NOTES		WHEN TO USE	
L 01	Refer to "Roadway Standard Drawings NCDOT" dated July 2006 and "Standard Specifications for Roads and Structures" dated July 2006.	**H 01**	All Plans except Developer Plans
L 03	Refer to "Roadway Standard Drawings NCDOT" dated July 2006, "Standard Specifications for Roads and Structures" dated July 2006, and all applicable sections of the latest version of the generic Project Special Provisions. The PSP can be accessed at the following website: http://www.ncdot.org/doh/preconstruct/traffic/itss/	**H 03**	Developer Plans
L 04	Do not program signal for late night flashing operation unless otherwise directed by the Engineer.	**H 04**	For locations without railroad preemption
L 05	This location contains railroad preemption phasing. Do not program signal for late night flashing operation.	**H 05**	For locations with railroad preemption
L 10	Omit phase 1 during phase 2 on.	**H 10**	Phase omit note for TS1,TS2, and 2070 operation
L 11	Program phase 1 as protected/permissive.	**H 11**	Phase omit note for 170 operation
L 12	Omit phase 5 during phase 6 on.	**H 12**	Phase omit note for TS1,TS2, and 2070 operation
L 13	Program phase 5 as protected/permissive.	**H 13**	Phase omit note for 170 operation
L 14	Omit phase 3 during phase 4 on.	**H 14**	Phase omit note for TS1,TS2, and 2070 operation
L 15	Program phase 3 as protected/permissive.	**H 15**	Phase omit note for 170 operation
L 16	Omit phase 7 during phase 8 on.	**H 16**	Phase omit note for TS1,TS2, and 2070 operation
L 17	Program phase 7 as protected/permissive.	**H 17**	Phase omit note for 170 operation
L 18	Wire cabinet to allow the controller to clear from phase # to phase # by progressing through phase # (see Electrical Details for wiring).	**H 18**	Additional note for omit situations for TS1 operation
L 19	Program controller to clear from phase # to phase # by progressing through phase # (see Electrical Details).	**H 19**	Additional note for omit situations for TS2, 2070, and 170 operation
L 20	Enable Backup Protect for phase # to allow the controller to clear from phase # to phase # by progressing through an all red display.	**H 20**	Alternate to Phase Omits in 2070s. Used with Red Revert.
L 21	Disable Backup Protect for phase #.	**H 21**	Use for FYA plans with existing 2070 cabinets where backup protection is no longer needed.

NOTES		WHEN TO USE	
L 22	Phase 1 and/or phase 5 may be lagged.	**H 21**	Use for exclusive left turns and Flashing Yellow Arrows
L 23	Phase 3 and/or phase 7 may be lagged.	**H 22**	Use for exclusive left turns and Flashing Yellow Arrows
L 24	The order of phase 3 and phase 4 may be reversed.	**H 23**	Use for split side streets
L 25	Program phase 4 and phase 8 for dual entry.	**H 24**	For use with TS-1 or TS-2 equipment
L 30	Relocate existing signal heads numbered #.	**H 30**	Use when head is moved to new span
L 31	Reposition existing signal heads numbered #.	**H 31**	Use when head is "slid" on same span
L 32	Install backplates for signal heads numbered #.	**H 32**	As needed
L 33	Tether signal heads numbered #.	**H 33**	As needed
L 40	Run all lead-in cable overhead on existing utility poles where possible.	**H 40**	Urban projects with many driveways
L 41	Abandon existing loops #.	**H 41**	As needed, usually by contracts
L 42	Use controller input delay for phase #. Override channel # call delay during peak hours.	**H 42**	Add this note for variation on protected-permissive design.
L 43	Set all detector units to presence mode.	**H 43**	All Plans
L 44	In the event of loop replacement, refer to the current ITS and Signals Design Manual and submit a Plan of Record to the Signal Design Section.	**H 44**	Use when not replacing "old style" loops
L 50	Locate new cabinet so as not to obstruct sight distance of vehicles turning right on red.	**H 50**	All plans with new cabinets
L 51	The cabinet should be designed to include an Auxiliary Output File for future use.	**H 51**	Use on plans with new 2070 cabinets and no FYA
L 52	Program all timing information into phase banks 1, 2, and 3 unless otherwise noted.	**H 52**	Standard with 170 operation
L 53	Set phase bank 3 maximum limit to 250 seconds for phases used.	**H 52**	Signal system plans with 170s
L 60	Omit "WALK" and flashing "DON'T WALK" with no pedestrian calls.	**H 60**	Use for pedestrian-activated signals

NOTES		WHEN TO USE	
L 61	Program pedestrian heads to countdown the flashing "Don't Walk" time only.	**H 61**	Use with countdown peds
L 70	Flash beacon # continuously.	**H 70**	Actuated flasher plan
L 71	Flash beacons # when actuated by loop #.	**H 71**	Actuated flasher plan
L 80	Thirty days after implementation of the revised signal operation, signs # and/or orange flags may be removed at the discretion of the Regional Traffic Engineer.	**H 80**	Use on plans being revised from fully protected or split side street phasing to protected-permissive phasing
L 81	Remove existing "Left Turn Signal" sign(s)-(R10-10L) and/or existing "Right Turn Signal" sign(s)-(R10-10R).	**H 81**	As needed
L 82	Existing "Left Turn Yield on Green" ball sign(s)-(R10-12) may be removed at the discretion of the Regional Traffic Engineer.	**H 82**	As needed
L 90	Pavement markings are existing.	**H 90**	Signal upgrades
L 91	Repaint stopbars and/or crosswalks.	**H 91**	As needed
L 92	Install pavement markings to designate lane separations for **APPROACH**.	**H 92**	As needed
L 93	Revise pavement markings as shown. All pavement markings and raised reflective markings shown are a representation of actual placement criteria. Refer to NCDOT Roadway Standard Drawings actual placement.	**H 93**	Safety plan with proposed reflectorized markings
L 100	Install box span, if possible.	**H 100**	As needed
L 110	This is a proposed plan view only. Field adjust all drainage, superelevation, utility conflicts, and grade changes.	**H 110**	Geometric changes only.
L 120	Locate emergency vehicle preemption switch in **LOCATION**.	**H 120**	Emergency vehicle preemption (pushbutton actuated)
L 121	The Division Traffic Engineer will determine the Delay Time and Preempt Dwell Min Time for the emergency vehicle preemption timing.	**H 121**	Emergency vehicle preemption (pushbutton actuated)
L 122	This intersection features an optical preemption system. Shown locations of optical detectors are conceptual only.	**H 122**	Optical preemption

NOTES	WHEN TO USE
L 123 Program signal heads numbered # to clear to all red before going into preempt.	**H 123** Use in place of dummy phase for emergency vehicle preemption
L 124 Ensure flashing operation does not alter operation of blankout signs.	**H 124** Standard with RR preemption with blank-out signs
L 125 Clear signal heads numbered # from flashing 8" yellow to steady 12" yellow during interval 1 and steady red during interval 2.	**H 125** RR preemption plans with advance flashing heads (for non-standard clearance)
L 126 Program start vehicle call OFF for phase #.	**H 126** RR preemption plans with preempt phase that does not have corresponding regular phase (170 controller)
L 127 Program parent phases for Overlap "P" for all phases used in normal operation.	**H 127** Most signal plans with railroad preemption that have a Track Clearance phase.
L 128 Upon completion of Railroad (or Emergency Vehicle) Preemption, controller returns to normal operation based on vehicle demand.	**H 128** RR or EV Preemption plan when an exit phase (first normal phase served after preemption) is not or cannot be designated
L 129 The Division Traffic Engineer will determine the hours of use for each phasing plan.	**H 129** Flashing Yellow Arrow plans designed with multiple or time of day phasing options.
L 131 These loops serve as queue backup detectors. After # seconds of constant actuation, the detector unit places a call to the controller to preempt normal operation to clear out the storage lanes.	**H 131** Backup queue detectors
L 132 Existing Yellow Change Interval for phase # may be decreased by # seconds per week until the required value is reached.	**H 132** Major adjustments to clearance times
L 133 Maximum times shown in timing chart are for free-run operation only. Coordinated signal system timing values supersede these values.	**H 133** Standard with coordination
L 134 Closed loop system data: Intersection Number #, Local telemetry address number #, Channel number #.	**H 134** Closed loop signal system plans
L 135 Closed loop system data: Master Asset #, Controller Asset #.	**H 135** 2070 Closed loop signal system plans

OASIS 2070L LOOP & DETECTOR INSTALLATION CHART

	INDUCTIVE LOOPS					DETECTOR PROGRAMMING							
	LOOP	SIZE (FT)	DISTANCE FROM STOPBAR (FT)	TURNS	NEW LOOP	PHASE	CALLING	EXTENSION	FULL TIME DELAY	STRETCH TIME	DELAY TIME	SYSTEM LOOP	NEW CARD
Volume density loops combined w/system loops	2A/S1	6X6	420	5	Y	2	Y	Y	–	–	–	Y	Y
	2B/S2	6X6	420	5	Y	2	Y	Y	–	–	–	Y	Y
Queue Detector	3A	6X15	50	3	Y	3	Y	Y	–	–	15	–	Y
	8A	6X40	+5	2–4–2	Y	8	Y	Y	–	–	–	–	Y
Volume Density with DC/EC for sidestreet	4A	6X6	300	5	Y	4	–	Y	–	–	–	–	Y
	4B	6X40	0	2–4–2	Y	4	Y	Y	Y	2.0	5	–	Y
Left turn loop calling 2 phases (with volume density on phase 2)	5A	6X60	0	2–4–2	Y	5	Y	Y	–	–	15	–	Y
						2	Y	Y	Y	–	3	–	Y
Stretch loops	6A, 6B	6X6	300	EXISTING	–	6	Y	Y	–	1.6	–	–	Y
	6C, 6D	6X6	90	EXISTING	–	6	Y	Y	–	–	–	–	Y
System Loop	S3	6X6	+120	4	Y	–	–	–	–	–	–	Y	Y

Oasis 2070L Controller

Detector Programming Attributes

Calling - Select to place call during red. Selecting this attribute is similar to selecting ALL for NEMA's "Place Call During Phase." (Usually selected)

Extension - Select to extend the green time. Gap resets after each call. Must be selected whenever Vehicle Extension Time is entered in the timing chart. (Usually selected)

Full Time Delay - Select to delay during red, yellow, and green. If not selected, controller will time delay during red and yellow only. Selecting this attribute is equivalent to selecting NO for NEMA's "Inhibit Delay During Green." (Usually not selected)

