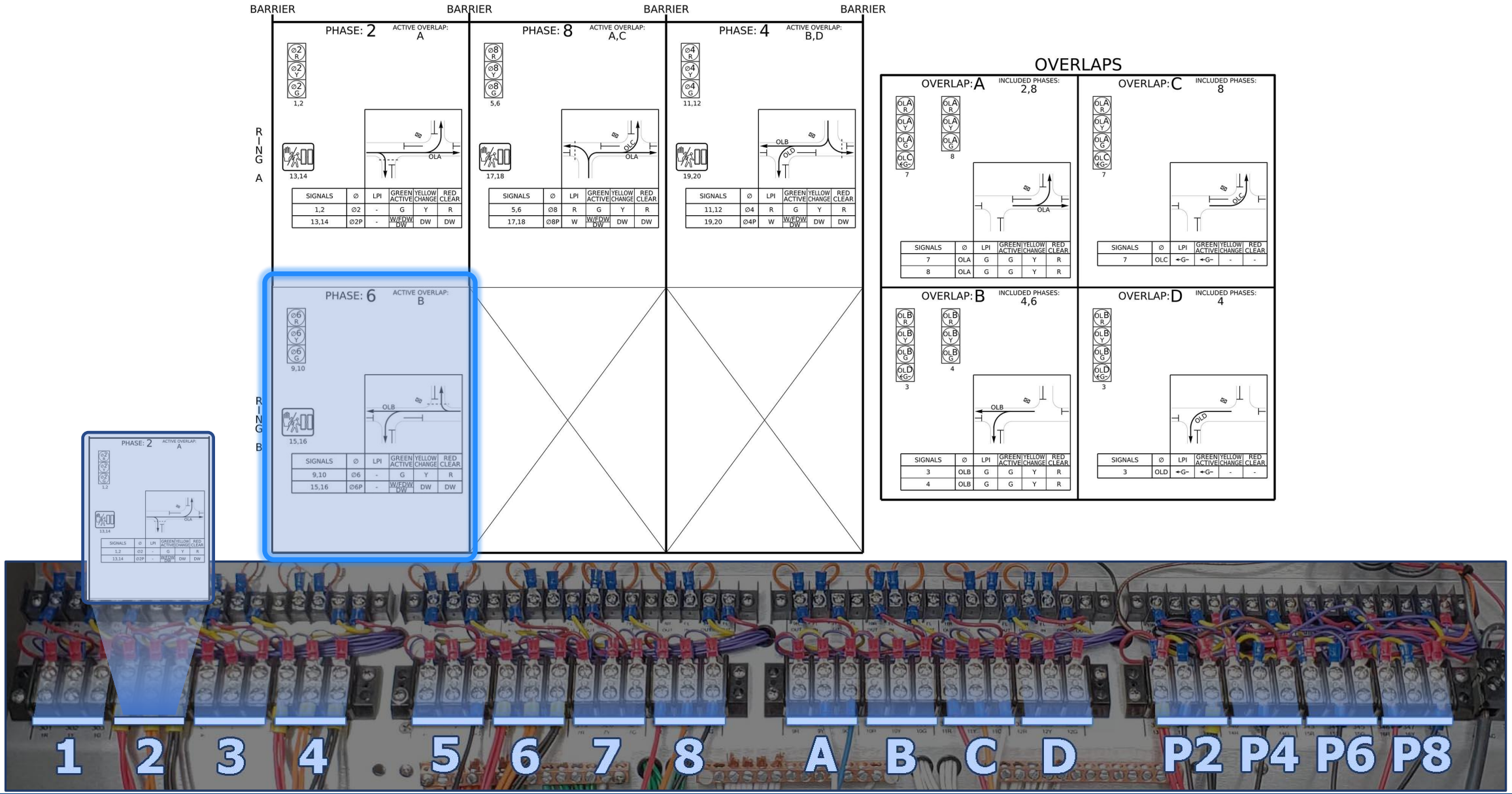
SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
7	OLC	←G–	←G–	-	-

SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
3	OLB	G	G	Y	R
4	OLB	G	G	Y	R

