BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

ELECTRICAL AND TRAFFIC ENGINEERING MANUAL

Appendix 400.2

Traffic Signal Timing Sheets – How to Complete

(LMD, Naztec and Cobalt Controllers)

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Introduction

This document should be used as a guideline for completing Ministry standard Traffic Signal Timing Sheets. Only qualified professional engineers familiar with the Ministry Traffic and Electrical Engineering Standards manual and associated Technical Bulletins should complete this form.

Responsibility for traffic signal timing configuration and programming is divided into two groups:

1) *Project Traffic Engineer* and the *Ministry Traffic Operations Engineer* (TOS)
2) *Electrical Maintenance Contractor* and the Ministry *Manager, Electrical Services* (MES)

The TOS and the MES will review monitor the operations undertaken by the Project Traffic Engineer and the Electrical Maintenance Contractor.

The Project Traffic Engineer is responsible for performing the capacity analysis and determining the appropriate phasing and timing to use at intersections. They are also responsible for preparing coordination timing plans (via Synchro analysis) and identifying all of the special requirements such as preemption, detection delays, etc. The TOS uses the Ministry Traffic and Electrical Engineering Manual as their standard for developing timing plans.

The Electrical Maintenance Contractor is responsible for programming the traffic controller units and configuring the traffic controller cabinet to ensure that the traffic signal will operate as desired by the Project Traffic Engineer. The Electrical Maintenance Contractor *interprets* the information provided by the Project Traffic Engineer into appropriate programming and configuration of the controller. The Project Traffic Engineer uses the appropriate programming manual depending on the signal traffic controller in use, and the MOTI Traffic Controller Design Manuals as their standard for programming and configuring the controller units. The Programming Manuals outline in detail the default values for many of the controller parameters.

To ensure that the operation that is being desired by the Project Traffic Engineer is correctly interpreted by the Electrical Maintenance Contractor, the Ministry has established a Traffic Signal Timing Sheet format that allows the Project Traffic Engineer to relay their requirements in a clear and concise manner to the Electrical Maintenance Contractor

In addition to the blank sample Signal Timing Sheet figures included as figures in this document, the Traffic and Electrical Engineering Manual website contains blank and sample documents that may be helpful.

Where Do I Start?

For each Ministry controller type, workbooks have been created so that the information entered on one sheet is generally automatically passed on to the other sheets as appropriate. Typically, the information that needs to be filled on a worksheet has been shaded yellow. All other cells are either labels or automatically generated from other cells or worksheets.

As a first step, the designer shall mark-up a copy of the proposed traffic signal layout drawing showing all pavement markings and signal head locations. This drawing shall clearly indicate the paths and measurements that are to be used in the development of the timing sheet (clearance and conflict distances). This sheet shall be submitted along with the timing sheet itself to the Ministry.

If you are preparing a timing sheet for the first time (or the existing timing sheet does not conform to the current format), the following is the preferred order of completing the workbook:

1) Prepare a marked-up site plan showing the distances to be used for clearance and conflict distances as per the Traffic and Electrical Engineering manual.
2) Choose the appropriate workbook for the controller in use. For LMD controllers, you will also need to choose the appropriate workbook for the sequence in use (NEMA DUAL RING, PEDESTRIAN, etc.)
3) **FOR LMDs ONLY**: Press the “Click Here to Clear Workbook” button if you are starting a new timing sheet. Do not press this button if you are modifying an existing timing sheet as it will clear all entered data.
4) Complete the general information on the SIGNAL TIMING SHEET (*Date Issued, Location, Sheet Number/Revision, Phase Settings, Description, Function, and Overlap sections*)
5) Complete the speed and distance information on the CALCULATION SHEET (*posted speed, approach grade, clearance distance, conflict distance, walking speed, walking distance, approach speed, clearance speed, conflict speed, and advance warning distance*)
6) **FOR LMDs ONLY:** Complete a COORDINATION SHEET for each coordination timing plan or time of day MAXPLAN required (*MAXPLAN #, Day of Week, Time of Day, Cycle Length, Offset & total split*)
7) Return to the SIGNAL TIMING SHEET and complete the remaining manually filled sections.
8) You should now have a completed timing sheet that must be signed and sealed by a qualified Engineer of Record prior to submission to the Ministry. The Ministry shall receive the submission and distribute the timing sheet to the appropriate MOTI personnel.