Stretch Time - Enter times in intervals of .1 second

SE-PAC 2070: Use with Burlington and Raleigh Signal Systems

SE-PAC 2070 LOOP & DETECTOR UNIT INSTALLATION CHART

	INDUCTIVE LOOPS						DETECTOR PROGRAMMING															
								TIMING		OPERATION MODE											STATUS	
										0	1	2	3	4	5	6	7					
	LOOP NO.	SIZE (ft)	TURNS	DIST. FROM STOPBAR (ft)	NEW	EXISTING	ASSIGNED PHASE	DELAY	EXTEND (STRETCH)	VEHICLE	PEDESTRIAN	1 CALL	STOP A	STOP B	PROT/PER LEFT	PROT/PER THROUGH	AND	SWITCH	SYSTEM LOOPS	NEW	EXISTING
VD loops combined w/system loops	2A/S1	6X6	5	300	X	–	2	– SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
	2B/S2	6X6	5	300	X	–	2	– SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
Volume Density with DC/EC for sidestreet	4A	6X6	5	300	X	–	4	100 SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
	4B	6X40	2–4–2	0	X	–	4	5 SEC.	2.0 SEC.	X	–	–	–	–	–	–	–	–	–	X	–
Left turn loop calling 2 phases	5A	6X40	2–4–2	0	X	–	5	15 SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
							2	– SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
Stretch loops	6A, 6B	6X6	5	300	X	–	6	– SEC.	1.6 SEC.	X	–	–	–	–	–	–	–	–	X	X	–
	6C, 6D	6X6	5	90	X	–	6	– SEC.	– SEC.	X	–	–	–	–	–	–	–	–	X	X	–
Protected Left Turn Loop	7A	6X40	2–4–2	0	X	–	7	3 SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
Sidestreet Loop	8A	6X40	2–4–2	0	X	–	8	10 SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
System Loop	S3	6X6	5	+125	X	–	–	– SEC.	– SEC.	–	–	–	–	–	–	–	–	–	X	X	–

Detector Programming Attributes

Vehicle- Vehicle detector operates as standard vehicle detector

Pedestrian - Vehicle detector operates as standard pedestrian detector (Not Used)

1 Call - Typically Not Used

Stop A - Typically Not Used

Stop B - Typically Not Used

Prot/Per Left - Typcially Not Used

Prot/Per Through - Typically Not Used

And - Typically Not Used

Switch - List an alternate phase that could be extended when green by loop detection while the assigned primary phase is red (Not Normally Used)

Extend (Stretch) - Enter times in intervals of .1 second

SE-PAC cannot be programmed for Full Time Delay

Loop Chart Typicals

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO.
5.1

NAZTEC 2070: Use with Greensboro Signal System

LOOP & DETECTOR UNIT INSTALLATION CHART
NAZTEC APOGEE SOFTWARE 2070 CONTROLLER

	INDUCTIVE LOOPS					DETECTOR PROGRAMMING								
	LOOP	SIZE (FT)	DISTANCE FROM STOPBAR (FT)	TURNS	NEW LOOP	PHASE	SWITCH (PHASE)	DELAY TIME	STRETCH TIME	CALLING	EXTENSION	ADDED INIT.	SYSTEM LOOP	NEW CARD
P/P Left turn loop calling 2 phases	1A	6X40	0	2–4–2	X	1	6	15	–	X	X	–	–	X
VD loop combined w/system loop	2A/S1	6X6	300	5	X	2	–	–	–	X	X	X	X	X
	2B/S2	6X6	300	5	X	2	–	–	–	X	X	X	X	X
Stretch Detection for sidestreet	4A	6X6	300	5	X	4	–	–	3.4	–	X	–	–	X
	4B	6X40	0	2–4–2	X	4	–	10	–	X	X	–	–	X
P/P Left turn loop calling 2 phases	5A	6X40	0	2–4–2	X	5	2	15	–	X	X	–	–	X
Stretch loops	6A, 6B	6X6	300	5	X	6	–	–	1.6	X	X	–	–	X
	6C, 6D	6X6	90	4	X	6	–	–	–	X	X	–	–	X
Protected left turn phase loop	7A	6X40	0	2–4–2	X	7	–	3	–	X	X	–	–	X
Sidestreet loop	8A	6X40	0	2–4–2	X	8	–	10	–	X	X	–	–	X
System Loop	S3	6X6	+125	5	X	–	–	–	–	–	–	–	X	X

2070 Controller w/Naztec Apogee Software

Detector Programming Attributes

Switch (Phase) - Typically used for protected/permitted left turns to call and extend the (primary) protected phase after the side street is serviced and extend the (secondary) permitted time for the corresponding adjacent through phase.

Calling - Select to place call during red. Selecting this attribute is similar to selecting ALL for NEMA's "Place Call During Phase." (Usually selected)

Extension - Select to extend the green time. Gap resets after each call. Must be selected whenever Vehicle Extension Time is entered in the timing chart. (Usually selected)

Added Init. - Volume-density feature that extends the Minimum Green timer. Use if loop operates using volume-density detection

Stretch Time - Enter in intervals of .1 second

Naztec Apogee cannot be programmed for Full Time Delay

NEMA LOOP & DETECTOR INSTALLATION CHART
with TS-1 CABINET

	INDUCTIVE LOOPS						DETECTOR UNITS								
	LOOP	SIZE (ft)	DIST. FROM STOPBAR (ft)	TURNS	NEW	EXISTING	UNIT NO.	NEW	EXISTING	CHANNEL	NEMA PHASE	TIMING FEATURE	TIMING TIME	PLACE CALL DURING PHASE	INHIBIT DELAY DURING GREEN?
Volume density loop	2A	6X6	300	4	X		1		X	1	2	–	–	ALL	NO
Volume Density with DC/EC for sidestreet	4A	6X6	300	4	X		2		X	1	4	–	–	4	NO
	4B	6X40	0	2-4-2	X					2	4	DC/EC	5/2	ALL	NO
Left turn loop calling 2 phases (with volume density on phase 2)	5A	6X40	0	2-4-2	X		3	X		1	5	DELAY	15	ALL	YES
										2	2	DELAY	3	2	NO
Stretch Loops	6A, 6B	6X6	300	4	X		4		X	1	6	EXTEND	1.75	ALL	NO
	6C, 6D	6X6	90	4	X					2	6	–	–	ALL	NO
Sidestreet loop	8A	6X40	0	EXIST		X	1		X	2	8	–	–	ALL	NO
System Loop	SD1	6X6	+150	4	X		5	X		2	System Detector				

TS-1 Cabinet

Enter Stretch times in intervals of .25 second

Both of these charts are also used for Cary Signal System (2070N Equipment)

NEMA LOOP & DETECTOR INSTALLATION CHART
with TS-2 CABINET

	INDUCTIVE LOOPS						DETECTOR UNITS					
	LOOP	SIZE (ft)	DIST. FROM STOPBAR (ft)	TURNS	NEW	EXISTING	NEMA PHASE	NEW	EXISTING	TIMING FEATURE	TIMING TIME	INHIBIT DELAY DURING GREEN?
Volume density loop combined w/ System Loop	2A/SD1	6X6	300	4	X		2	X		–	–	NO
							–	X		System Detector		
Volume Density with DC/EC for sidestreet	4A	6X6	300	4	X		4	X		DELAY	100	YES
	4B	6X40	0	2-4-2	X		4	X		DC/EC	5/2	NO
Left turn loop calling 2 phases (with volume density on phase 2)	5A	6X40	0	2-4-2	X		5	X		DELAY	15	YES
							2			DELAY	3	NO
Stretch loops	6A	6X6	300	4	X		6		X	EXTEND	1.6	NO
	6B	6X6	90	4	X		6			–	–	NO
Sidestreet loop	8A	6X40	0	EXIST		X	8	X		–	–	NO
System Loop	SD2	6X6	+150	4	X		–	X		System Detector		

TS-2 Cabinet

Enter Stretch times in intervals of .1 second

Loop Chart Typicals

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-09

STD. NO.
5.1
SHEET 4 OF 5

170 LOOP & DETECTOR INSTALLATION CHART

	INDUCTIVE LOOPS						DETECTOR PROGRAMMING												
								TIMING		ATTRIBUTES								STATUS	
										1	2	3	4	5	6	7			
	LOOP	SIZE (ft)	DIST. FROM STOPBAR (ft)	TURNS	NEW	EXISTING	NEMA PHASE	DELAY	CARRY (STRETCH)	FULL TIME DELAY	PEDESTRIAN CALL	RESERVED	COUNT	EXTENSION	TYPE 3	CALLING	SYSTEM LOOPS	NEW	EXISTING
Volume density loop	2A	6X6	300	4	X		2	– SEC.	– SEC.	–	–	–	X	X	–	X	–	–	X
Volume Density with DC/EC for sidestreet	4A	6X6	300	EXIST		X	4	– SEC.	– SEC.	–	–	–	–	X	–	–	–	–	X
	4B	6X40	0	2–4–2		X	4	5 SEC.	2.0 SEC.	X	–	–	–	X	–	X	–	–	X
Left turn loop calling 2 phases (with omit phase programmed)	5A	6X40	0	2–4–2	X		5	30 SEC.	– SEC.	–	–	–	–	X	–	X	–	X	–
							4	30 SEC.	– SEC.	–	–	–	–	–	–	X	–	X	–
							2	3 SEC.	– SEC.	X	–	–	–	X	–	X	–	X	–
Stretch loops	6A, 6B	6X6	300	4	X		6	– SEC.	1.6 SEC.	–	–	–	–	X	–	X	–	–	X
	6C, 6D	6X6	90	4	X		6	– SEC.	– SEC.	–	–	–	–	X	–	X	–	–	X
Sidestreet loop	8A	6X40	0	EXIST		X	8	– SEC.	– SEC.	–	–	–	–	X	–	X	–	–	X
Pedestrian pushbutton	P81, P82	N/A	N/A	N/A	X		8	– SEC.	– SEC.	–	X	–	–	–	–	–	–	–	–
System Loop	SD1	6X6	+150	3	X		–	– SEC.	– SEC.	–	–	–	–	–	–	–	X	X	–

170 Controller

(Use for Durham and Hickory Signal Systems)

Detector Programming Attributes

Full Time Delay - Select to delay during green and red. If not selected, controller will time delay during red only. Selecting this attribute is equivalent to selecting NO for NEMA's "Inhibit Delay During Green." (Usually not selected)

Pedestrian Call - Select to assign as a pedestrian detector. Used with ped push-button.