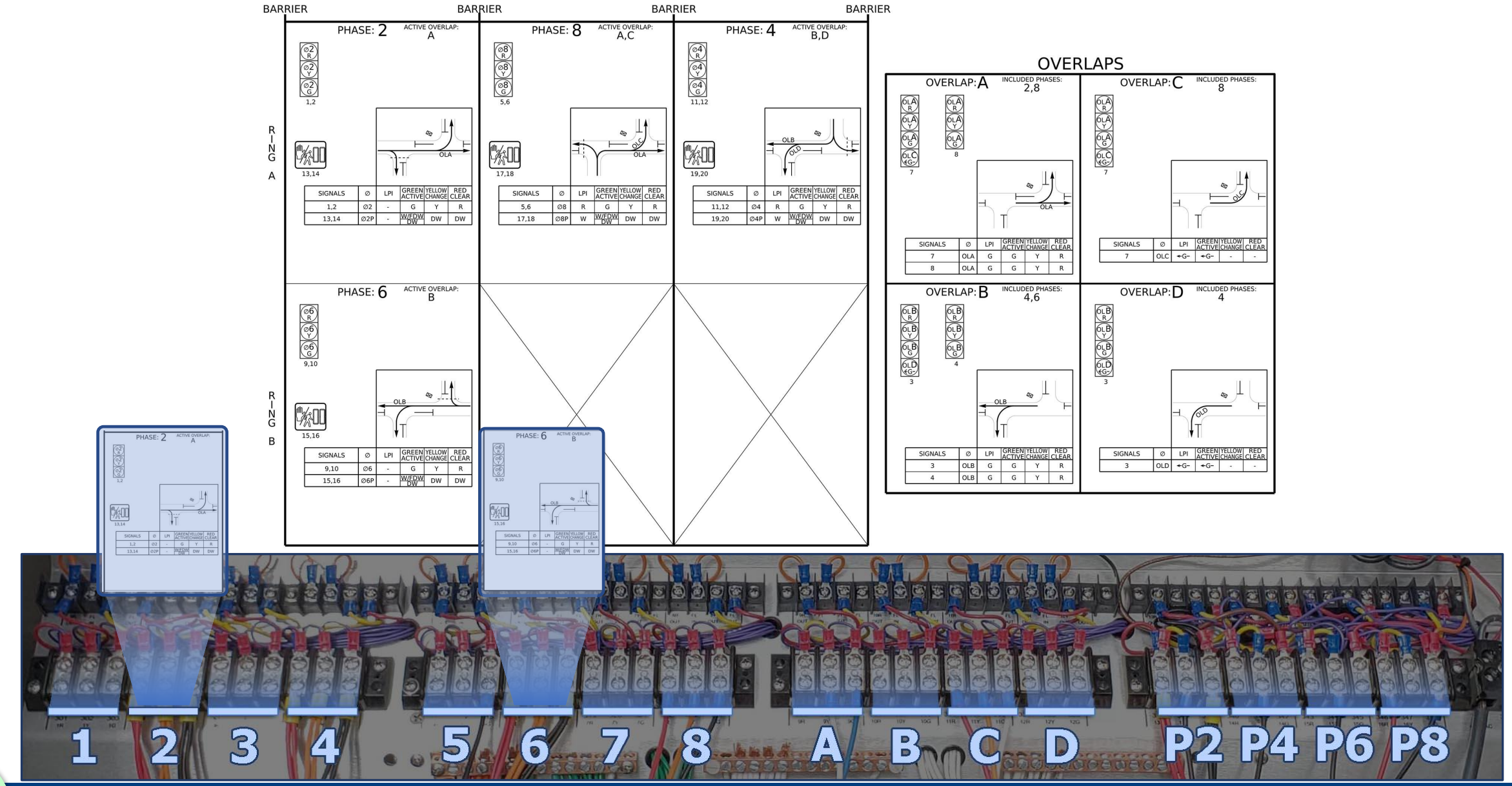
SIGNALS	∅	LPI	GREEN ACTIVE	YELLOW CHANGE	RED CLEAR
3	OLD	←G–	←G–	-	-



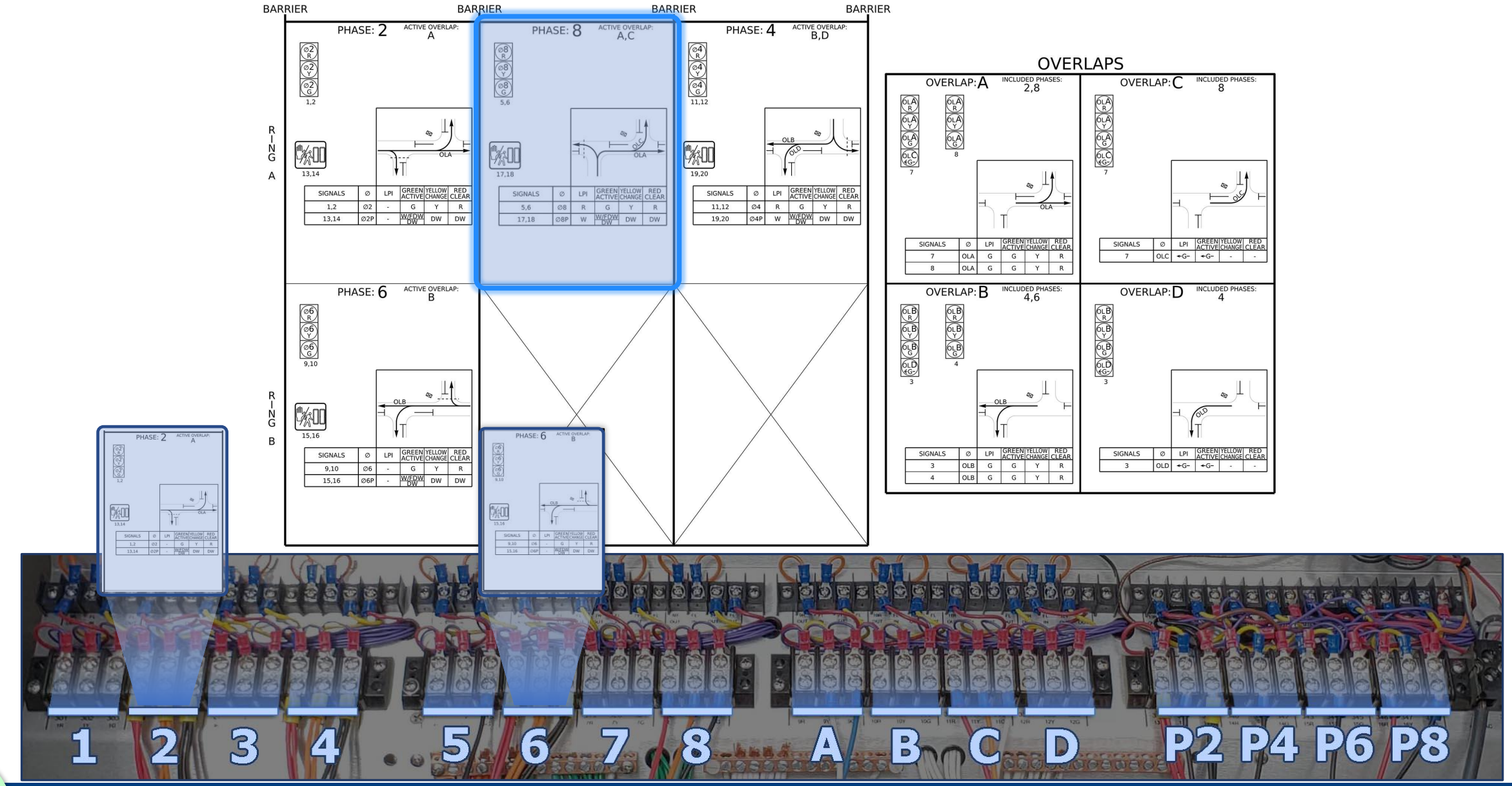
MST CHART – PHASING DIAGRAM



MST CHART – PHASING DIAGRAM



MST CHART – PHASING DIAGRAM



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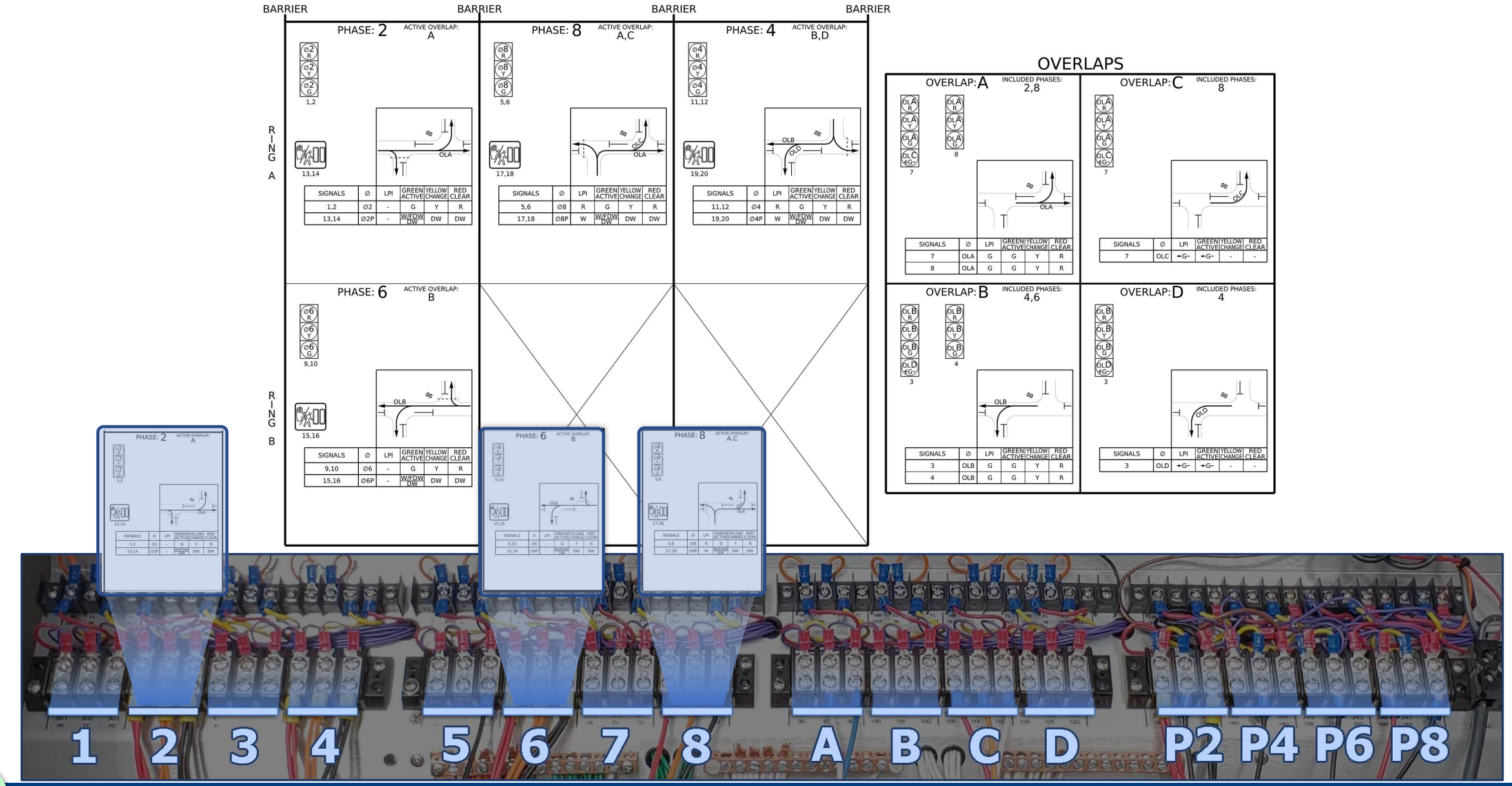

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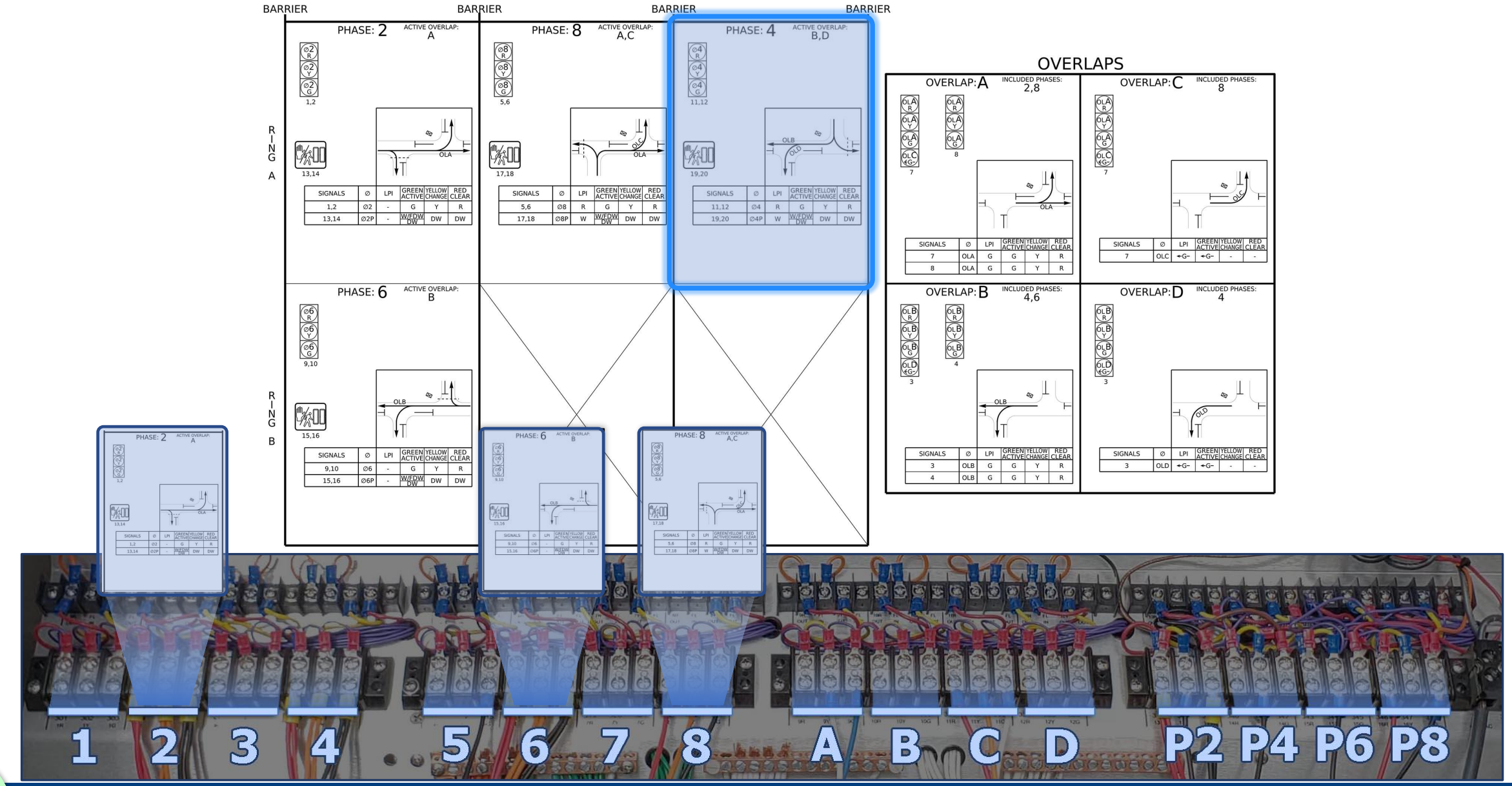

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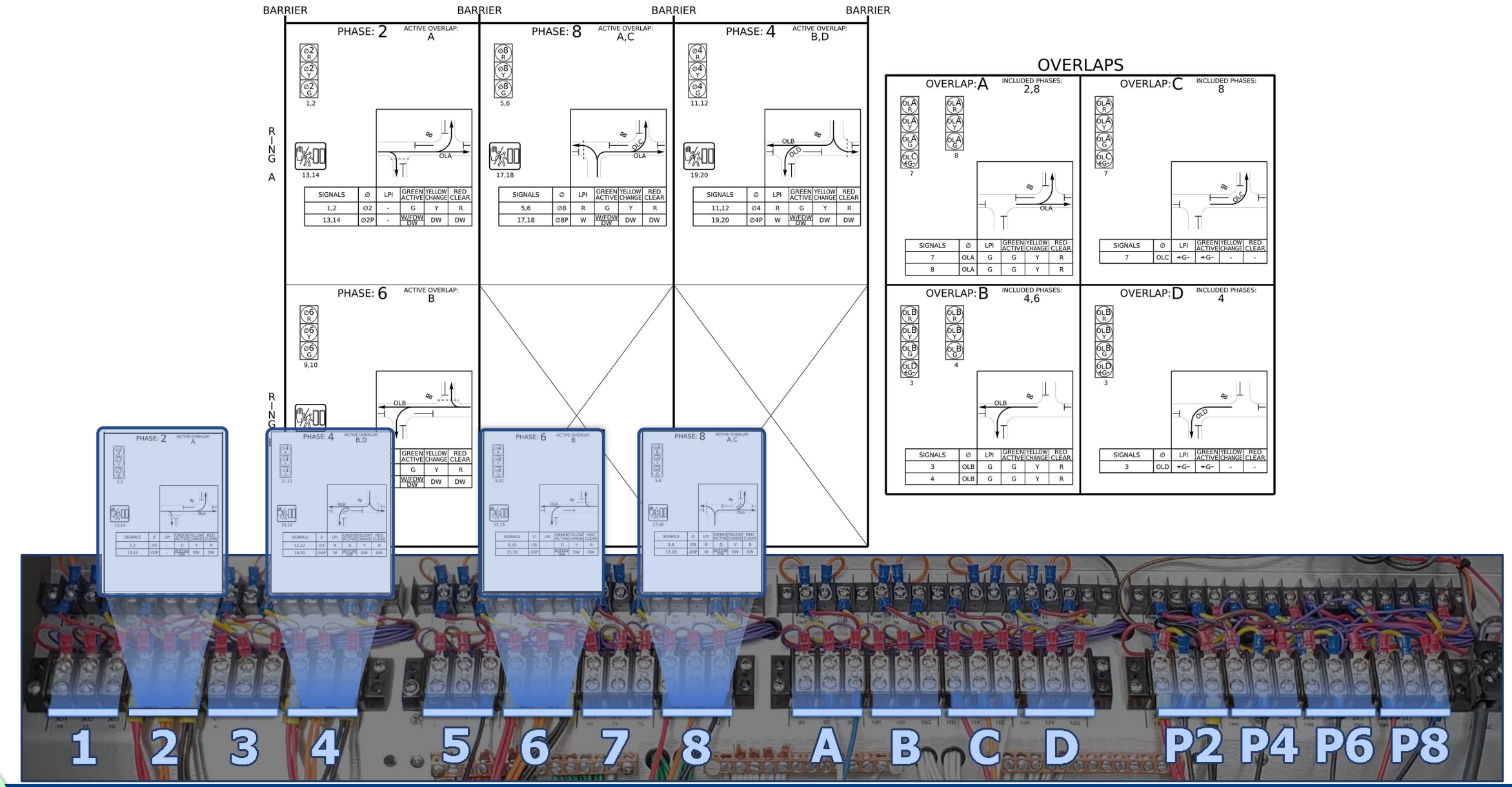