Warning: The Ministry does not perform reviews or quality checks on consultant timing plans. Consultants are advised to ensure that they are qualified and have appropriate quality management plans for the development and review of the timing plans. In the event of an incident due to improperly timed traffic signals, the consultant shall be responsible for all costs associated with the incident via their errors and omissions insurance.

Warning: The provided workbooks have not been confirmed for accuracy. It is the responsibility of the consultant to confirm all formulas and calculations, and to ensure final submissions conform to the applicable Ministry, local and national standards. Errors in the spreadsheets should be forwarded to the Regional Traffic Engineer in South Coast Region.

How to Complete - LMD 8000 & 9200

1. Introduction

The Ministry uses LMD8000/9200 traffic controller units supplied by Peek Traffic Systems installed in Ministry-specific traffic controller cabinets to operate traffic signals. The equipment is sophisticated and requires expert knowledge and skills to correctly program and implement in the field. The LMD8000/9200 has approximately 35 pages of programming information that must be correctly entered in each field controller.

2. The Timing Sheets

The Ministry has developed several excel workbooks to capture most of traffic controller configurations. The workbooks available are:

a) NEMA DUAL RING
b) 2 OVER 2 PLUS 4
c) 4 PHASE SEQUENTIAL
d) 4 PLUS 2 OVER 2
e) PEDESTRIAN

Traffic Signal Timing Sheet designers shall choose the appropriate workbook to use depending on what configuration they are using as per the Traffic and Electrical Engineering Manual standards. It should be noted that NEMA DUAL RING is the preferred configuration option; however, this sequence may not be possible for some new and existing configurations.

Each workbook is divided into several worksheets as follows:

1) SIGNAL TIMING SHEET
2) CALCULATION SHEET
3) COORDINATION SHEETS 1 - 6

The SIGNAL TIMING SHEET contains most of the information required to program the controller (aside from coordination information) on a single sheet of paper.

The CALCULATION SHEET contains the information required to calculate the clearance and advance warning times for the phases. This sheet contains information related to speed limits, clearance distances, approach grades, conflict distances, etc., which are typically a constant once the signal is in operation.

The COORDINATION SHEETS 1-6 are six spreadsheets that can be used to outline the coordination information being requested. These sheets typically allow the user to input the split information from Synchro along with the cycle length and offset information to automatically calculate the force-offs and permissives for the various phases.

3. The Details

Building in the information from the **Where Do I Start** section, this section describes in detail the various fields in the Traffic Signal Timing Plan Workbooks.

WORKSHEET: SIGNAL TIMING SHEET

a) **Date Issued** – Enter the current date in the format *February 5, 2003*
b) **Controller Type** – Currently this will be an LMD 8000 unless otherwise indicated by the RTE.
c) **Cabinet Type** – Enter the cabinet type. Options include S-Rack, M-Rack, P, M-Shelf. New controllers shall always be either M-Rack or S-Rack. For existing cabinets, confirm with the RTE as to status and future requirements.
d) **Sequence** – Enter the appropriate SEQUENCE. This information should already be automatically filled in as each workbook is specifically set up for one configuration. You will need to enter a New sequence for configurations that are currently not provided (3 OVER 3 PLUS 2, 4 OVER 4 NO BARRIER); Refer to the Traffic and Electrical Engineering Manual for signal sequences. In particular note that for geometric conflicts for opposing left turns, the controller sequence must be sequential for that side of the barrier (i.e. you must use a 2 OVER 2 PLUS 4, or 4 PLUS 2 OVER 2 sequence)
e) **Intersection** – Enter the intersection location in the format MAIN STREET NAME @ MINOR STREET NAME
f) **Location** – Enter the city name
g) **Sheet Number & Revision** – Enter the electrical drawing series, sheet number and *revision* of the 1:250 site plan for the signal in the format *TE- 89106-10A.*
h) **Phase Setting** – Enter ON for each phase that will be active. Enter OFF in all other fields.
i) **Description** – Enter the description of the phase in the following format:

- **ROUTE 19**
- **NB LT**
- **EMERG PREEMPTION #**
- **RAIL PREEMPTION #**

The first lines should indicate the Street Name; the next lines should contain the direction and any movement (northbound left turn, etc.);and the following lines should contain any reference to Emergency or Railway preemption as appropriate, including preemption number.