Reserved - Currently not in use. (Not selected)

Count - Select to count vehicles. (Usually selected with volume density loops)

Extension - This allows the detector to extend the green time. Gap resets after each call. Must be selected whenever Vehicle Extension Time is entered in the timing chart. (Usually selected)

Type 3 - This attribute will place call during green until the call drops or the Type 3 Limit expires. Once the Type 3 detector drops off it will not be active until the next phase. This attribute is similar to NEMA's EC/DC operation except that the loop is disconnected after a set time instead of after a gap in traffic. (Usually not selected)

Calling - Select to place call during red. Selecting this attribute is similar to selecting ALL for NEMA's "Place Call During Phase." (Usually selected)

Carry (Stretch) - Enter times in intervals of .1 second

For All Plans

Oasis 2070L Timing Chart (Part 1)

- Main Street:
  55 mph (88 km/hr) - 14 sec
  50 mph (80 km/hr) - 14 sec
  45 mph (72 km/hr) - 12 sec
  40 mph (64 km/hr) - 12 sec
  ≤35 mph (56 km/hr) - 10 sec

- Main Street - Typically 2.0 sec for stretch detection, 3.0 sec for low speed detection. For volume density, amount of time required to get vehicle traveling 5 mph (8 kph) under the speed limit from upstream loop to stop line, generally 6.0 sec.
  Side Street - Typically 1.0-3.0 sec. Adjust for size of detection area, grade, truck traffic, etc.

- Maximum green times may be determined with the help of a software package. Alternately, a hand calculation may be suitable:

$$\text{Max Green} = 4 + 2\left(\frac{\text{Heaviest PHV per lane}}{\text{3600/est cycle length}}\right)$$

PHV = Peak hour volume

- See STD. NO. 5.2.2

- A type of Backup Protection. Typically set to 5.0 for phase(s) used, otherwise default is 2.0 sec. (See Std. 2.3)

- Typically 4-7 seconds

- See STD. NO. 6.0

- None, Min Recall, Max Recall, Soft Recall, Ped Recall or Ped Soft Recall

- None, Red, or Yellow (See Definitions)

- On or not selected (see Definitions)

- On or not selected, usually selected (see Definitions)

Note: For Pre-Timed Signal, set Extension 1 to 0.0 and Recall Position to Max Recall. Enter N/A for Vehicle Call Memory.

Side Streets, Lefts, and Main Street Stopbar Detection:
Set to 4-8 sec, depending on size of detection area, grade, truck traffic, etc.
Typically 7 sec.

OASIS 2070L TIMING CHART

FEATURE	PHASE 2	PHASE 4	PHASE 5
• Min Green 1*	10	7	7
• Extension 1*	3.0	1.0	3.0
• Max Green 1*	45	20	25
• Yellow Clearance	3.6	3.7	3
• Red Clearance	1.9	2.1	
• Red Revert	5.0	2.0	
• Walk 1*	4	-	
• Don't Walk 1	12	-	
Seconds Per Actuation*	-	-	
Max Variable Initial*	-	-	
Time Before Reduction*	-	-	
Time To Reduce*	-	-	
Minimum Gap	-	-	
• Recall Mode	MIN RECALL	-	
• Vehicle Call Memory	YELLOW	-	
• Dual Entry	-	O	
• Simultaneous Gap	ON		

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Oasis 2070L Timing Chart (Part 2)

For Volume Density Plans (See 5.2.3 Sheet 1)

Variable Initial Features (Time only during non–green portion of phase)

- Amount added to Variable Initial Time (starting at 0) for each actuation of detector loops. Typical values:
  - 2.5 secs for single through lane
  - 1.5-1.8 sec for two through lanes
  - 1.0-1.5 sec for three through lanes

  When traffic is more evenly distributed over multiple lanes, use lower number. Increase for high truck traffic.

- Time needed to service a queue reaching from detector loop to stop line. Calculated by:

$$\text{Maximum Variable Initial} = 4 + 2\left(\frac{\text{Distance to loop}}{\text{Std veh length} = 20' \ (6m)}\right)$$

Gap Reduction Features (Time only during green portion of phase)

- Time that expires before gap reduction begins. Prevents premature transfer of green. Typically 15-30 secs, but never less than the minimum green.
  For sidestreet Volume Density, may use 0 or 5 sec.
- Amount of time over which gap time will reduce from initial value (Extension 1) to minimum value (Minimum Gap). Typically 30-60 secs.
  For sidestreet Volume Density, may use 15 or 20 sec.
- Set equal to lowest gap time that allows vehicle to clear dilemma zone. Typically 3.0 sec - 4.0 sec., but no lower than 3.4 sec. for 55 MPH

Notes:
- The sum of the Time Before Reduction and the Time to Reduce should not exceed the Max Green 1 time.
- The Extension 1 resets to the initial value if the serviceable conflicting call is removed (eg. Turns right on red).

OASIS 2070L TIMING CHART

FEATURE	PHASE 2	PHASE 4	PHASE 5
Min Green 1*	12	7	7
Extension 1*	6.0	6.0	2.0
Max Green 1*	90	30	25
Yellow Clearance	4.3	3.6	3.1
Red Clearance	1.4	2.1	2
Red Revert	5.0	2.0	
Walk 1*	4	–	
Don't Walk 1	12	–	
• Seconds Per Actuation*	1.5	–	
• Max Variable Initial*	34	–	
• Time Before Reduction*	15	0	
• Time To Reduce*	30	15	
• Minimum Gap	3.0	3.0	
Recall Mode	MIN RECALL	–	
Vehicle Call Memory	YELLOW	–	
Dual Entry	–	O	
Simultaneous Gap	ON		

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

SE–PAC 2070 Timing Chart
(Burlington and Raleigh Signal Systems)

For All Plans

- See Sheet 1, Min Green 1
- See Sheet 1, Extension 1
- See Sheet 1, Max Green 1
- See STD. NO. 5.2.2
- See Sheet 1, Walk 1
- See Sheet 1, Don't Walk 1

For Volume Density Plans

- See Sheet 2, Seconds per Actuation
- See Sheet 2, Maximum Variable Initial
- See Sheet 2, Time Before Reduction
- See Sheet 2, Time to Reduce
- See Sheet 2, Minimum Gap

For All Plans

- None, Min Recall, Max Recall, Soft Recall, or Ped Recall
- Lock or Non-Lock (See Definitions)
- On or not selected (see Definitions)
- On or not selected, usually selected (see Definitions)

Note: For Pre-Timed Signal, set Extension 1 to 0.0 and Recall Position to Max Recall. Enter Non-Lock for Vehicle Call Memory.

Note: SE-PAC Software cannot use Red Revert for backup protection. Phase omits must be used.

SE-PAC 2070 TIMING CHART

FEATURE	2	4	5
• Min Green *	10	7	7
• Passage Gap *	3.0	2.0	2.0
• Maximum Green *	45	25	15
• Yellow Change	3.9	3.4	3.0
• Red Clear	1.8	2.1	2.2
• Walk *	–	–	–
• Pedestrian Clear	–	–	–
• Added Initial *	–	–	
• Maximum Initial *	–	–	
• Time Before Reduction *	–	–	
• Time To Reduce *	–	–	
• Minimum Gap	–	–	
• Recall Mode	MIN RECALL	–	
• Vehicle Call Memory	LOCK	NON–LOCK	
• Dual Entry	–	ON	
• Simultaneous Gap	ON	ON	

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Naztec Apogee 2070 Timing Chart
(Greensboro Signal System)

For All Plans

- See Sheet 1, Min Green 1
- See Sheet 1, Extension 1
- See Sheet 1, Max Green 1
- See STD. NO. 5.2.2
- See Sheet 1, Walk 1
- See Sheet 1, Don't Walk 1

For Volume Density Plans

- See Sheet 2, Seconds per Actuation
- See Sheet 2, Maximum Variable Initial
- See Sheet 2, Time Before Reduction
- See Sheet 2, Time to Reduce
- See Sheet 2, Minimum Gap

For All Plans

- None, Min Recall, Max Recall, Soft Recall, or Ped Recall
- Yes or No (See Definitions)
- On or not selected (see Definitions)
- On or not selected, usually selected (see Definitions)

Note: For Pre-Timed Signal, set Gap, Extension 1 to 0.0 and Recall Position to Max Recall. Enter No for Lock Calls.

Note: Naztec Apogee Software can not use Red Revert for backup protection. Phase omits must be used.

NAZTEC APOGEE 2070 TIMING CHART

FEATURE	PHASE 2	PHASE 4	PHASE 5
• Min Green *	12	7	7
• Gap, Extension *	6.0	2.0	2.0
• Maximum Green 1 *	90	30	20
• Maximum Green 2 *	110	25	25
• Yellow Clear	5.1	3.8	3.0
• Red Clear	1.2	1.9	2.1
• Walk *	4	–	–
• Pedestrian Clear	16	–	–
• Added Initial *	1.5	–	
• Maximum Initial *	34	–	
• Time Before Reduction *	15	–	
• Time To Reduce *	60	–	
• Minimum Gap	3.0	–	
• Recall Mode	MIN RECALL	–	
• Lock Calls	YES	NO	
• Dual Entry	–	ON	
• Simultaneous Gap	ON	ON	

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

NEMA Timing Chart (Also for Cary 2070N Signal System)

For All Plans

- See Sheet 1, Min Green 1
- See Sheet 1, Extension 1
- See STD. NO. 5.2.2
- See Sheet 1, Max Green 1
- None, Min Recall, Max Recall, Soft Recall or Ped Recall
- Lock or Nonlock
- See Sheet 1, Walk 1
- See Sheet 1, Don't Walk 1

For Volume Density Plans (See 5.2.3 Sheet 1)

Variable Initial Features (Active only during non-green portion of phase)

- Number of vehicles that arrive that will not count toward Maximum Initial value. For most controllers, this value is zero. If needed (such as Traconex TMP 390 and Minnesota Microtronics 800 controllers), the Actuation B4 Add may be calculated:

  $$\text{Actuation B4 Add} = \frac{\text{Min green} - 4}{2}$$

- Amount added to Variable Initial Time (starting at 0) for each actuation of detector loops. Typical values:
  - 2.5 secs for single through lane
  - 1.5-1.8 sec for two through lanes
  - 1.0-1.5 sec for three through lanes

  When traffic is more evenly distributed over multiple lanes, use lower number. Increase for high truck traffic. For the Traconex and Minnesota Microtronics controllers:
  - 2.0 secs for single through lane
  - 1.3-1.5 sec for two through lanes
  - 1.0-1.3 sec for three through lanes
- See Sheet 2, Maximum Variable Initial

Gap Reduction Features (see Sheet 2)

Notes:
- The sum of the Time Before Reduction and the Time to Reduce should not exceed the Max Green 1 time.
- The Passage/Gap resets to the initial value if the serviceable conflicting call is removed (eg. Turns right on red).