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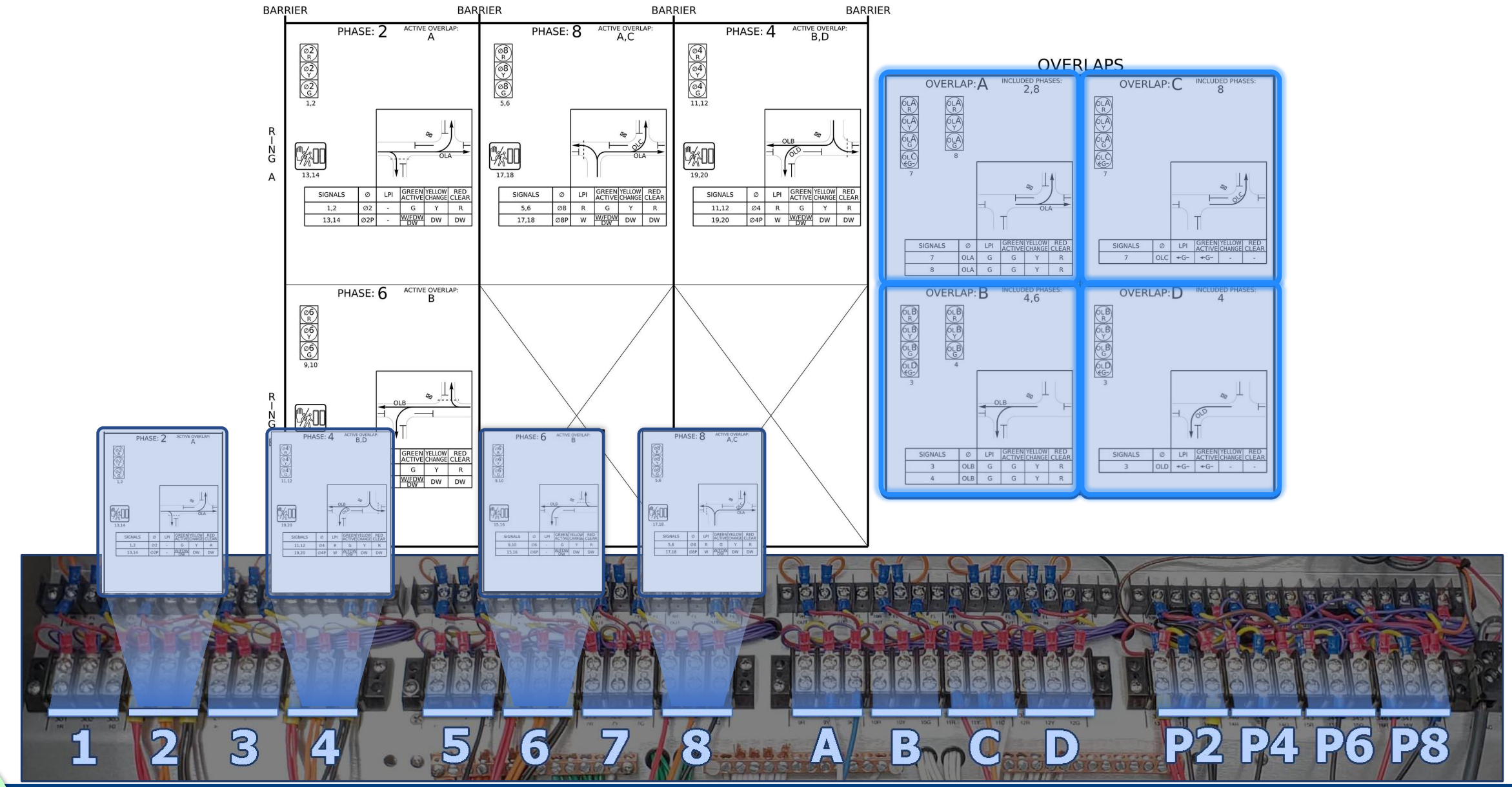

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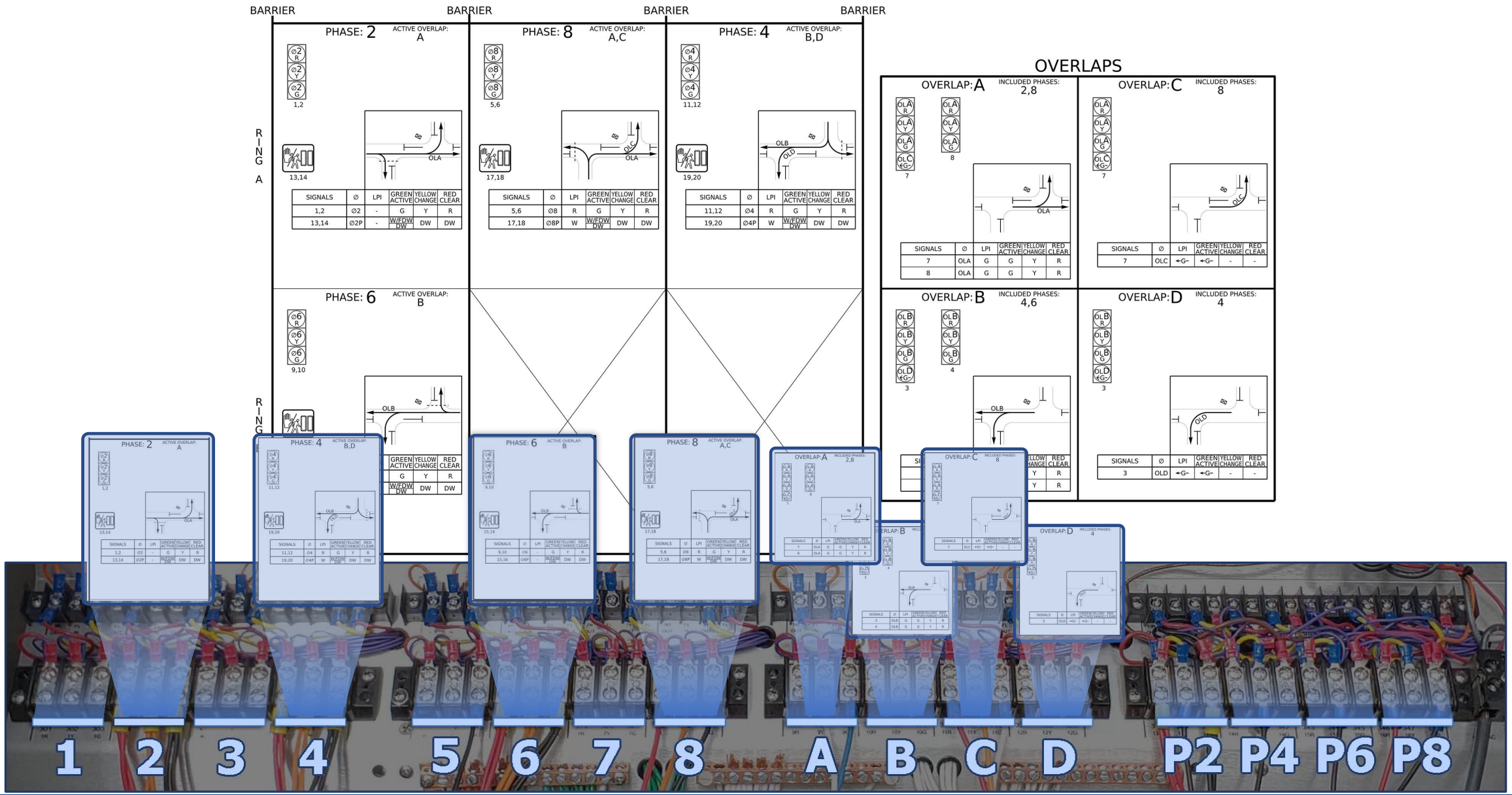

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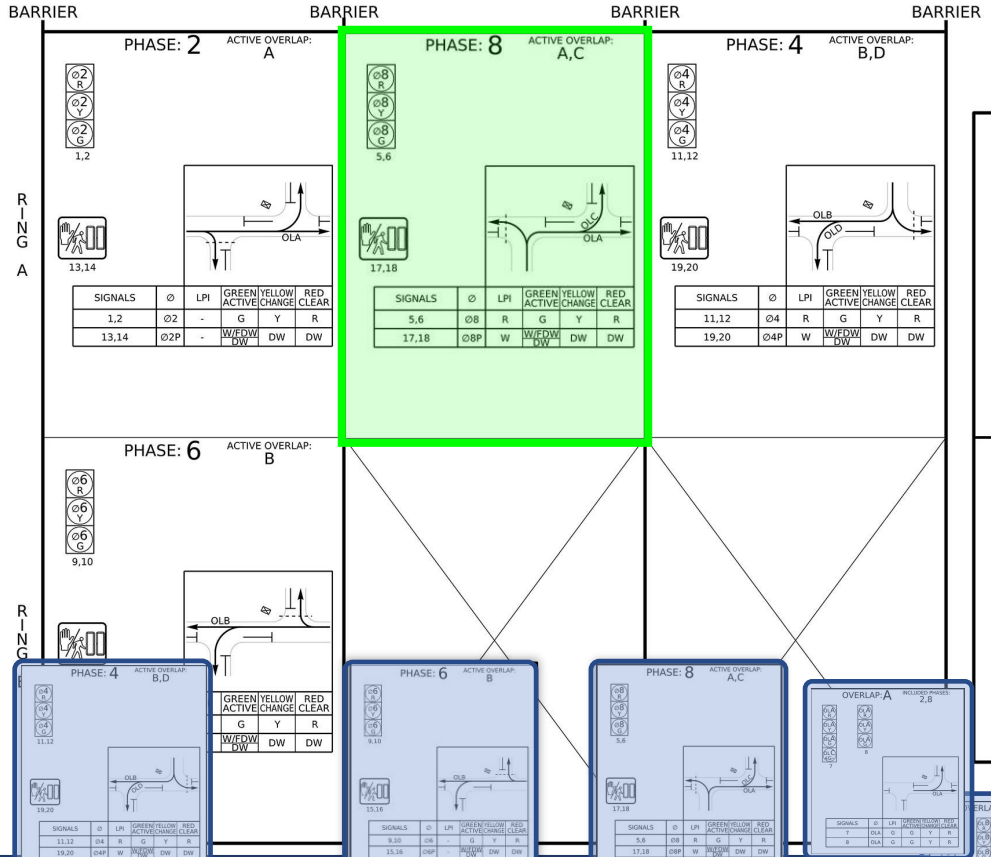
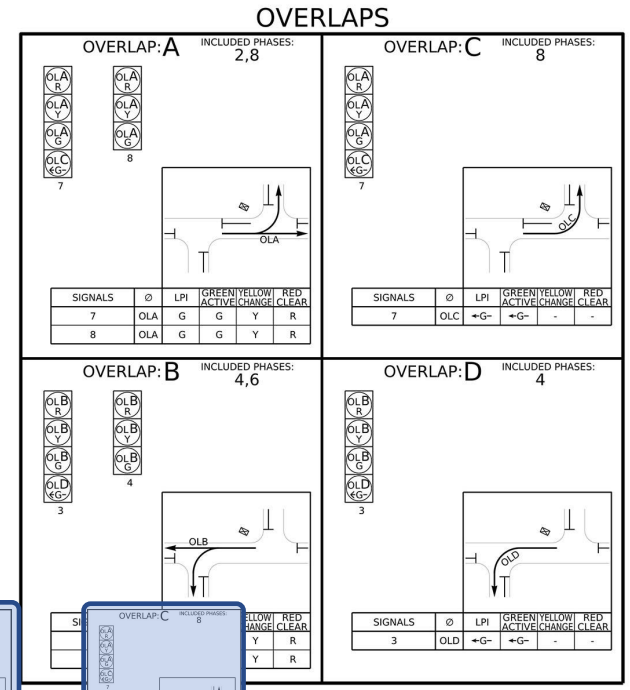
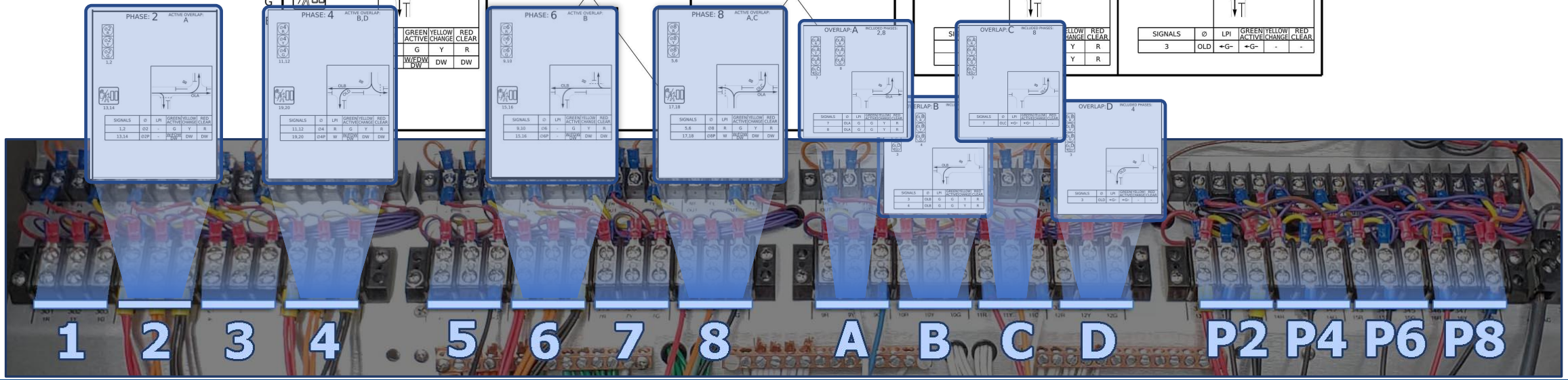
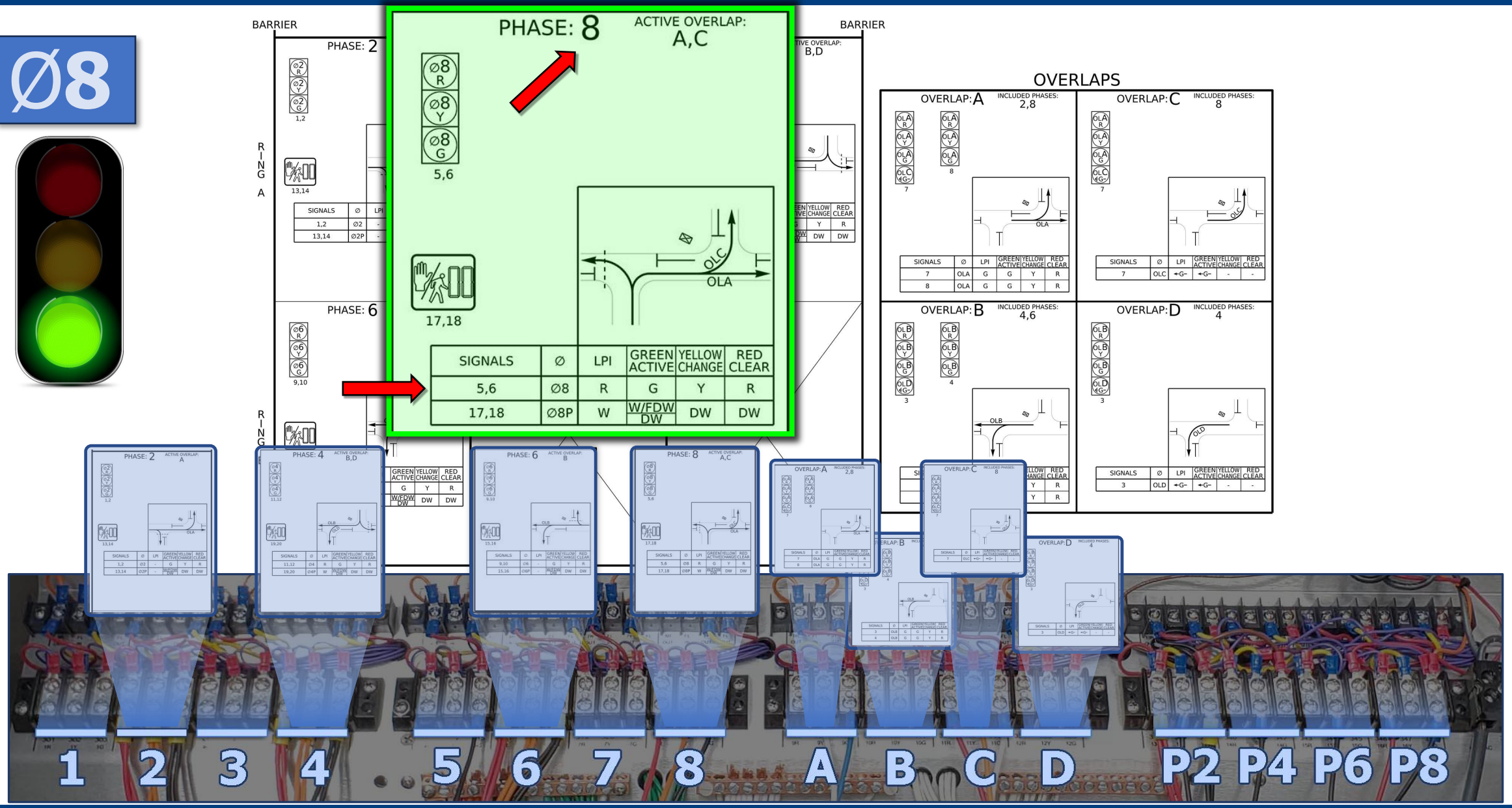