j) **Function** – Enter the phase letter designation as per the Traffic and Electrical Engineering Manual standards (A1, B1>, Ay, C, etc.)
k) **Overlap** – Enter the phase letter designation for any overlap movements including any pedestrian overlaps. (A1, B1>, Ay, C, PA3, etc.)
l) **Minimum Green Time** – This information is automatically entered based on the Sequence chosen. It may be overridden however the user is referred to the Traffic and Electrical Engineering manual for applicable MOTI standards
m) **Passage** – This information is automatically entered based on sequence chosen, however the Traffic designer shall select the most appropriate times based on field conditions. See the T&E Engineering Manual for further information.

n) **Yellow** – This information is automatically calculated from the CALCULATION SHEET and is the yellow portion of the intergreen clearance period for each phase.
o) **Red** – This information is automatically calculated for the CALCULATION SHEET and is the red portion of the intergreen clearance period for each phase.
p) **MaxI/MaxII** – This information must be entered by the traffic designer. The Max I is the default maximum green values for each phase as calculated through a Synchro analysis. MaxI/II are superseded by any MAXPLANS in effect during that portion of the day. MAX II provides an alternative maximum plan for use at other time periods.
q) **Maxplan (1-8)** – These maximum green values are automatically entered from the COORDINATION SHEETS. The Ministry typically invokes a different Maxplan for each coordination plan. However, the Maxplans can be invoked separately by either overwriting these fields directly and completing the TIME OF DAY information at the bottom of the sheet, or entering the information in the TOTAL SPLIT fields in the COORDINATION SHEETS and leaving the Cycle Length and Offset information blank.
r) **Walk** – This information is automatically entered from the CALCULATION SHEET and represents the amount of Walk time required for the phase. Refer to the Traffic and Electrical Engineering Manual for appropriate walk intervals.
s) **Pedestrian Clearance** - This information is automatically entered from the CALCULATION SHEET and represents the amount of Pedestrian Clearance or flashing Don't Walk time required for the phase. Refer to the Traffic and Electrical Engineering Manual for appropriate walk intervals.
t) **Walk** – Note there are two WALK fields. The Second WALK field identifies whether the WALK output from the controller flashes or is steady. This field is STEADY for all controller types except for the Sequence PEDESTRIAN where it is set to FLASH for the main street movement (see T&E Manual for standards for Pedestrian signals)
u) **Recall** – This field indicates the type of recall for each phase. Options include OFF, EXT, MAX, CNA1. The field should be set to OFF for any movements that are not the resting phases; EXT for resting phases; MAX for movements with no actuation (pushbuttons or loops); CNA1 for pedestrian signals (see T&E Manual).
v) **Memory** – This field allows a call to be placed in the controller and locked in until that phase is serviced. It is used on occasion when vehicles consistently stop past the stop bar which does not allow a call to be placed to the controller. For most applications this should be set to OFF.
w) **Coordination Phase** – Mark an **XXXX** in the phases that are coordinated if applicable. Typically, these would be the main street movements.
x) **First Green Display** – Mark an **XXXX** in the first serviceable phase after the signal comes out of flash. The FIRST GREEN DISPLAY would typically be the first through movement(s) on the cross street. Note that on earlier timing sheets, the term FOP or Full Operation Point was used which is the phase before the FIRST GREEN DISPLAY (when using older timing sheets, corrections must be made to reflect FIRST GREEN DISPLAY).
y) **Intersection Flash** – This is the flashing operation of the signal when a malfunction has occurred, or the signal is first powering up. Typically for Urban locations, the intersections flash all red. Rural locations usually flash yellow on the main street and red on the cross street. The Yellow flash is typically only used for simple phasing arrangements (2 or 3 phase) with no fully-protected left turns and usually no more than a three-lane cross section on any roadway.

z) **AWF Time** and **AWF Time [CH1/CH2]** – This is the advance warning time. This information should be automatically calculated and inserted from the CALCULATION SHEET. The first field indicates the total amount of advance warning time that should be allocated to each phase. If concurrent phases that terminate simultaneously have advance warning times that differ by more than 0.5 seconds and the intersection does not have fully protected left turns, cascading advance warning must be used in order to prevent a trap situation in the intersection. To accomplish this, the AWF TIME [CH1/CH2] field is divided into two components. The first is the difference between the two concurrent advance warning times (i.e. 6.2s – 5.2s= 1.0s); the second is the smaller of the two advance warning times (i.e. therefore the AWF TIME [CH1/CH2] for the above example would be 1.0 in the first box and 5.2 in the second box).