NEMA TIMING CHART

FEATURE	PHASE 2	PHASE 4	PHASE 6
• Minimum Green*	12	7	12
• Passage/Gap*	6.0	1.0	6.0
• Yellow Change Int	4.3	3.6	4.
• Red Clearance	1.4	2.1	1
• Maximum 1*	90	20	
• Recall Position	MIN RECALL	NONE	
• Vehicle Call Memory	LOCK	NONLOCK	
• Walk *	4	-	
• Flashing Don't Walk	12	-	
Volume Density	ON	OFF	
• Actuation B4 Add*	0	-	
• Sec Per Actuation*	2.5	-	
• Maximum Initial*	34	-	
• Time B4 Reduction*	15	-	
• Time To Reduce*	30		
• Minimum Gap	3.0		

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Note: For Pre-Timed Signal, set Passage/Gap to 0.0 and Recall Position to Max Recall. Enter N/A for Vehicle Call Memory.

Note: NEMA Equipment cannot use Red Revert for backup protection. Phase omits must be used.

For All Plans

170 Timing Chart (Durham and Hickory Signal Systems)

- See Sheet 1, Min Green 1
- See Sheet 1, Extension 1
- See STD. NO. 5.2.2
- See Sheet 1, Max Green 1
- None, Veh Recall, Ped Recall, Max Recall, Soft Recall
- None, Yellow Lock, Red Lock
  Yellow Lock begins locking call during yellow, Red Lock begins locking call during red. Typically None for stopbar detection and Yellow Lock for setback detection.
- On or Off
- See Sheet 1, Walk 1
- See Sheet 1, Don't Walk 1
- Used with Type 3 Limit Detector Attribute, See STD NO. 5.2:3

For Volume Density Plans (See 5.2.3 Sheet 2)

Variable Initial Features (Active only during non-green portion of phase)

- See Sheet 2, Seconds per Actuation
- See Sheet 2, Maximum Variable Initial

Gap Reduction Features (Time only during green portion of phase)

- The gap the controller starts reducing from. Unlike NEMA and 2070L controllers, the 170 starts reducing this gap immediately. Typically 6.8-8.0 secs. If Volume Density is not used, enter Vehicle Extension time, as a time must be entered.
- Maximum Gap reduces by 0.1 sec after this much time until it reduces to the Minimum Gap. Typically 1.0-2.4 secs.
- See Sheet 2, Minimum Gap. If Volume Density is not used, enter Vehicle Extension time, as a time must be entered.

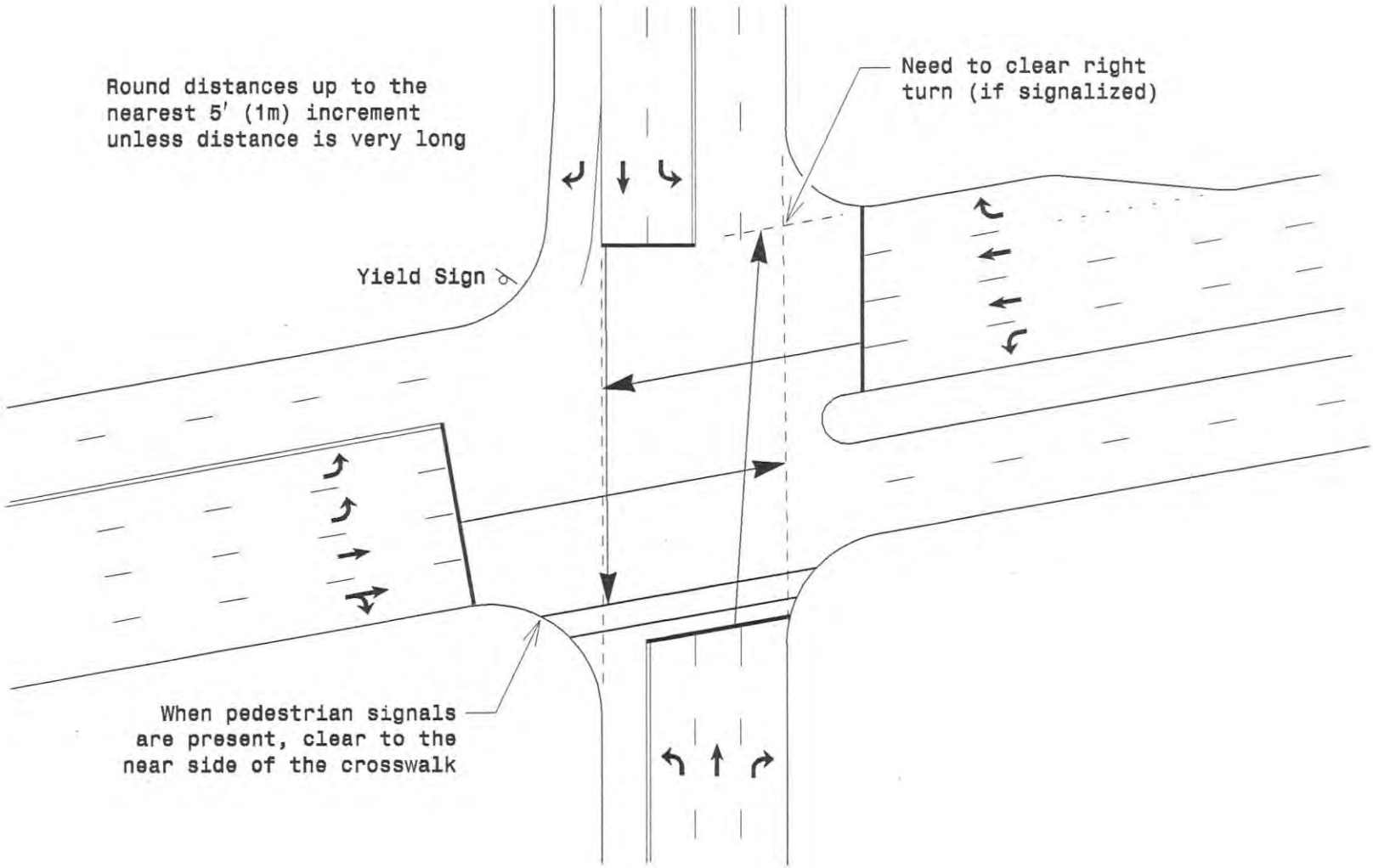
170 TIMING CHART

FEATURE	PHASE 2	PHASE 4	PHASE 6
• Minimum Initial*	12	7	12
• Vehicle Extension*	6.0	1.0	6.0
• Yellow Change Int	4.3	3.6	4.4
• Red Clearance	1.4	2.1	1.4
• Maximum Limit*	90	20	90
• Recall Position	VEH RECALL	NONE	VEH RE
• Vehicle Call Memory	YELLOW LOCK	NONE	YELLOW
• Double Entry	OFF	ON	O
• Walk*	4	-	
• Flashing Don't Walk	12	-	
• Type 3 Limit	–	-	
• Add Per Vehicle*	1.5	-	
• Maximum Initial*	34	-	
• Maximum Gap*	7.0	1.0	
• Reduce 0.1 Sec Every*	1.5	-	
• Minimum Gap	3.0	1.0	

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Notes:
- For non-volume density operation, set Maximum Gap and Minimum Gap equal to Vehicle Extension.
- For Pre-Timed Signal, set Vehicle Extension to 0.0 and Recall Position to Max Recall. Enter none for Vehicle Call Memory.

Through Movement Clearance Distances



Change and Clearance Intervals

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7-05

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5.2.2
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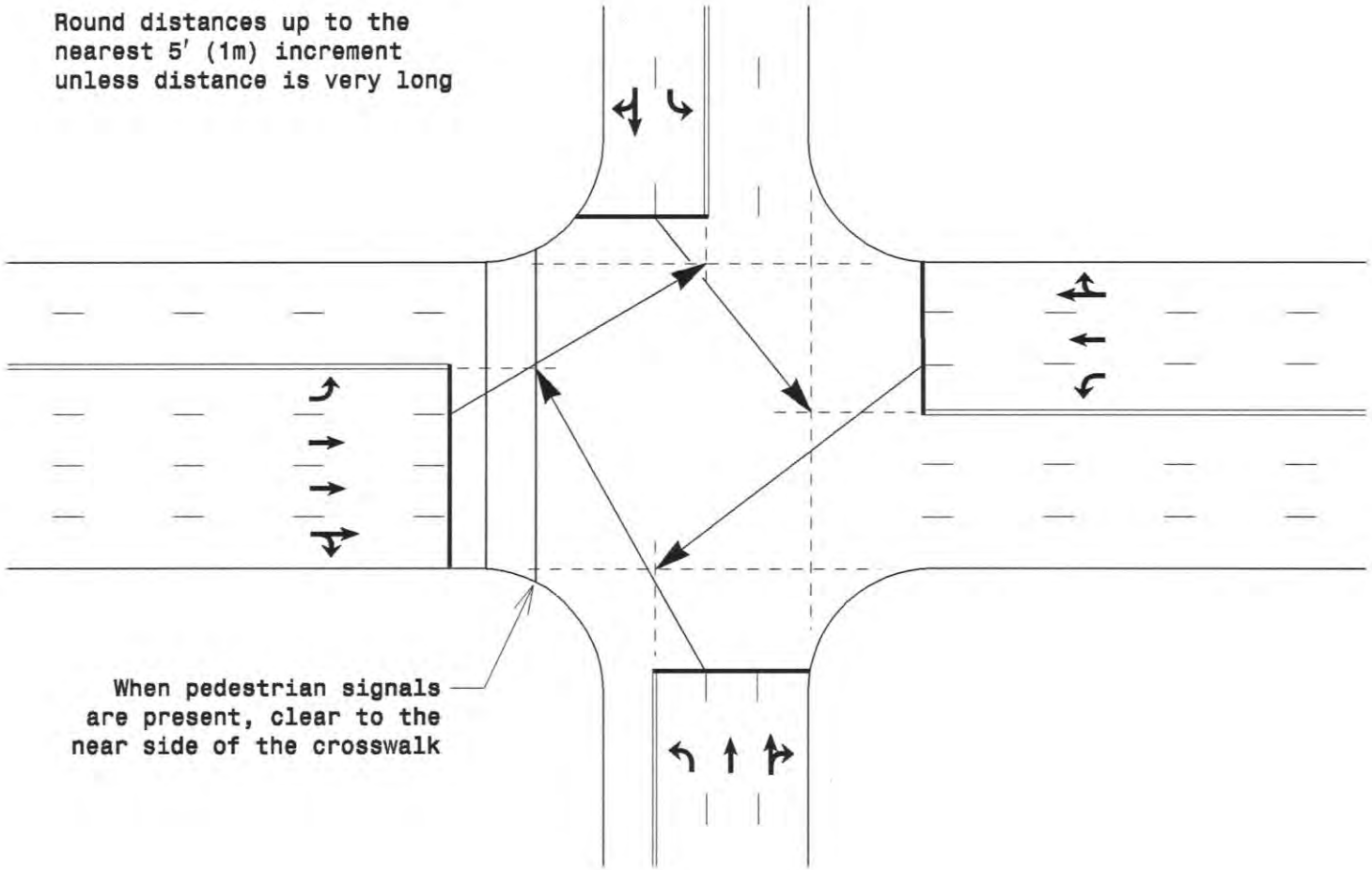
Standard Left Turn Movement Clearance Distances