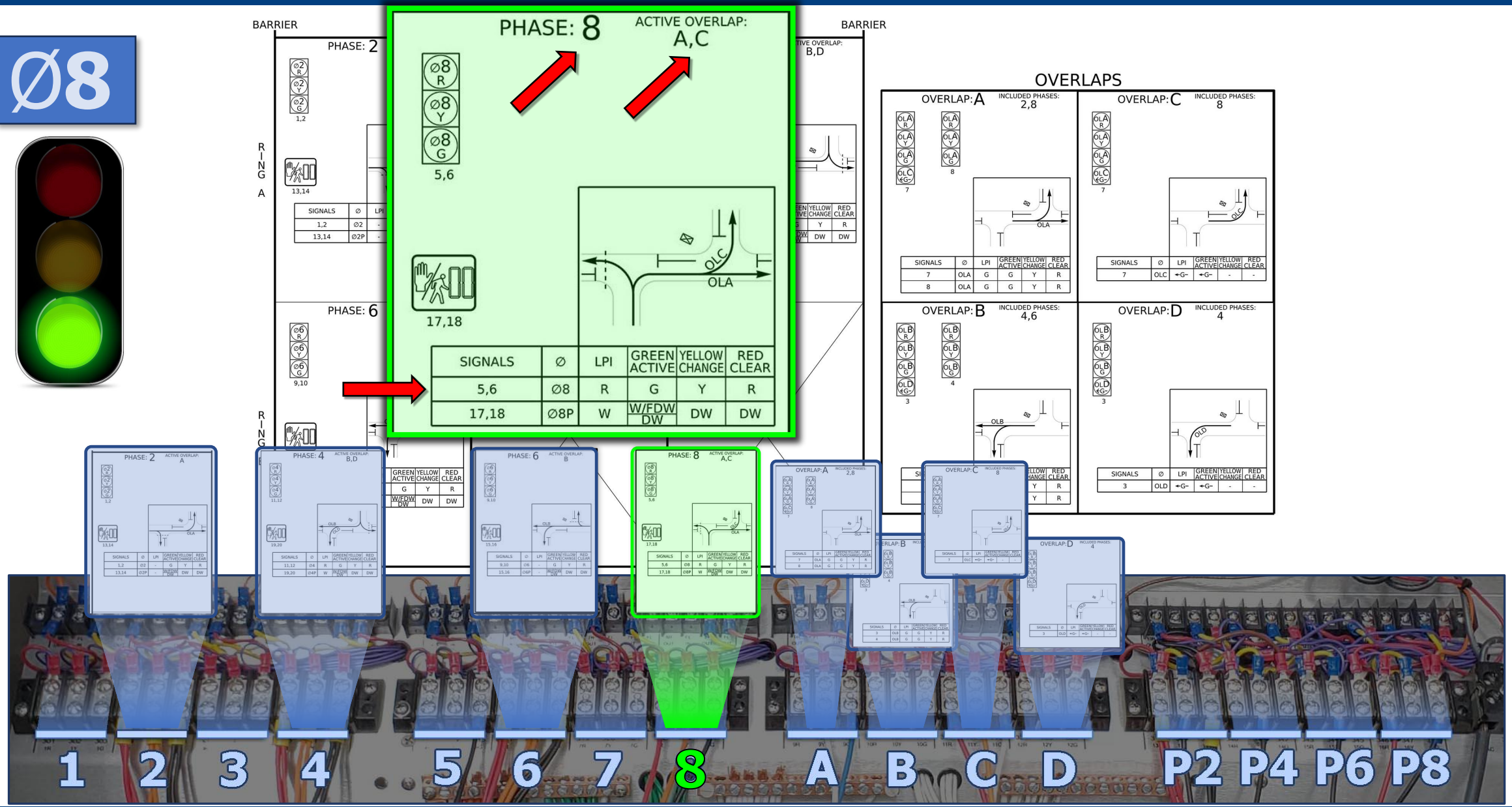




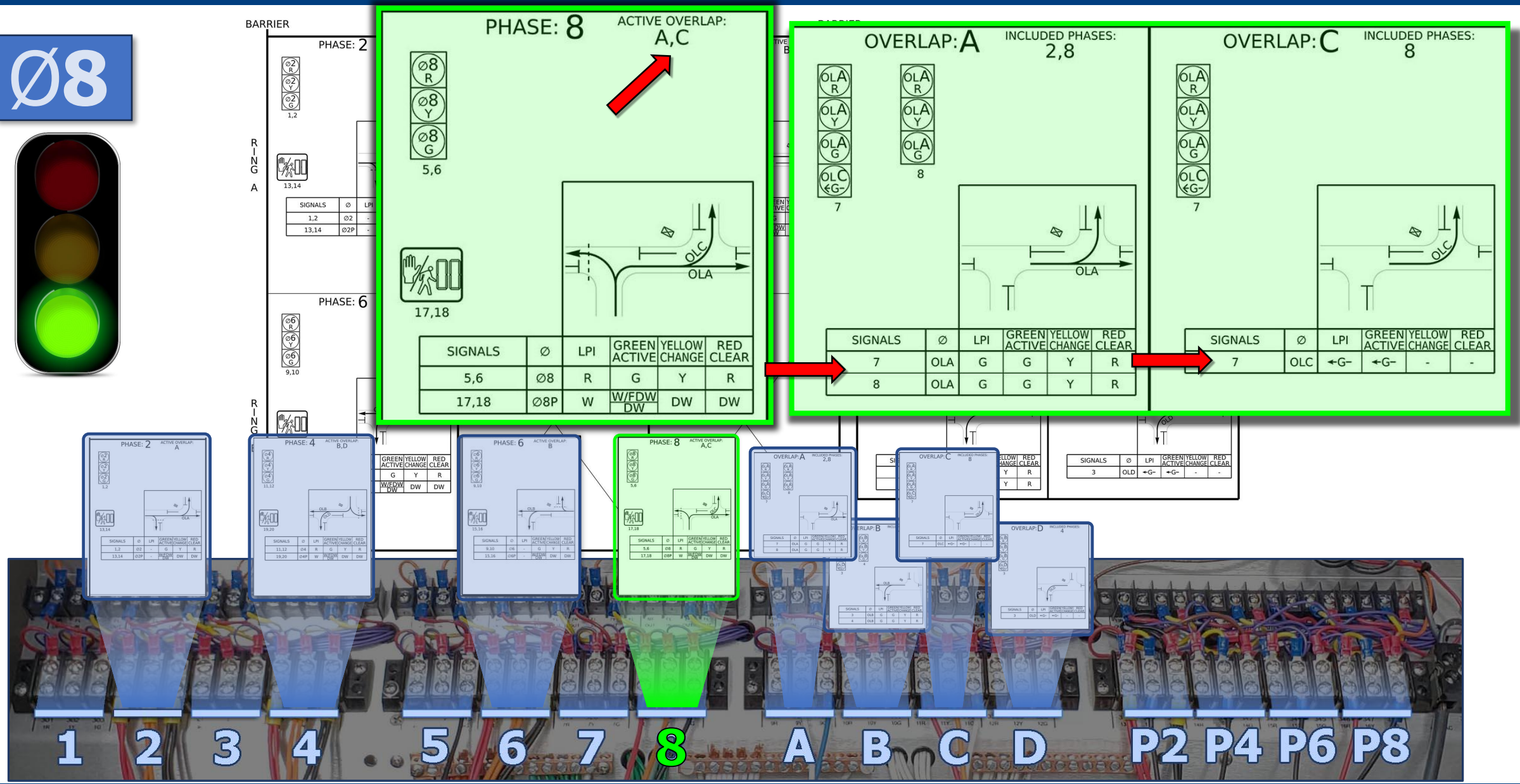
MST CHART – PHASING DIAGRAM



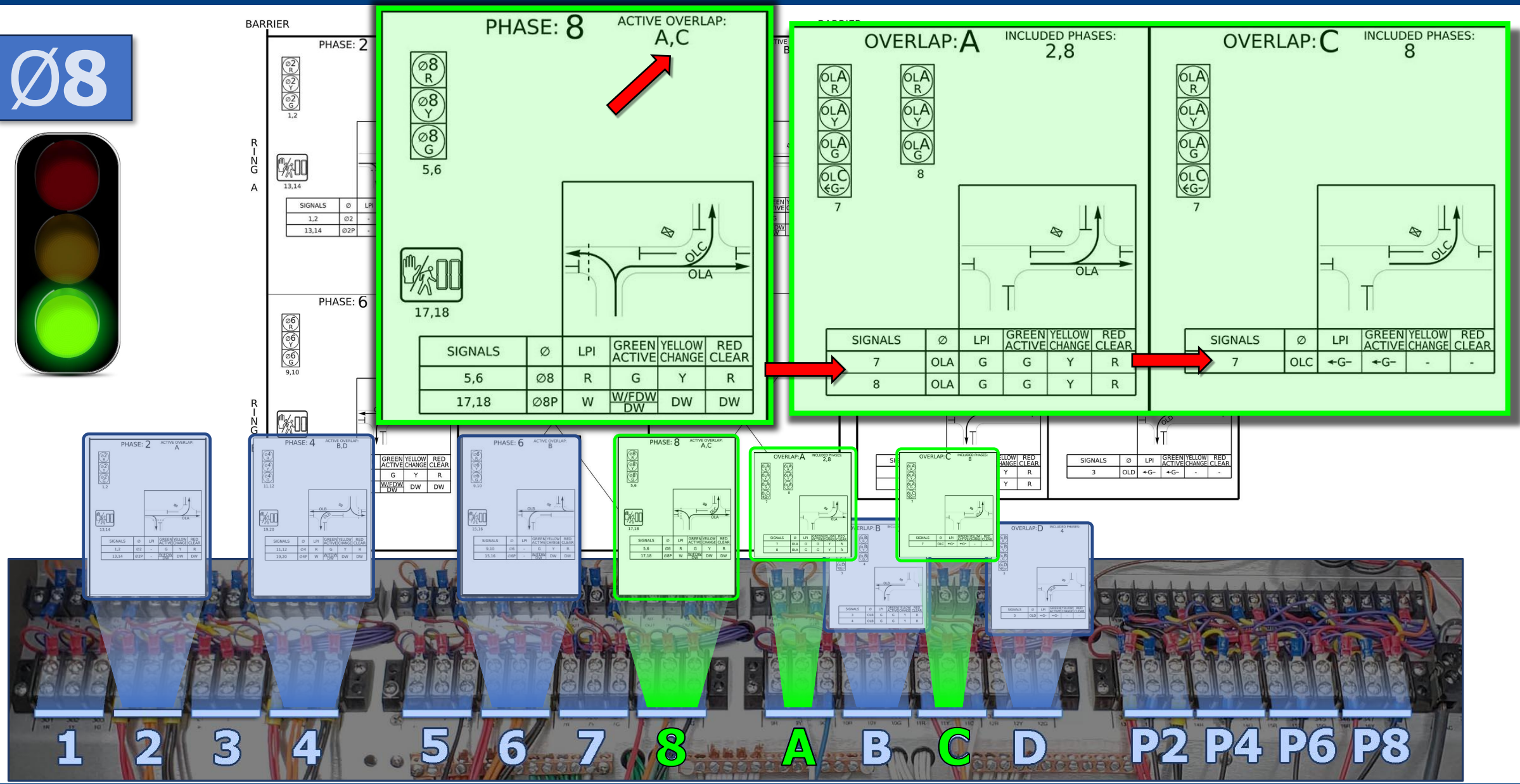
MST CHART – PHASING DIAGRAM



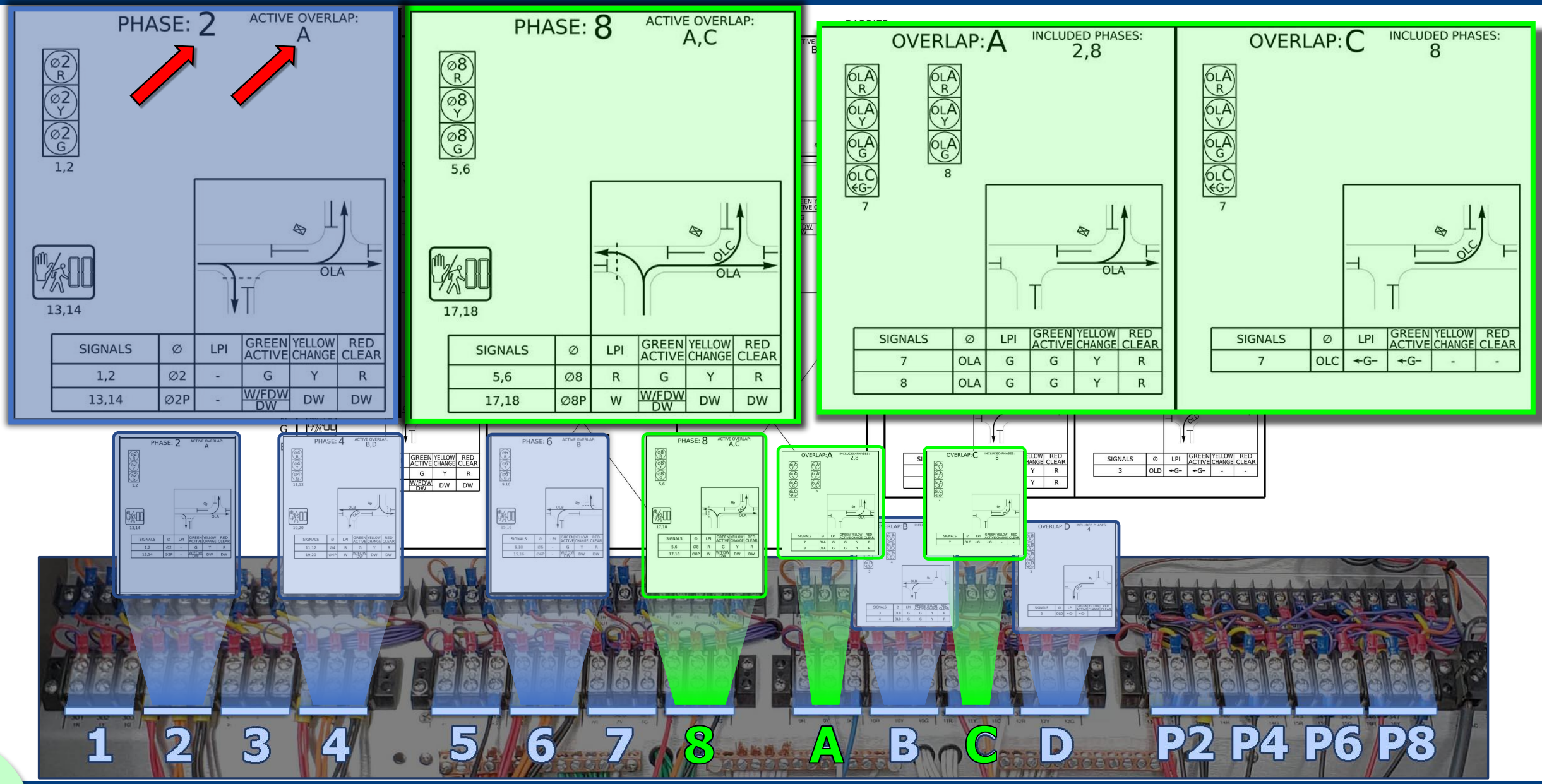
MST CHART – PHASING DIAGRAM