Change and Clearance Intervals

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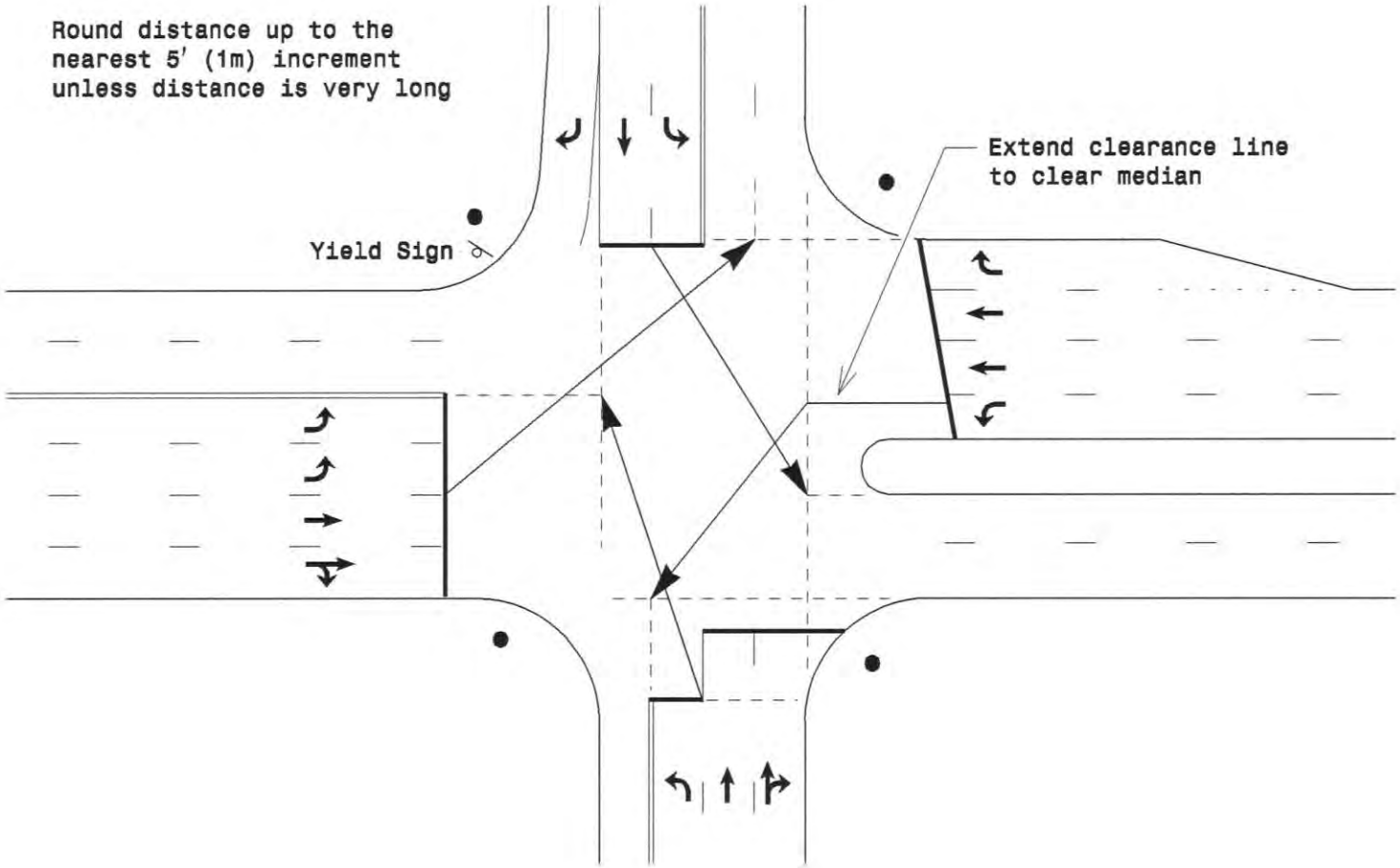
Other Left Turn Movement Clearance Distances
Median, Dual Left, Setback



Change and Clearance Intervals

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STD. NO.
5.2.2
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Determination of Yellow Change and Red Clearance Intervals

Yellow Change Interval

$$\text{Yellow interval} = t + \frac{v}{2a + 64.4g}$$

t = perception reaction time, typically 1.5 seconds
v = design speed*, in ft/sec
a = deceleration rate, typically 11.2 ft/sec^2
g = grade

Round up to nearest 0.1 second.

Minimum yellow change interval is 3.0 seconds.

Hold stakeholder discussion** when calculated yellow change interval is longer than 6.0 seconds.

Red Clearance Interval

$$\text{Red interval} = \frac{W}{V}$$

w = width of intersection, in feet
v = design speed*, in ft/sec

If the initial calculation results in an all red time longer than 3.0 seconds, recalculate the red time as follows:

$$\text{Recalculated red interval} = \frac{1}{2}\left(\frac{W}{V} - 3\right) + 3$$

Round up to nearest 0.1 second.

Red clearance interval should be between 1.0 and 6.0 sec.

Hold stakeholder discussion** when recalculated red clearance interval is longer than 4.0 seconds.

Notes

*Design speed is the speed limit unless a speed study determines that the 85th percentile speed is faster or intersection geometrics compel vehicles to traverse the intersection slower.

**The purpose of a stakeholder discussion is to provide advance notification and involvement to stakeholders and provide an opportunity to consider possible countermeasures.

For most left turn lanes, assume a speed of 20 mph (32 kph) to 30 mph (48 kph). For locations with unusual conditions a higher or lower speed may be appropriate.

For separate left turn phases, calculate yellow and red intervals.

For left turns without a separate phase, calculate yellow and red times for both the through movement and the left turn movement. Use the highest yellow and enough red to equal the highest total time.

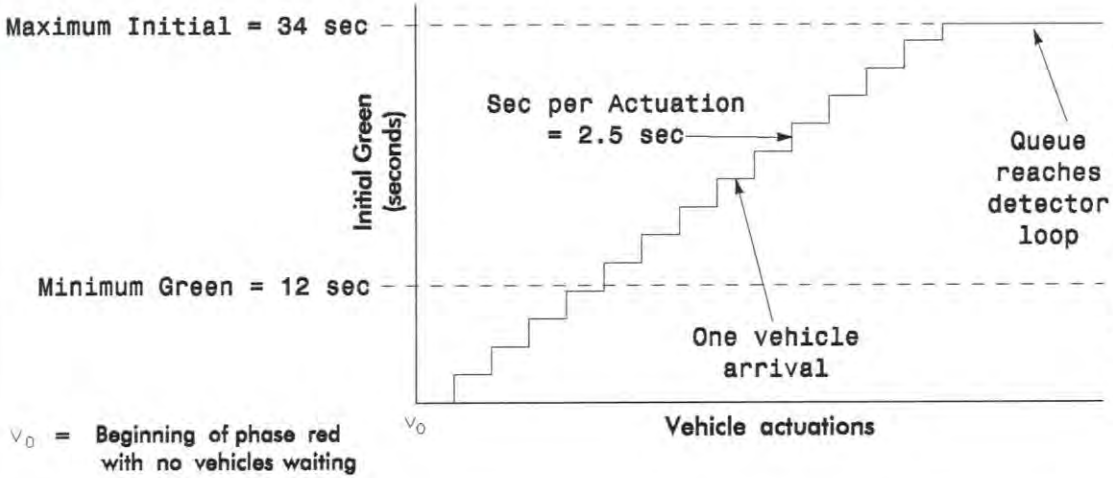
Where existing times are higher than calculated times, use the calculated values unless there is a documented history of the need for higher times. If approach is high speed and existing times are significantly higher than the calculated times, use the calculated values but consider adding a note to the plan to direct field forces to reduce the time incrementally. Include in the note how much and how often to reduce time until the final value is reached. (Ex. Existing Yellow Change Interval for phase 2 may be decreased by 0.2 seconds per week until the required value is reached.)

Where revising a location or adding a new signal along a corridor, consider comparing clearance times at adjacent intersections to new calculations to meet driver expectations.

Sources:
Traffic Engineering Handbook, Fifth Edition, Institute of Transportation Engineers, 1999.

A Policy on Geometric Design of Highways and Streets, Fourth Edition, American Association of State Highway and Transportation Officials, 2001.

Variable Initial Parameters

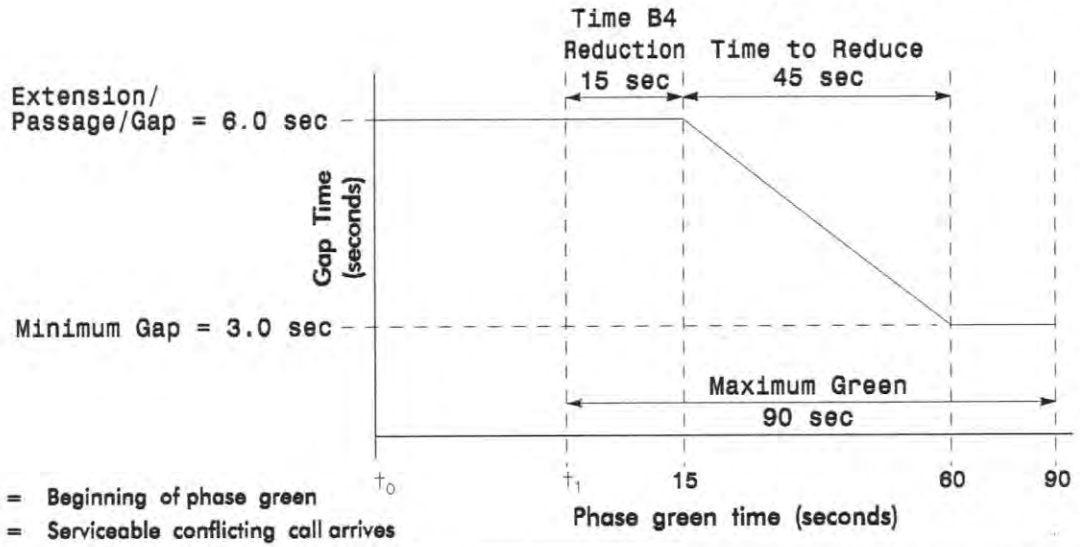


Variable initial operation increases the MIN Green interval in a manner dependent upon the number of vehicle actuations placed on the phase while it is in the Yellow or Red interval. The variable initial interval is calculated as a function of the vehicle actuations and the MIN Green, Seconds Per Actuation, and MAX Variable Initial settings. The following relationship calculates the variable initial interval:

Initial Interval = (# of Vehicle Actuations) X (Seconds Per Actuation Setting)

If the calculated initial interval is less than the MIN Green setting, the MIN Green time will be used as the initial interval. If the calculated initial interval is greater than the MAX Variable initial setting, the MAX Variable initial will be used as the initial interval.

Gap Reduction Parameters



Gap Reduction reduces the allowable gap between successive vehicle actuations by dynamically decreasing the extension time. The rate of reduction is based on the setting of the Extension, Minimum Gap, and Time to Reduce settings. Using this method, the gap will be reduced by the following relationship:

$$\text{Reduction} = \frac{\text{Extension} - \text{Minimum Gap}}{\text{TTR}} \times (\text{Current Green Interval Time} - \text{TBR})$$

This reduction begins when the Green interval has timed the Time Before Reduction (TBR) setting. Reduction of the allowable gap will continue until the gap reaches a value equal to or less than the Minimum Gap In the presence of continual vehicle actuations, the phase will not gap out, even if the gap has been reduced to zero.

Volume Density Timing Example 2070L and NEMA Controllers

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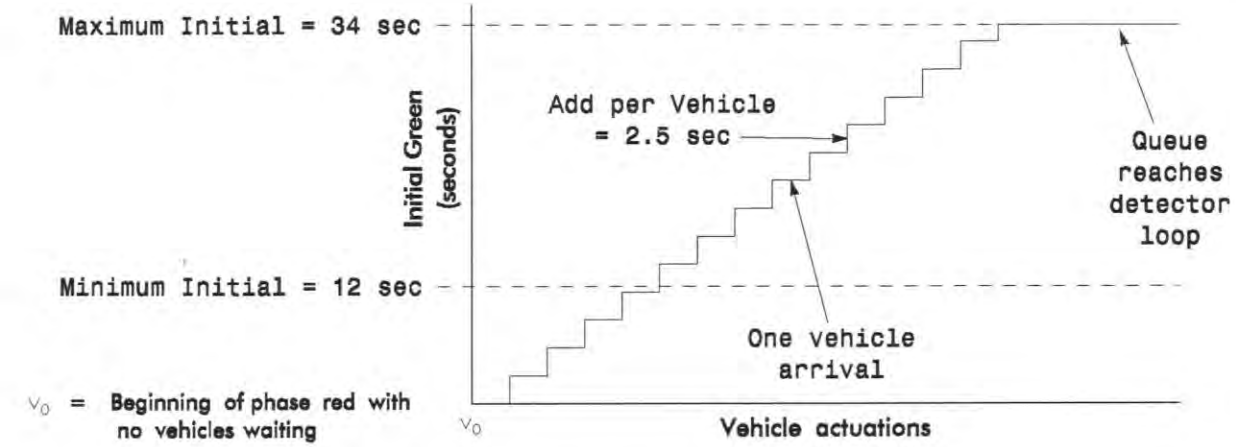
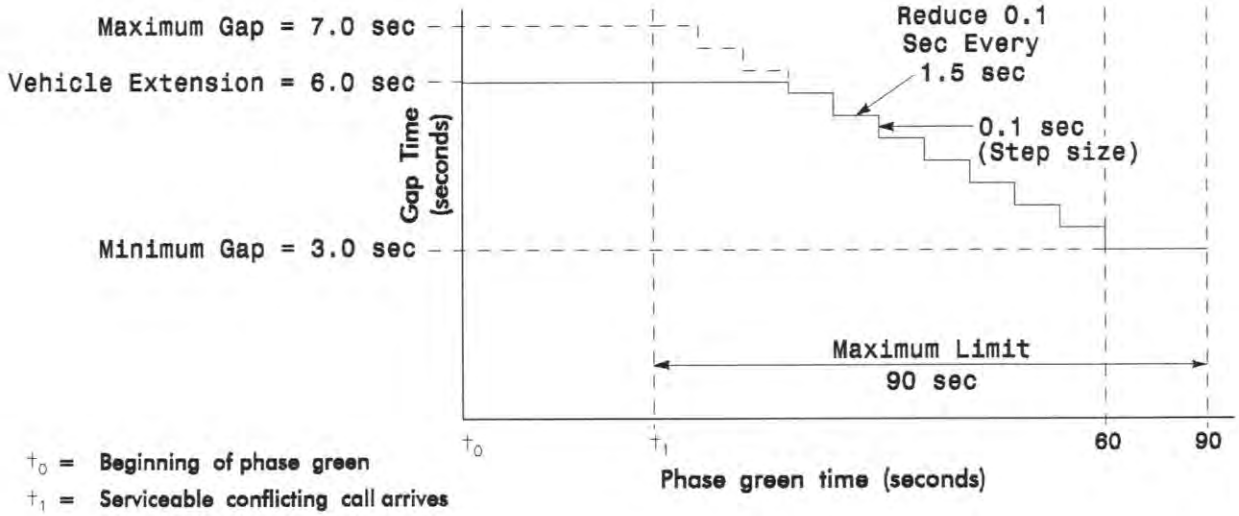


Variable Initial Parameters



Gap Reduction Parameters

Note: The controller begins timing the gap reduction from the Maximum Gap (7.0 sec) when it gets a conflicting call; however, the 'real' maximum gap is the Vehicle Extension (6.0 sec). The Vehicle Extension time will never go above 6.0 seconds. The time the controller takes to reach the Vehicle Extension from the Maximum Gap is the 170's version of Time B4 Reduction.

Volume Density Timing Example – 170 Controller

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Standard Signal Plan Legend

LEGEND

PROPOSED		EXISTING
	Traffic Signal Head	
	Modified Signal Head	N/A
	Sign	
	Pedestrian Signal Head With Push Button & Sign	
	Signal Pole with Guy	
	Signal Pole with Sidewalk Guy	
	Inductive Loop Detector	
	Controller & Cabinet	
	Junction Box	
	2-in Underground Conduit	
N/A	Right of Way	
	Directional Arrow	

Note:

Symbols for utilities, hydrology, property lines, etc. should mirror standards set by NCDOT's Roadway Design Unit.

Other Common Symbols

PROPOSED		EXISTING
	Modified Pedestrian Head	N/A
	Metal Strain Pole	
	Metal Pole with Mastarm	
	Signal Pedestal	
DD	Directional Drill	N/A
	Out of Pavement Detector	
	Video Detection Area	
	Out of Pavement Detection Area	
M	Master Controller & Cabinet	M
N/A	Railroad Cantilever	
N/A	Railroad Gate and Flasher	
N/A	Railroad Tracks	
	Construction Zone Drums	
	Construction Zone	
	New Pavement	N/A
N/A	Wheelchair Ramp	WCR
N/A	Wheelchair Ramp	
A	Sign I.D.	A

Common Drawing Symbols

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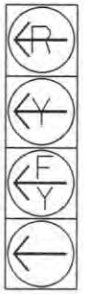
SHEET 1 OF 1

Typical Appearance of Signal Face I.D.

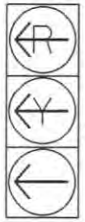
SIGNAL FACE I.D.

All Heads L.E.D.



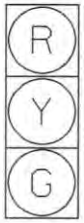
12" (300mm)

51



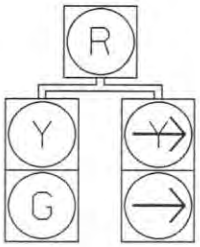
12" (300mm)

11, 12



12" (300mm)

21, 22
42
61, 62



12" (300mm)

42

12" (300mm)

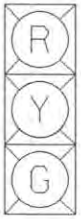
P21, P22

16" (400mm)

P61, P62

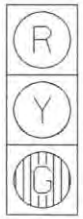
Signal Faces/Heads with Special Characteristics

Optically Programmed Head



12" (300mm)

Section with Louver



12" (300mm)

Signal Face I.D. Details

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Project Type

Indicate whether 'New Installation,' 'Signal Upgrade,' or 'Temporary Signal.'

Graphic Scale

Include a graphic scale on all plans.

Plan Description

Description should include:

- # Phases
- Type of Actuation
- w/ Special Features (if any)
- Isolated or System (including type)

Text and Lettering

-Letter sizes should approximate the following:
Title block street names and title heads...3/16in (5mm)
All other lettering.....1/8in (3mm)

-List the routes in the title block using the word "at", not "and", as follows:

SR XXXX (Tree Avenue) at SR XXXX (Stump Drive)

-OR-

SR XXXX (Tree Avenue) at SR XXXX (Stump Drive)/NC 123 (Branch Street)

Metric Block

For metric plans, include the metric block in the upper righthand corner.

North Arrow

For Spot Safety projects, align the main street to run horizontally across the plan where possible. For Contract projects, align the plan in the same general direction as the roadway plans. For closed loop system projects, align signal plan sheets in the same general direction as the cable routing plans where possible.

Address

For plans developed in house, include the department logo with the Signals & Geometrics Section's address in the title block.