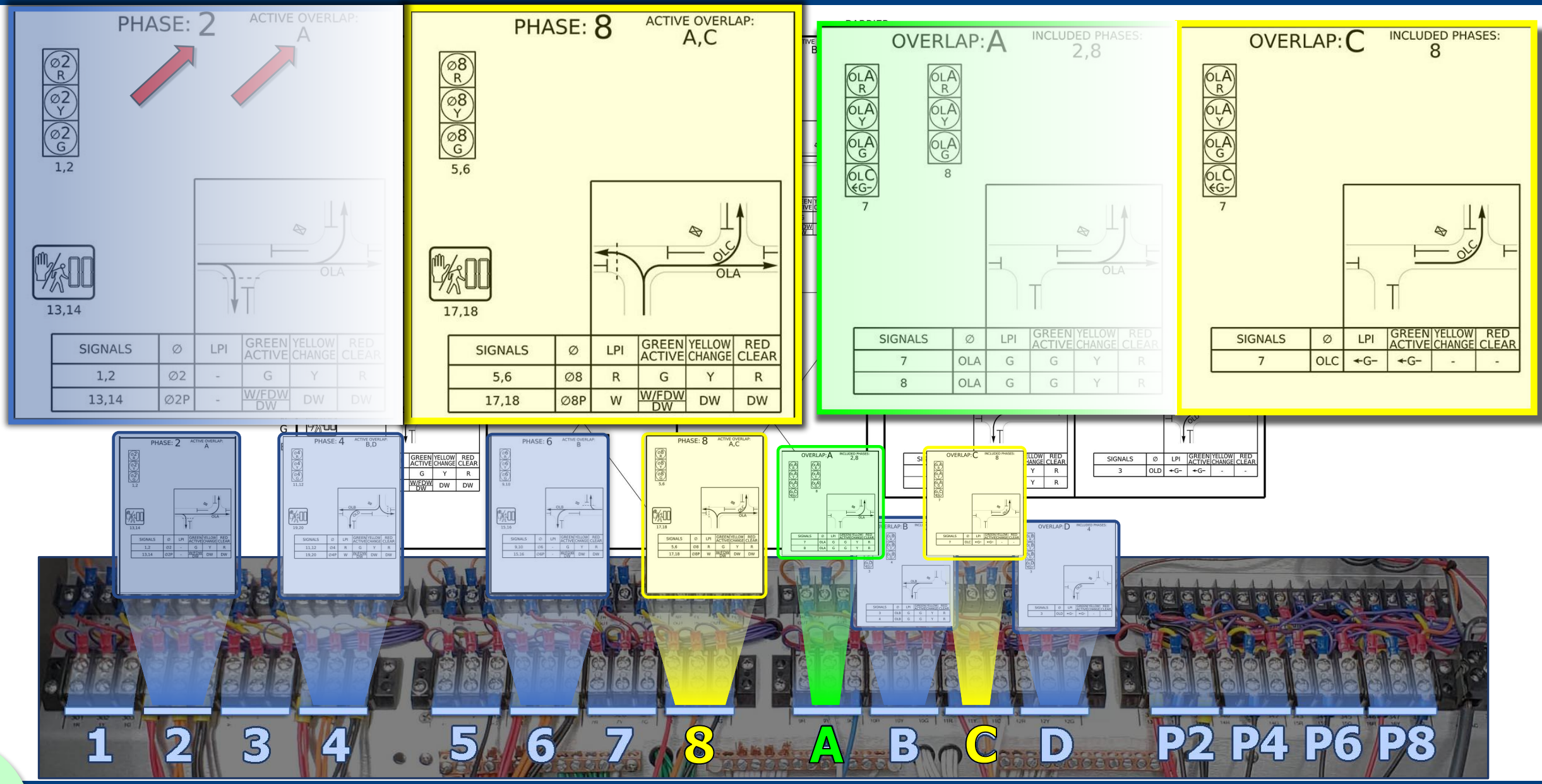
MST CHART – PHASING DIAGRAM



MST CHART – PHASING DIAGRAM



MST CHART – PHASING DIAGRAM



MST CHART – PHASING DIAGRAM

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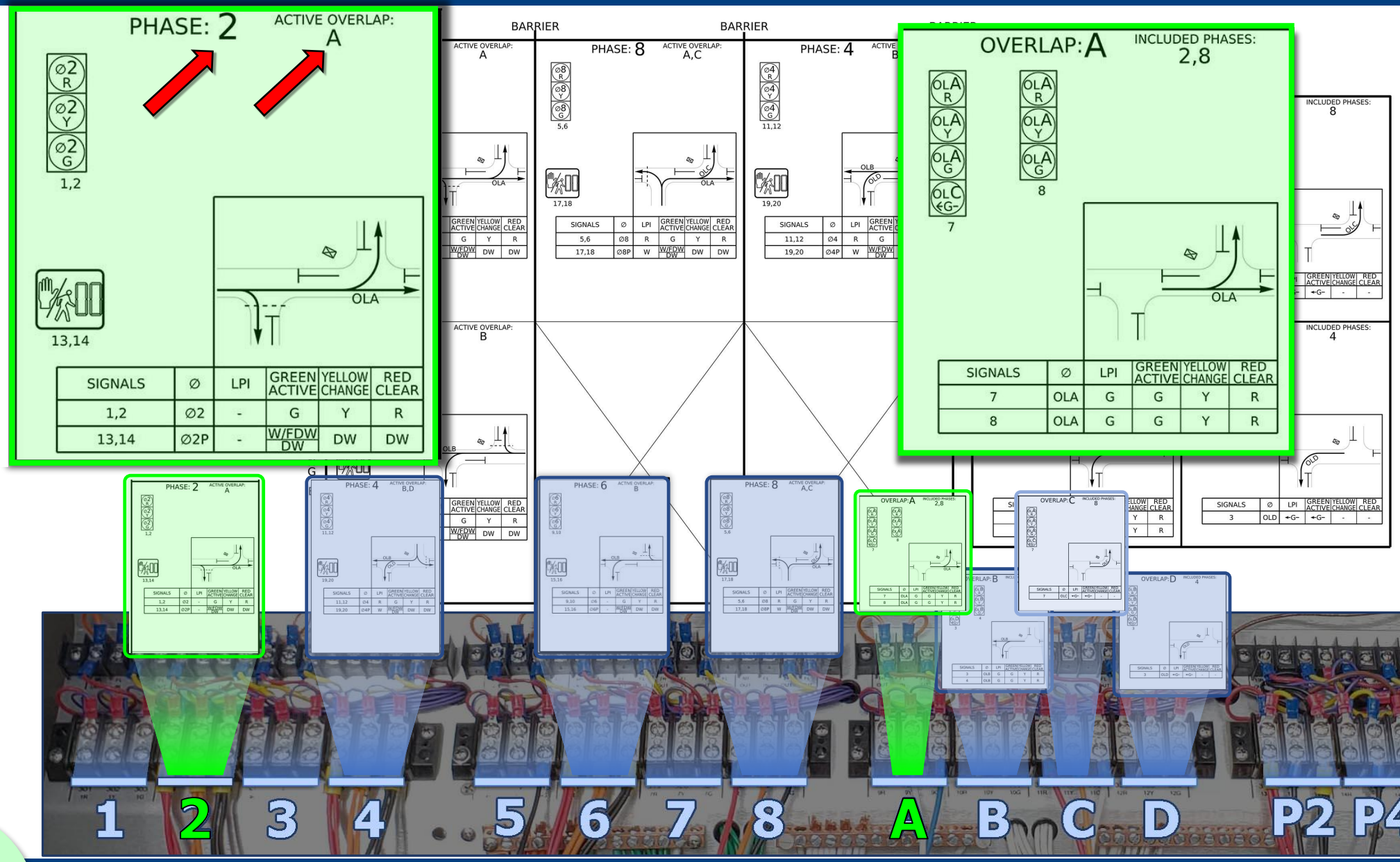


MST CHART PROPOSED TABLES

Programming Tables

MST CHART PROPOSED TABLES

Programming Tables

- Timings
- Preemption
- Overlaps

MST CHART PROPOSED TABLES

Programming Tables

Timings | Preemption | Overlaps

Green Timings:

PHASE TIMING

PHASES	1	2	3	4	5	6	7	8
MIN GREEN	5	12		5	5	12		5
ADVANCE WALK								
WALK		7		7				
PED CLEAR		10		20				
VEH EXT	2	2		2	2	2		2
MAX 1	30	60		30	30	60		30
MAX 2	30	60		30	30	60		30
YELLOW	4	4		3	4	4		3
RED	3	3		3	3	3		3
MIN RECALL								
MAX RECALL								
SOFT RECALL		X				X		
PED RECALL								
REST IN WALK								
DUAL ENTRY				X				X
LOCKING	X				X			

Shows all *individual* Phase TIMINGS.

Shows all *individual* Phase SETTINGS.

Easier to Read

MST CHART PROPOSED TABLES

Programming Tables

Timings

Preemption

Overlaps

Green Timings:

Clearance Times:

PHASE TIMING

PHASES	1	2	3	4	5	6	7	8
MIN GREEN	5	12		5	5	12		5
ADVANCE WALK								
WALK		7		7				
PED CLEAR		10		20				
VEH EXT	2	2		2	2	2		2
MAX 1	30	60		30	30	60		30
MAX 2	30	60		30	30	60		30
YELLOW	4	4		3	4	4		3
RED	3	3		3	3	3		3
MIN RECALL								
MAX RECALL								
SOFT RECALL		X				X		
PED RECALL								
REST IN WALK								
DUAL ENTRY				X				X
LOCKING	X				X			

Shows all *individual* Phase TIMINGS.

Shows all *individual* Phase SETTINGS.

Easier to Read

MST CHART PROPOSED TABLES

Programming Tables

Timings | Preemption | Overlaps

Green Timings:

Clearance Times:

Vehicle Recall:

PHASE TIMING

PHASES	1	2	3	4	5	6	7	8
MIN GREEN	5	12		5	5	12		5
ADVANCE WALK								
WALK		7		7				
PED CLEAR		10		20				
VEH EXT	2	2		2	2	2		2
MAX 1	30	60		30	30	60		30
MAX 2	30	60		30	30	60		30
YELLOW	4	4		3	4	4		3
RED	3	3		3	3	3		3
MIN RECALL								
MAX RECALL								
SOFT RECALL		X				X		
PED RECALL								
REST IN WALK								
DUAL ENTRY				X				X
LOCKING	X				X			

Shows all *individual* Phase TIMINGS.

Shows all *individual* Phase SETTINGS.

Easier to Read

MST CHART PROPOSED TABLES

Programming Tables

Timings

Preemption

Overlaps

Green Timings:

Clearance Times:

Vehicle Recall:

Pedestrian Recall:

PHASE TIMING

PHASES	1	2	3	4	5	6	7	8
MIN GREEN	5	12		5	5	12		5
ADVANCE WALK								
WALK		7		7				
PED CLEAR		10		20				
VEH EXT	2	2		2	2	2		2
MAX 1	30	60		30	30	60		30
MAX 2	30	60		30	30	60		30
YELLOW	4	4		3	4	4		3
RED	3	3		3	3	3		3
MIN RECALL								
MAX RECALL								
SOFT RECALL		X				X		
PED RECALL								
REST IN WALK								
DUAL ENTRY				X				X
LOCKING	X				X			

Shows all *individual* Phase TIMINGS.

Shows all *individual* Phase SETTINGS.

Easier to Read

MST CHART PROPOSED TABLES

Programming Tables

Timings | Preemption | Overlaps

Green Timings:

Clearance Times:

Vehicle Recall:

Pedestrian Recall:

Side Street Operation:

PHASE TIMING

PHASES	1	2	3	4	5	6	7	8
MIN GREEN	5	12		5	5	12		5
ADVANCE WALK								
WALK		7		7				
PED CLEAR		10		20				
VEH EXT	2	2		2	2	2		2
MAX 1	30	60		30	30	60		30
MAX 2	30	60		30	30	60		30
YELLOW	4	4		3	4	4		3
RED	3	3		3	3	3		3
MIN RECALL								
MAX RECALL								
SOFT RECALL		X				X		
PED RECALL								
REST IN WALK								
DUAL ENTRY				X				X
LOCKING	X				X			

Shows all *individual* Phase TIMINGS.

Shows all *individual* Phase SETTINGS.

Easier to Read

MST CHART PROPOSED TABLES

Programming Tables

Timings

Preemption

Overlaps

- **Green Timings:**
- **Clearance Times:**
- **Vehicle Recall:**
- **Pedestrian Recall:**
- **Side Street Operation:**
- **Detector Memory:**

PHASE TIMING

PHASES	1	2	3	4	5	6	7	8
MIN GREEN	5	12		5	5	12		5
ADVANCE WALK								
WALK		7		7				
PED CLEAR		10		20				
VEH EXT	2	2		2	2	2		2
MAX 1	30	60		30	30	60		30
MAX 2	30	60		30	30	60		30
YELLOW	4	4		3	4	4		3
RED	3	3		3	3	3		3
MIN RECALL								
MAX RECALL								
SOFT RECALL		X				X		
PED RECALL								
REST IN WALK								
DUAL ENTRY				X				X
LOCKING	X				X			

Shows all *individual* Phase TIMINGS.

Shows all *individual* Phase SETTINGS.

Easier to Read

MST CHART PROPOSED TABLES

Programming Tables

Timings

Preemption

Overlaps

MST CHART PROPOSED TABLES

Programming Tables

Timings

Preemption

- **EVP** (Emergency Vehicle)
- **Queue** (Ramp)
- **RR** (Railroad)

Overlaps

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP (Emergency Vehicle) | Queue | RR

Confirmation Light

EVP PREEMPTION

CONFIRMATION SIGNAL	A	B	C	D
DWELL PHASES Ø	1,6	2,5	4	8
DWELL OVERLAPS	B		A	
EXIT PHASE Ø	1,6	2,5	4	8

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP (Emergency Vehicle) | Queue | RR

Confirmation Light

Active Phases

EVP PREEMPTION

CONFIRMATION SIGNAL	A	B	C	D
DWELL PHASES Ø	1,6	2,5	4	8
DWELL OVERLAPS	B		A	
EXIT PHASE Ø	1,6	2,5	4	8

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP (Emergency Vehicle) | Queue | RR

Confirmation Light

Active Phases

Exit Phases

EVP PREEMPTION

CONFIRMATION SIGNAL	A	B	C	D
DWELL PHASES Ø	1,6	2,5	4	8
DWELL OVERLAPS	B		A	
EXIT PHASE Ø	1,6	2,5	4	8

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP | **Queue** (Ramp) | RR

Detector Number

QUEUE PREEMPTION

DETECTOR #	4
DELAY	30
DWELL PHASES Ø	4
DWELL OVERLAPS	A
PREEMPT MIN	35
PREEMPT MAX	35
EXIT PHASE Ø	4

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP | **Queue** (Ramp) | RR

Detector Number

Delay

QUEUE PREEMPTION

DETECTOR #	4
DELAY	30
DWELL PHASES Ø	4
DWELL OVERLAPS	A
PREEMPT MIN	35
PREEMPT MAX	35
EXIT PHASE Ø	4

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP | **Queue** (Ramp) | RR

Detector Number

Delay

Active Phases

QUEUE PREEMPTION

DETECTOR #	4
DELAY	30
DWELL PHASES Ø	4
DWELL OVERLAPS	A
PREEMPT MIN	35
PREEMPT MAX	35
EXIT PHASE Ø	4

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP | **Queue** (Ramp) | RR

Detector Number

Delay

Active Phases

Preempt Time

QUEUE PREEMPTION

DETECTOR #	4
DELAY	30
DWELL PHASES Ø	4
DWELL OVERLAPS	A
PREEMPT MIN	35
PREEMPT MAX	35
EXIT PHASE Ø	4

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP | **Queue** (Ramp) | RR

Detector Number

Delay

Active Phases

Preempt Time

Exit Phases

QUEUE PREEMPTION

DETECTOR #	4
DELAY	30
DWELL PHASES Ø	4
DWELL OVERLAPS	A
PREEMPT MIN	35
PREEMPT MAX	35
EXIT PHASE Ø	4

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP | Queue | **RR** (Railroad)

Clear Phases

RR PREEMPTION

TRACK CLEAR PHASE Ø	1,6
TRACK CLEAR OVERLAP	B
TRACK CLEAR GREEN	10
TRACK CLEAR YELLOW	5
TRACK CLEAR RED	2
RR DWELL PHASES Ø	2,6
RR DWELL OVERLAPS	A
EXIT PHASE Ø	2,6

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP | Queue | **RR** (Railroad)

Clear Phases

Clear Duration

RR PREEMPTION

TRACK CLEAR PHASE Ø	1,6
TRACK CLEAR OVERLAP	B
TRACK CLEAR GREEN	10
TRACK CLEAR YELLOW	5
TRACK CLEAR RED	2
RR DWELL PHASES Ø	2,6
RR DWELL OVERLAPS	A
EXIT PHASE Ø	2,6

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP | Queue | **RR** (Railroad)

Clear Phases

Clear Duration

Clearance Times

RR PREEMPTION

TRACK CLEAR PHASE Ø	1,6
TRACK CLEAR OVERLAP	B
TRACK CLEAR GREEN	10
TRACK CLEAR YELLOW	5
TRACK CLEAR RED	2
RR DWELL PHASES Ø	2,6
RR DWELL OVERLAPS	A
EXIT PHASE Ø	2,6

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP | Queue | **RR** (Railroad)

Clear Phases

Clear Duration

Clearance Times

Preempt Phases

RR PREEMPTION

TRACK CLEAR PHASE Ø	1,6
TRACK CLEAR OVERLAP	B
TRACK CLEAR GREEN	10
TRACK CLEAR YELLOW	5
TRACK CLEAR RED	2
RR DWELL PHASES Ø	2,6
RR DWELL OVERLAPS	A
EXIT PHASE Ø	2,6

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP | Queue | **RR** (Railroad)

Clear Phases

Clear Duration

Clearance Times

Preempt Phases

Exit Phases

RR PREEMPTION

TRACK CLEAR PHASE Ø	1,6
TRACK CLEAR OVERLAP	B
TRACK CLEAR GREEN	10
TRACK CLEAR YELLOW	5
TRACK CLEAR RED	2
RR DWELL PHASES Ø	2,6
RR DWELL OVERLAPS	A
EXIT PHASE Ø	2,6

MST CHART PROPOSED TABLES

Programming Tables

Timings | **Preemption** | Overlaps

EVP (Emergency Vehicle) | **Queue** (Ramp) | **RR** (Railroad)

EVP PREEMPTION

CONFIRMATION SIGNAL	A	B	C	D
DWELL PHASES Ø	1,6	2,5	4	8
DWELL OVERLAPS	B		A	
EXIT PHASE Ø	1,6	2,5	4	8

QUEUE PREEMPTION

DETECTOR #	4
DELAY	30
DWELL PHASES Ø	4
DWELL OVERLAPS	A
PREEMPT MIN	35
PREEMPT MAX	35
EXIT PHASE Ø	4

RR PREEMPTION

TRACK CLEAR PHASE Ø	1,6
TRACK CLEAR OVERLAP	B
TRACK CLEAR GREEN	10
TRACK CLEAR YELLOW	5
TRACK CLEAR RED	2
RR DWELL PHASES Ø	2,6
RR DWELL OVERLAPS	A
EXIT PHASE Ø	2,6