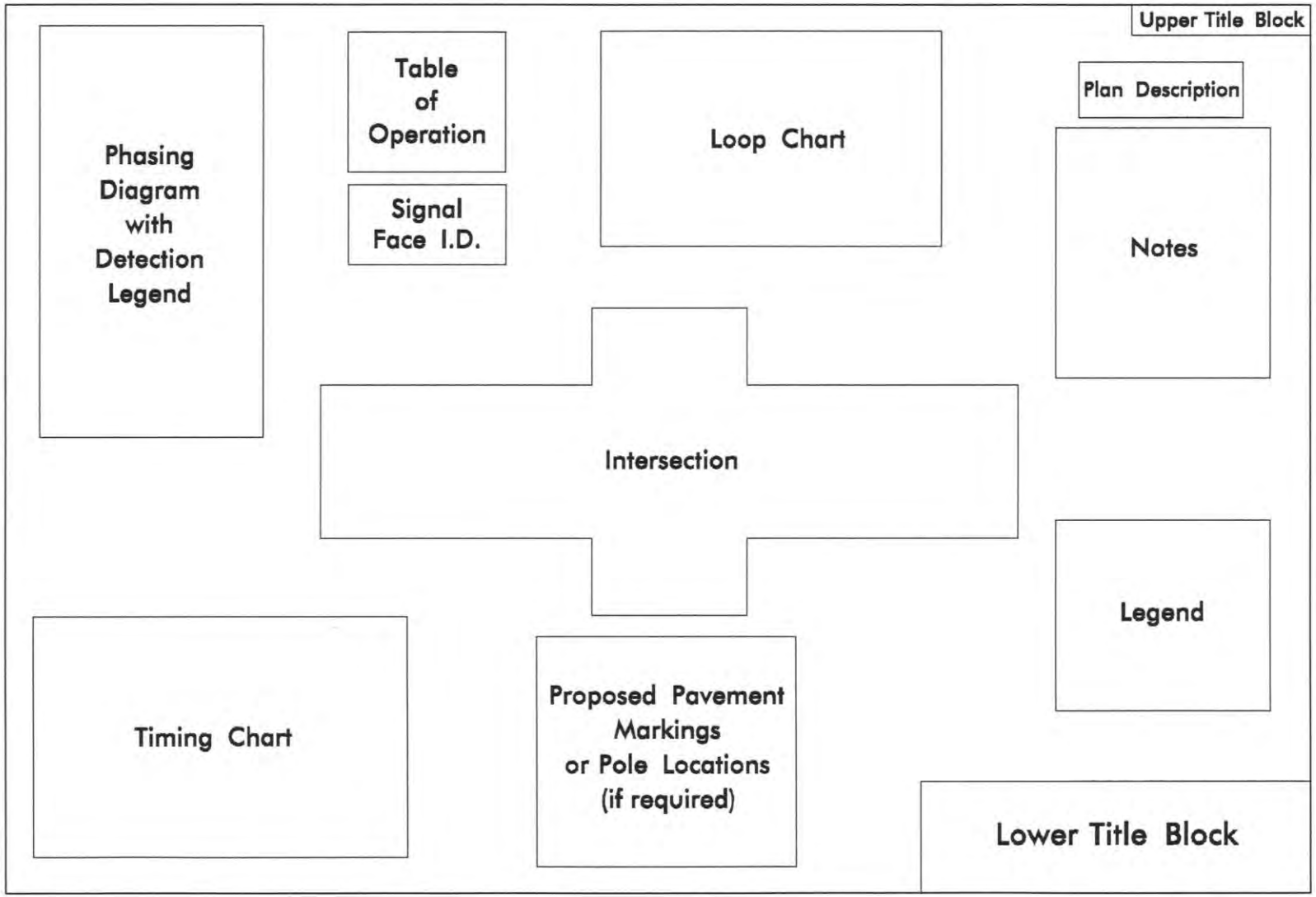
For plans developed by private engineering firms, include the department logo with the Signals & Geometrics Section's address in the title block and the firm's name with address on the plan sheet beside the title block.

For plans developed by municipalities, include the department logo with the Signals & Geometrics Section's address in the title block and the municipality's name with address on the plan sheet beside the title block.

For plans developed by private engineering firms for a municipality, include the department logo with the Signals & Geometrics Section's address in the title block and the firm's name with address on the plan sheet beside the title block.

Note: Private engineering firms and municipalities are responsible for placing their name with address on the plans. Company or municipal logos are permitted providing they do not detract from the plan.

Typical Signal Plan Layout



Miscellaneous Drawing Format Items

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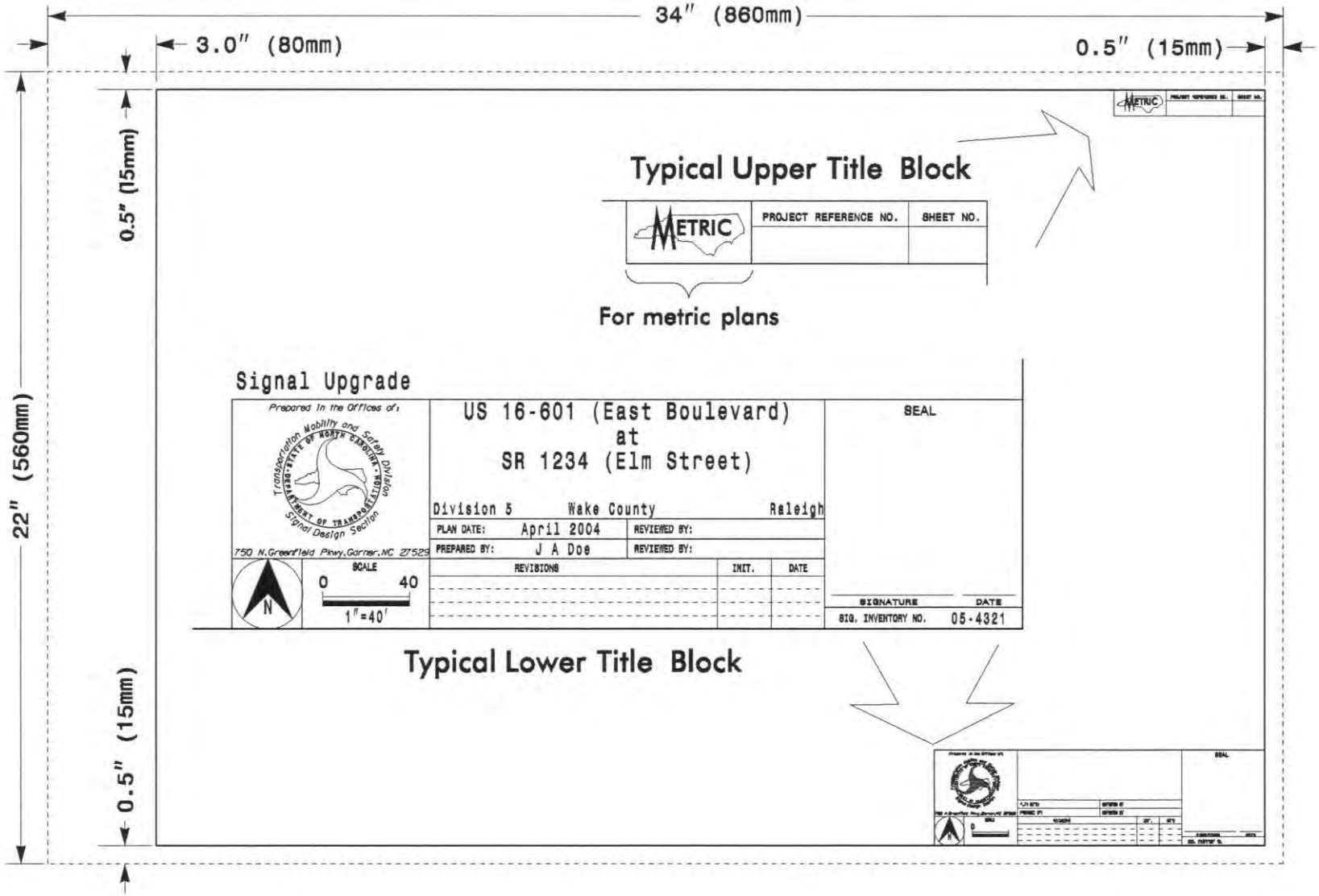
Typical Border Sheet with Dimensions



Miscellaneous Drawing Format Items

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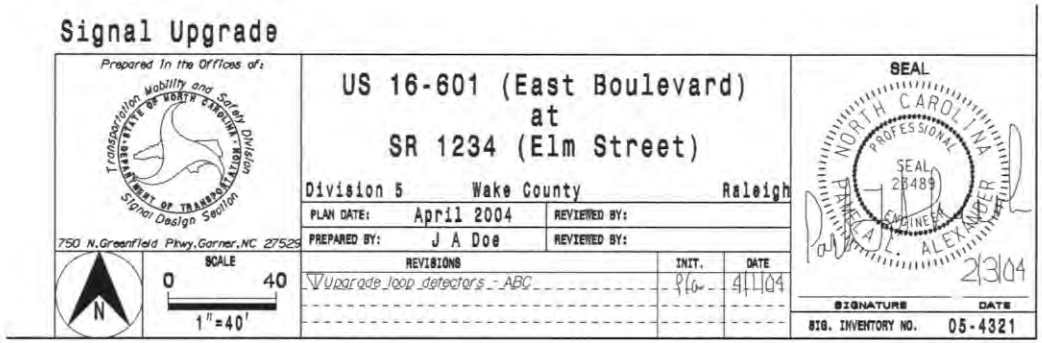
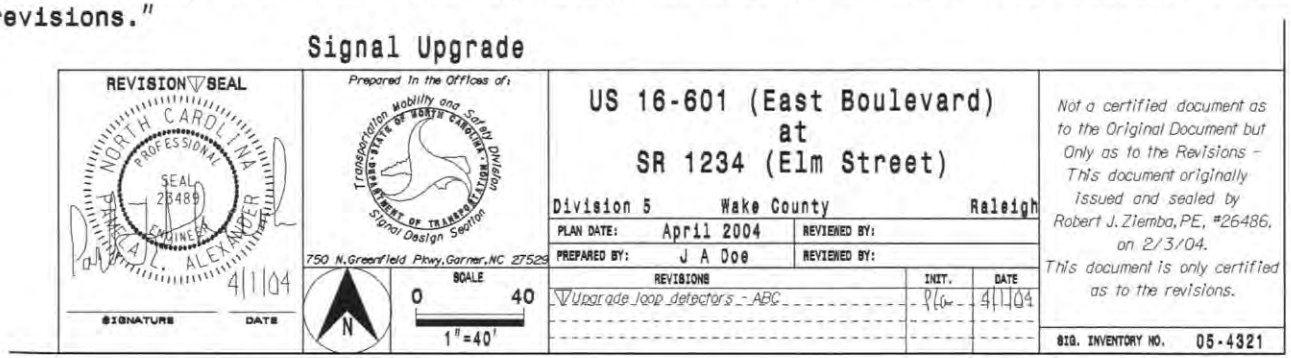
Revisions

When revising an existing traffic signal plan, include the revision number, date, and revision description. Additionally, enclose the revision number in a triangle and place the triangle on the plans near the affected area if needed for clarity.