MST CHART PROPOSED TABLES

Programming Tables

Timings | Preemption | **Overlaps**

Name:

OVERLAPS

OVERLAPS	A	B	C	D	E
SIGNALS	2	4	5	9,10	12
INDICATIONS	R Y ←G– G	←R– ←Y– ←FY–	←R– ←Y– ←FY–	R Y G	–Y→ –G→
TYPE	NORMAL	FYA	FYA	NORMAL	NORMAL
INCLUDED PHASES Ø	5			3,6	4,5,8
FYA PROTECTED Ø		5	1		
FYA PERMISSIVE Ø		6	2		
FYA START DELAY		2	2		
LAG GREEN	0	0	0	0	0
YELLOW	0	0	0	0	0
RED	0	0	0	0	0

MST CHART PROPOSED TABLES

Programming Tables

Timings | Preemption | **Overlaps**

Name:

Signals & Indications

OVERLAPS

OVERLAPS	A	B	C	D	E
SIGNALS	2	4	5	9,10	12
INDICATIONS	R Y ←G– G	←R– ←Y– ←FY–	←R– ←Y– ←FY–	R Y G	–Y→ –G→
TYPE	NORMAL	FYA	FYA	NORMAL	NORMAL
INCLUDED PHASES Ø	5			3,6	4,5,8
FYA PROTECTED Ø		5	1		
FYA PERMISSIVE Ø		6	2		
FYA START DELAY		2	2		
LAG GREEN	0	0	0	0	0
YELLOW	0	0	0	0	0
RED	0	0	0	0	0

MST CHART PROPOSED TABLES

Programming Tables

Timings | Preemption | **Overlaps**

Name:

Signals & Indications

Type:

OVERLAPS

OVERLAPS	A	B	C	D	E
SIGNALS	2	4	5	9,10	12
INDICATIONS	R Y ←G– G	←R– ←Y– ←FY–	←R– ←Y– ←FY–	R Y G	–Y→ –G→
TYPE	NORMAL	FYA	FYA	NORMAL	NORMAL
INCLUDED PHASES Ø	5			3,6	4,5,8
FYA PROTECTED Ø		5	1		
FYA PERMISSIVE Ø		6	2		
FYA START DELAY		2	2		
LAG GREEN	0	0	0	0	0
YELLOW	0	0	0	0	0
RED	0	0	0	0	0

MST CHART PROPOSED TABLES

Programming Tables

Timings | Preemption | **Overlaps**

Name:

Signals & Indications

Type:

Phases:

OVERLAPS

OVERLAPS	A	B	C	D	E
SIGNALS	2	4	5	9,10	12
INDICATIONS	R Y ←G– G	←R– ←Y– ←FY–	←R– ←Y– ←FY–	R Y G	–Y→ –G→
TYPE	NORMAL	FYA	FYA	NORMAL	NORMAL
INCLUDED PHASES Ø	5			3,6	4,5,8
FYA PROTECTED Ø		5	1		
FYA PERMISSIVE Ø		6	2		
FYA START DELAY		2	2		
LAG GREEN	0	0	0	0	0
YELLOW	0	0	0	0	0
RED	0	0	0	0	0

MST CHART PROPOSED TABLES

Programming Tables

Timings | Preemption | **Overlaps**

Name:

Signals & Indications

Type:

Phases:

FYA Operation:

OVERLAPS

OVERLAPS	A	B	C	D	E
SIGNALS	2	4	5	9,10	12
INDICATIONS	R Y ←G– G	←R– ←Y– ←FY–	←R– ←Y– ←FY–	R Y G	–Y→ –G→
TYPE	NORMAL	FYA	FYA	NORMAL	NORMAL
INCLUDED PHASES Ø	5			3,6	4,5,8
FYA PROTECTED Ø		5	1		
FYA PERMISSIVE Ø		6	2		
FYA START DELAY		2	2		
LAG GREEN	0	0	0	0	0
YELLOW	0	0	0	0	0
RED	0	0	0	0	0

MST CHART PROPOSED TABLES

Programming Tables

Timings | Preemption | **Overlaps**

Name:

Signals & Indications

Type:

Phases:

FYA Operation:

Lag & Clearance

OVERLAPS

OVERLAPS	A	B	C	D	E
SIGNALS	2	4	5	9,10	12
INDICATIONS	R Y ←G– G	←R– ←Y– ←FY–	←R– ←Y– ←FY–	R Y G	–Y→ –G→
TYPE	NORMAL	FYA	FYA	NORMAL	NORMAL
INCLUDED PHASES Ø	5			3,6	4,5,8
FYA PROTECTED Ø		5	1		
FYA PERMISSIVE Ø		6	2		
FYA START DELAY		2	2		
LAG GREEN	0	0	0	0	0
YELLOW	0	0	0	0	0
RED	0	0	0	0	0

MST CHART CHANGES

THANK YOU!

QUESTIONS?

DAN FEDIO
PENNDOT D-11
TRAFFIC SIGNAL SUPERVISOR

Pennsylvania
Department of Transportation

PUBLICATION 149: OTHER MAJOR UPDATES

ITE MID-COLONIAL DISTRICT ANNUAL MEETING • APRIL 17, 2026

Pennsylvania Department of Transportation

PHOTO CREDIT: CITY OF PITTSBURGH

Project Scope

Level	Title	Definition
0	Equipment Upgrades	Replacement, upgrade, or addition of traffic control signal equipment which does not impact information shown on the traffic control signal permit condition diagram
1	Retiming	Limited to timing/phasing modifications which are accomplished with existing equipment
2	Minor Alterations	Modifications to items shown on the traffic signal permit condition diagram, but does not include replacement or installation of mast arm, strain pole, or pedestal traffic control signal supports
3	Major Alterations	Modifications to the traffic control signal which include replacement or addition of mast arm, strain pole, or pedestal traffic control signal supports, but retain some existing traffic control signal equipment
4	New Construction/ Replacement	Installation of: ▪ a new traffic control signal at an unsignalized intersection, or ▪ full modernization/replacement of all traffic control signal equipment at an existing signalized intersection

Project Scope: Highlights

Work Required	Required for Level				
	0	1	2	3	4
Left turn phasing evaluation				◆	◆
New CADD drawing				◆	◆
Markup of existing permit is acceptable			◆		
Construction Plan			◆	◆	◆
Permit Plan		◆	◆	◆	◆
No plan required	◆				
Vulnerable Road User Study				◆	◆
Must add backplates			◆	◆	◆

Left Turn Phasing: Modes

- Permissive Only mode
- Protected Only Mode
  - Protected-Prohibited
  - Split Phasing
- Protected/Permissive Mode
- Variable Left-Turn Mode
- Prohibited

Left-Turn Phasing: Mode Selection

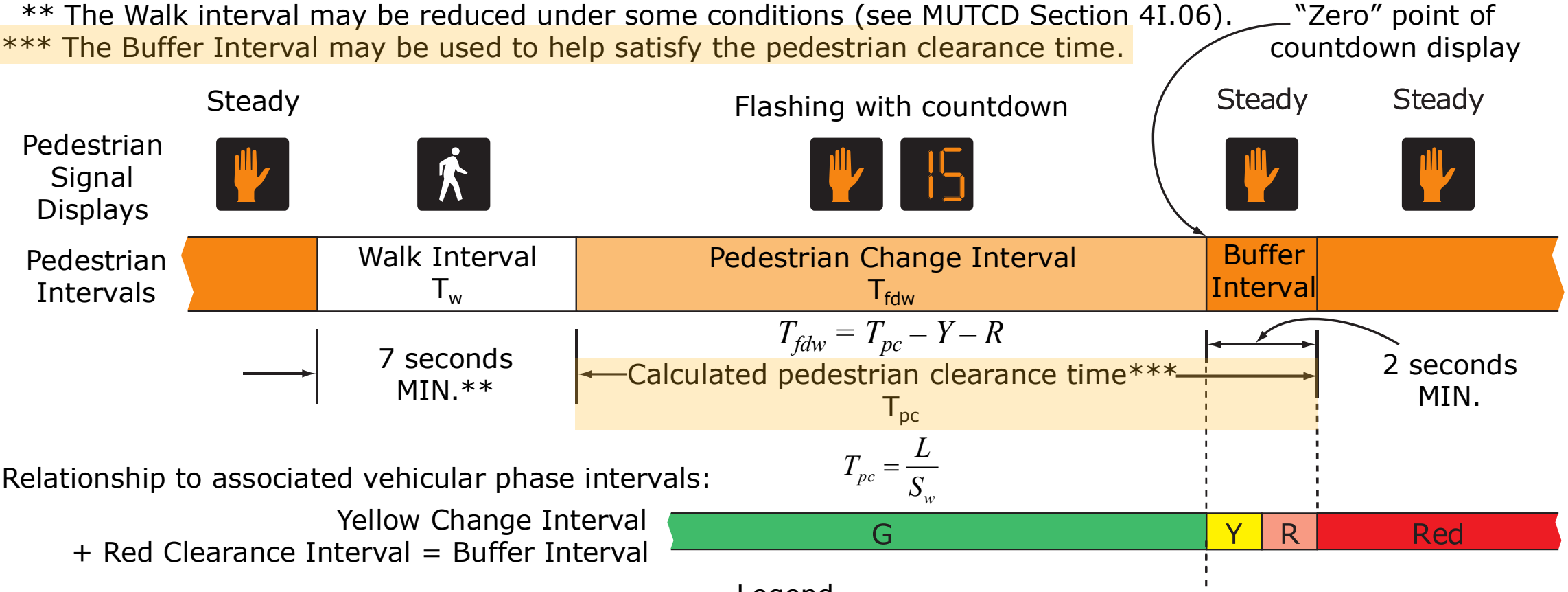
- Protected-only mode (permissive left turns always inappropriate)
  - Left turn can be made from more than one lane
  - Three or more opposing through lanes
  - Multi-legged intersections with more than four approaches
  - Approaches with significant non-correctable sight distance deficiencies, including deficiencies created by stopped opposing left-turn vehicles
- Variable mode (permissive left turns inappropriate sometimes)
  - Approaches with 5+ crashes susceptible to correction by protected-prohibited phasing
  - Min. 2 lefts per cycle AND conflict factor
    - >50,000 with one opposing lane
    - > 65,000 with two opposing lanes
  - Opposing speed limit > 45 AND 3+ left turns per cycle
  - Across two opposing through lanes and bike lane or crosswalk when > 1.5 permitted left turns per cycle with high potential for conflicts with ped/bike

Left-Turn Phasing: Mode Selection

- Other factors
  - Vehicle characteristics
  - Adjacent traffic signals
  - Delay
  - Induced demand
  - Left-turn storage
  - Intersection geometry
  - Pedestrian conflicts
  - Bicycle conflicts
  - Existing phasing

PEDESTRIAN INTERVALS

** The Walk interval may be reduced under some conditions (see MUTCD Section 4I.06).
*** The Buffer Interval may be used to help satisfy the pedestrian clearance time.



Legend

G = Green Interval
Y = Yellow Change Interval (of at least 3 seconds)
R = Red Clearance Interval
Red = Red because conflicting traffic has been released

Engineering judgment should be used to determine when it is appropriate to subtract the yellow change and red clearance interval from the calculated pedestrian clearance time.

Oversize Pedestrian Intervals

- When in coordination, pedestrian phase time should be incorporated into the background cycle if pedestrian phase is expected to be served 25% or more of the cycle on average while the coordinated timing pattern is in effect.
- When pedestrian actuation is rare (less than 25% of the cycles), split time may be set below the necessary pedestrian time, and signal may go "free" to serve pedestrian phase and then transition back to coordination. Controller features to minimize transition due to pedestrian times exceeding the split time should be used where available.

When pedestrian times are not accommodated within the split time during coordination, each cycle when pedestrians are served will cause the signal coordination to go into transition.

- ✓ The transition typically takes 3-4 cycles to return to synchronized coordination.
- ✓ Therefore, if pedestrians are served more than 1 in every 4 (25%) of cycles, the signal will effectively be in transition all the time and the benefits of coordination will not be achieved.