When the PE making the revision is the same PE who sealed the original plan, the PE initials and dates the revision block and reseals the original plan with the original date.



When the PE making the revision is different than the PE who sealed the original plan, then a "Revision Seal" block needs to be added to the title block to the left (preferred) or just above the title block on the original plans. In addition, add the text "Not a certified document as to the Original Document but only as to the Revisions - This document originally issued and sealed by 'name,' 'PE number,' on 'date.' This document is only certified as to the revisions."



Signal Cable Calculations

Signal Cable

There is only one pay item for signal cable; combine measurements for 16-4 and 16-7 cable. Route cable to minimize the length of cable used. Add 3′ (1 m) extra in cabinets. Add 3′ (1 m) extra at each signal head. Assume 30′ (10 m) down poles. Note: Use 2 separate cable runs if there are more than 6 heads on a phase.

Example (See sheet 2)

Heads 61 & 62:
3′ (beside head) + 12′ + 3′ (beside head) + 270′ + 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 331′

Head 11
3′ (beside head) + 256′ + 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 302′

Heads 41 & 42:
3′ (beside head) + 15′ + 3′ (beside head) + 105′ + 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 169′

Head 43:
3′ (beside head) + 220′ + 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 266′

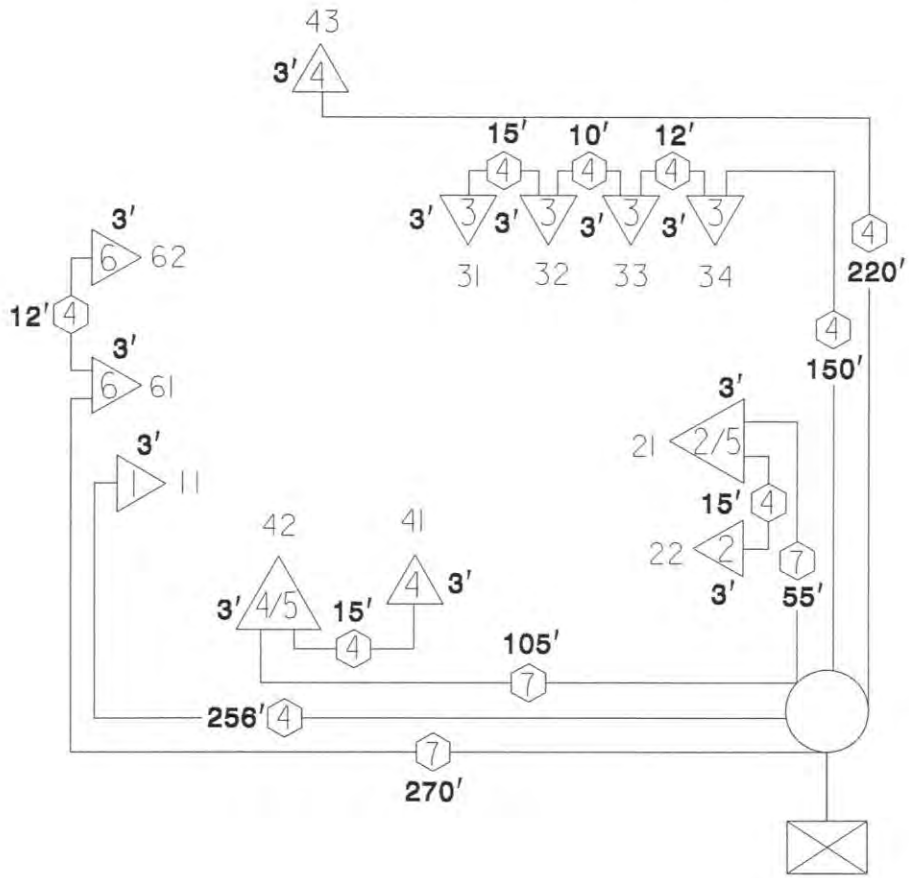
Heads 31, 32, 33 & 34:
3′ (beside head) + 15′ + 3′ (beside head) + 10′ + 3′ (beside head) + 12′ + 3′ (beside head) + 150′
+ 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 242′

Heads 21 & 22:
3′ (beside head) + 15′ + 3′ (beside head) + 55′ + 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 119′

Total: 331′ + 302′ + 169′ + 266′ + 242′ + 119′ = 1429′

Round up to nearest 10′ = 1430′

Signal Cable Example Diagram



Legend

- (4) 16–4 Conductor
- (7) 16–7 Conductor
- (4) Phase/Overlap
- 22 Signal Face I.D.
- 15′ Segment Distance

Plan Quantity Calculations

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Messenger Cable & Loop Lead-In Calculations

Messenger Cable (Spanwire)

Example (See sheet 4)

Note: Do not add any length for guys as they are included as a pay item for guy assemblies.

145′ + 170′ + 110′ + 172′ = 597′

Round up to nearest 10′ = 600′

Loop Lead-In Cable

Each loop lead-in wire connects 1 loop to the cabinet if the is wired separately. Quadrupole and volume density (counting) loops need to be wired separately. If multiple loops are wired together, 1 lead-in connects the group to the cabinet. Low speed and extend (stretch) loops may be wired together. Include lead-in for pedestrian pushbuttons and microwave detectors. Assume 30′ (10 m) up or down poles.

Example (See sheet 4)

Loops 2A & 2B (together) and 5A (separate):
25′ + 30′ (up pole) + 172′ + 30′ (down pole) + 10′ (to cabinet)
= 267′ X 2 = 534′

Loop 6A and 6B (each separate):
250′ + 25′ + 30′ (up pole) + 110′ + 30′ (down pole) +10′ (to cabinet)
= 455′ X 2 = 910′

Loop 1A:
25′ + 30′ (up pole) + 110′ + 30′ (down pole) + 10′ (to cabinet)
= 205′

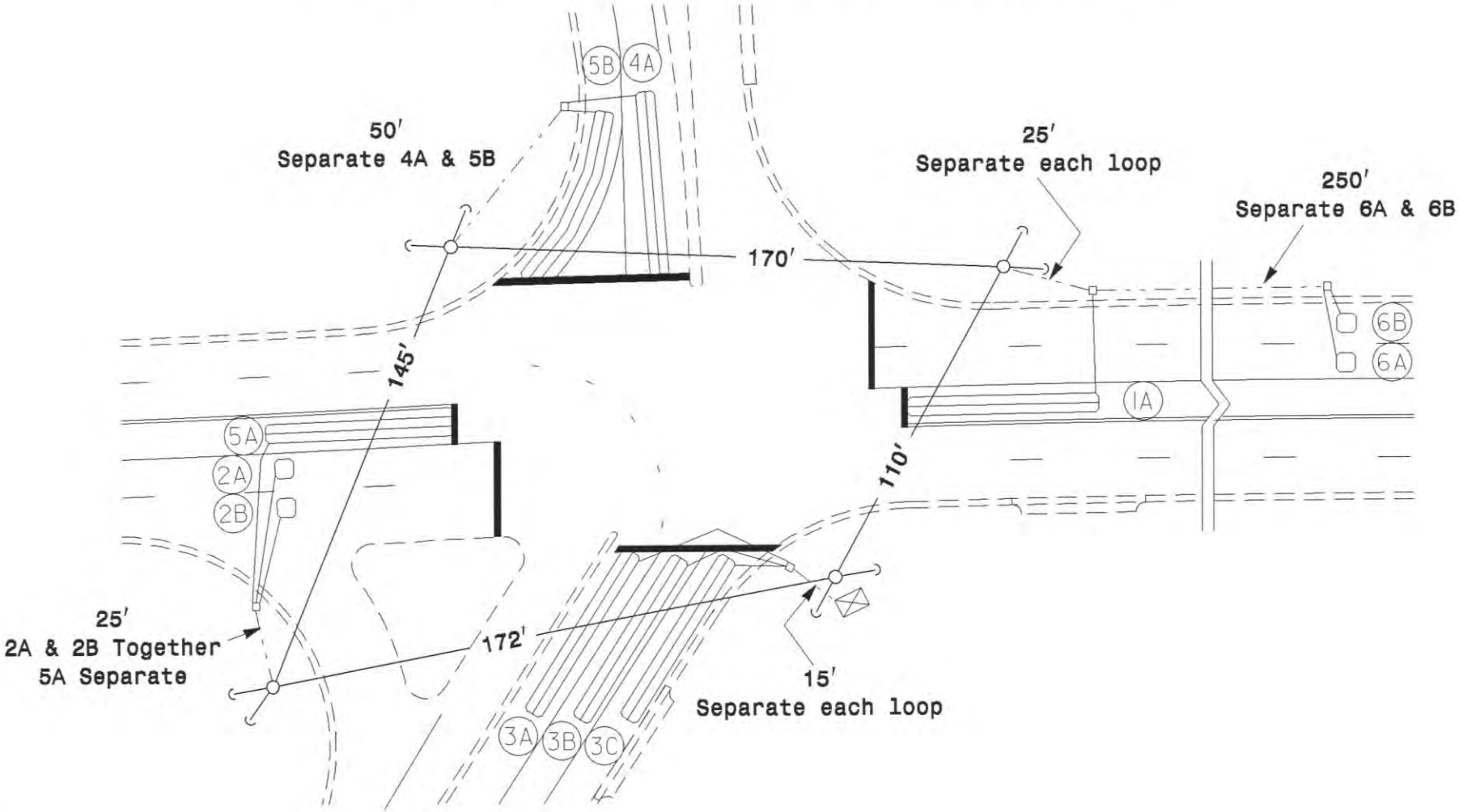
Loops 3A, 3B, and 3C (each separate): 15′
= 15′ X 3 = 45′

Loop 4A and 5B (each separate):
50′ + 30′ (up pole) + 170′ + 110′ + 30′ (down pole) +10′ (to cabinet)
= 400′ X 2 = 800′

Total: 534′ + 910′ + 205′ + 45′ + 800′ = 2494′

Round up to nearest 10′ = 2500′

Loop Lead-In & Messenger Cable Example Diagram



Plan Quantity Calculations

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