Leading Pedestrian Interval

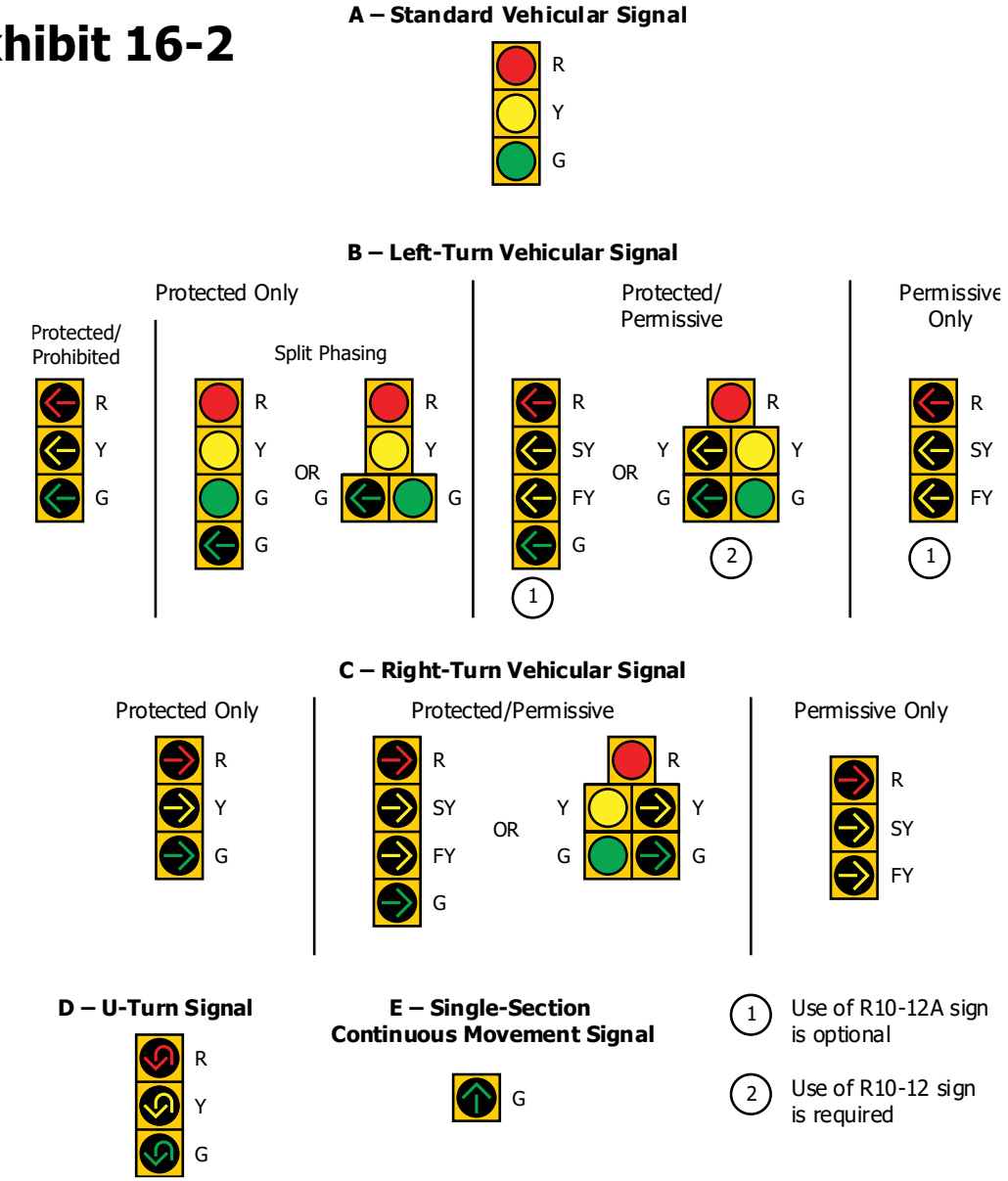
- Incorporated content from SOL 494-21-09
- Decision to use LPI:
  - Engineering judgment
  - Document in Form TE-674
- Should use LPI first before implementing a new exclusive pedestrian phase
- APS should be installed at locations with LPI. If not, walk indication should be displayed for LPI + 7 sec.

Flashing Operation

- Turn-on Flash
  - Yellow for approaches uncontrolled prior to signal being activated
  - Red for approaches which have stop signs prior to signal being activated
- Emergency Flash
  - Flashing red should be used for all approaches → all-way stop
  - Engineering judgment may be used to justify yellow/red flashing at a select location
- Scheduled Flash
  - Not recommended
  - Evaluate for removal during next permit update

VEHICLE SIGNALS

Exhibit 16-2



- All vertically-arranged signals should use a configuration shown in Exhibit 16-2
- 12-inch signal indications for all new signal faces, with limited exceptions
- All signal faces may be post-mounted if:
  - 1 thru lane and posted speed $\leq$25
  - Stem-approach of T-intersection if directly in line with approach lanes
- Adopt MUTCD distance for supplemental heads (180 ft)
- PA typicals for various phasing

Adaptive Signal Control Technology

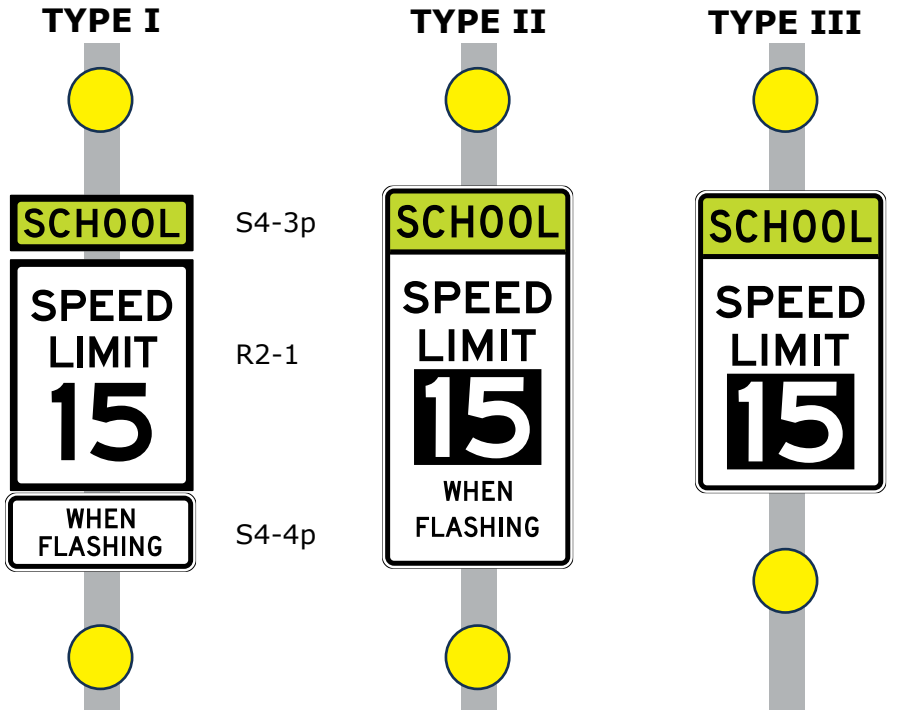
- Incorporated content from SOL 494-25-06
- Systems engineering process uses Form TE-153 (Pennsylvania Traffic Signal Systems Solutions Toolbox)
- Describe use of Pub 408 Master Items in Section 0957
  - Hardware Adaptive Signal System
  - Software Adaptive Signal System
  - Intersection Adaptive System Detection System

School Zone Flashers

MUTCD 11th Edition

NPA Preamble

438. In Section 4S.01 (existing Section 4L.01) General Design and Operation of Flashing Beacons, FHWA proposes to **revise Standard P4 to discontinue the existing allowance of a beacon within the border of a sign for School Speed Limit Sign Beacons**. FHWA proposes this change because under certain light and weather conditions, the flashing beacon causes irradiation that can obscure the sign message if the beacon is within the sign or too close to the sign legend.

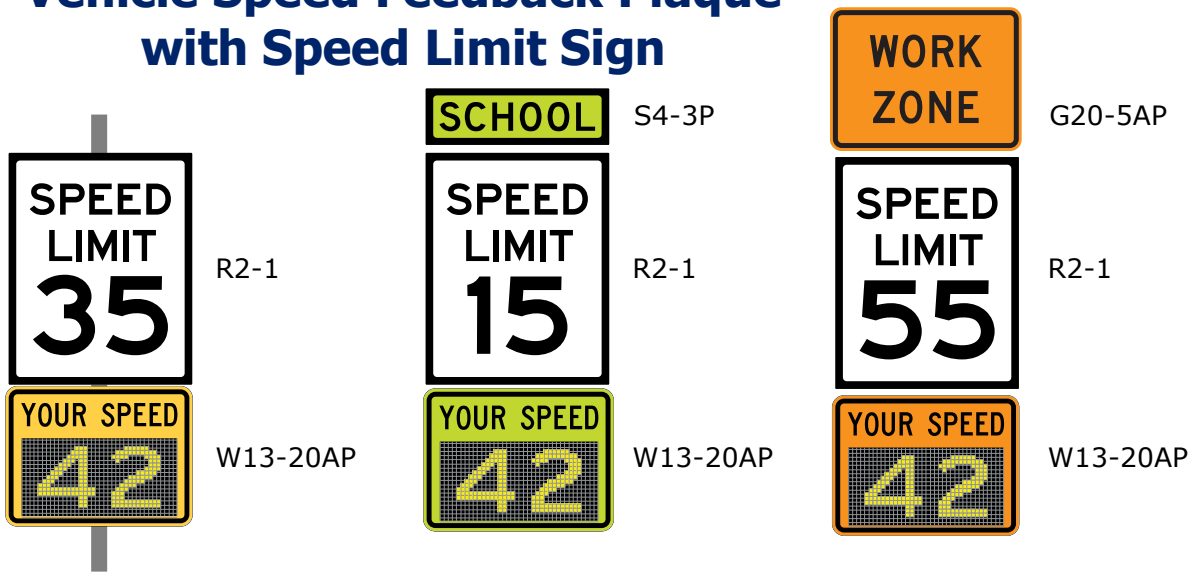


Notes:

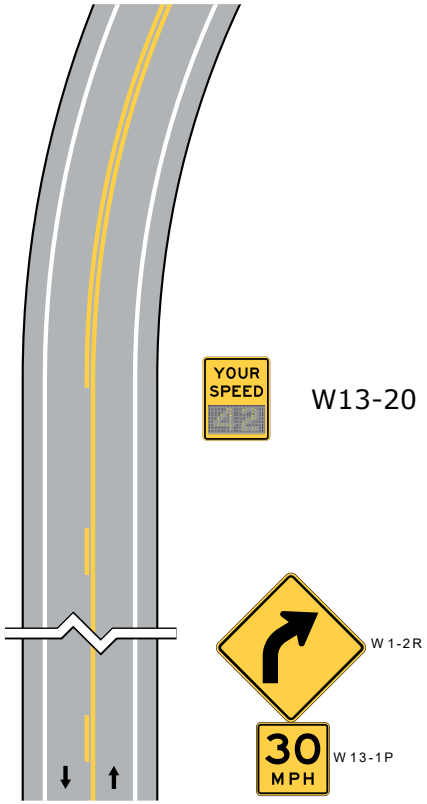
1. Any of the illustrated types of signs may be installed at the locations indicated on the Permit diagram.
2. Type I is comprised of standard signs having the PennDOT designation numbers indicated. It shall have 8" diameter signals mounted externally.
3. Type II must have a PennDOT certificate of approval. The sign shall have minimum dimensions of 24" x 48" and 8" diameter signals mounted externally and a blank-out speed message.
4. Type III must have a PennDOT certificate of approval. The sign shall be the changeable message type with minimum dimensions of 24" x 38" and 8" diameter signals mounted externally.
5. When the signals are flashed in Types II and III, the speed message "15" shall be visible.
6. The closest part of the signal housing should be 12" from the edge of the sign.
7. If a school zone flashing warning sign is installed overhead on a mast arm, the beacons should be mounted horizontally. This exhibit shows pedestal mounting of the school zone flashing warning sign.

Vehicle Speed Feedback Sign/Plaque

Vehicle Speed Feedback Plaque with Speed Limit Sign



Vehicle Speed Feedback Sign Supplementing Horizontal Curve Warning Advisory Speed



- Speed display sign → Vehicle speed feedback sign/plaque
- Typical application will need to be a plaque mounted on same post with R2-1 speed limit sign
- Flashing warning device permit required for permanent installations
- Shall not flash, strobe, change color, or use other animated elements integrated into the changeable legend display
- **No** other changeable messages (Slow Down, Thank You, red/blue lights)

Future Changes

- Chapter 12: Supports
  - Update design criteria from AASHTO 2001 to AASHTO LRFD
- Chapter 33: Digital Model
  - 3-D model as deliverable for traffic signal construction projects

Status

- Clearance Transmittal T-25-001 Step 2
  - Issued December 3, 2025
  - Comments due January 9, 2026
  - Documents available on PennDOT's Traffic Signal Portal www.penndot.pa.gov/signals
  - All comments addressed by April 3, 2026
- Submission to FHWA for final approval
  - April 7, 2026
- Final publication in 2026