aa) **Delay Detection Timing** – This section identifies any delays or extensions that need to be added to any specific loops as per the T&E Engineering Manual. Typical delays and how they should be listed include:

- Left Turn Clip L5, L6 - 3 SEC LT CLIP
- Right Turn Clip L4 - 3 SEC RT CLIP
- Advance Left Turn L8 - 10 SEC ALT
- Right Turn L2 - 5 SEC RT
- Advance Loops L12, L13 - 5 SEC EXT
- Queue Loops L1, L3 - 5 SEC QUEUE

Note that all protected permissive left turn movements (advanced left turns) on the MAIN STREET must have a 10-second delay per c) above.

bb) **Pre-Emption Type** – This section is used to identify the type of emergency preemption equipment being used. Options include SONIC (sound activated), OPTICOM (Strobe activated), EMTRAC (radio activated) and Direct (tied to a fire hall or municipal preemption system such as in Richmond) as well as others. Enter the appropriate type.

cc) **Delay Time** – Enter the amount of time that the Ministry controller should wait to initiate preemption phasing once a call has been received from the preemption system. This is typically used for Direct connections tied to a fire hall, however the emergency department should be advising of any delay time requirements. If there is no delay time enter 0.

dd) **Pre-Emption Time** – This is the length of time that the preemption will be in effect once the controller has cycled to the appropriate phase. This feature is typically used for direct connections tied to a fire hall and for some older systems. For newer systems that preempt the signal for as long as the sensors are activated such as Opticom and SONIC Systems enter “Sensor Actuated” in this field.

ee) **Volume Logging and MOES** – The ministry controllers log traffic volumes and some measures of effectiveness. This field should be set to **ON 15 MIN** which means the controller will perform volume counts and record MOES 24 hours per day at 15 minute intervals.

ff) **SCM** – This stands for Sub-Coordinated Mode. In certain instances where the split allocated to a phase causes the phase to run past its force off point, the controller may accidentally skip a phase trying to get back in synchronization. Setting SCM to **ON** avoids this, however the controller will take longer to resynchronize. Enter “ON” for all controllers that are coordinated.

gg) **Programming Comments** – These comments are meant to assist the Regional Electrical Maintenance personnel in programming the controller specifically for the site. Typically, comments are related to railway preemption parameters but may include items such as:

- SET SGO to ZERO (0) – PASSAGE CAN RESET
- RR PRE-EMPTION ENTRY PHASE MINIMUM GREEN = 4.0 SECS
- STEP 1 OF RR / EMERGENCY PRE-EMPTION IS ALL RED = 2.0 SECS.
- STEP 2 OF RR PRE-EMPTION IS PHASE B1 & B1-> GREEN = 22 SECS.
- STEP 3 OF RR PRE-EMPTION IS SERVICE PHASE A1 & A2.
- "NO LEFT TURN" SIGN ON DURING RR CLEARANCE & PRE- EMPTION.

hh) **Operational Comments** – These comments are meant as information to assist future Regional Traffic Engineers when modifying the traffic signal timings. If there are more PROGRAMMING COMMENTS than space available, you may also use this section for additional comments. Typically comments in this section include:

- SIGNAL COORDINATED WITH BRECHIN, HAMMOND BAY AND STEWART.
- CONTROLLER HAS TELPPHONE CONNECTION
- PEDESTRAIN WALKING SPEED 1.0 M/S DUE TO SCHOOL
- TIME FROM RR PRE-EMPTION CALL UNTIL RR LIGHTS FLASH
- = 17 SECS.
- TIME FROM RR PRE-EMPTION CALL UNTIL TRAIN CROSSES VALLEY DRIVE = 41 SECS.

ii) **PED Permissive** – If there are no advance warning signs, the PED permissive shall be set to AUTO. If there are advance-warning signs the PED PERMISSIVE shall be set to the shortest ped permissive period as calculated in all of the COORDINATION SHEETS. This information is typically entered automatically from the COORDINATION SHEETS.

jj) **Cycle (1 to 8)** – The fields represent the various cycle lengths assigned within the controller unit. This information is typically assigned in the COORDINATION SHEETS and is then automatically transferred to this sheet.

kk) **Offset (1 to 4)** – The fields represent the OFFSET values required for coordination. This information is typically assigned in the COORDINATION SHEETS and is then automatically transferred to this sheet.

ll) **Time Clock Settings** – For coordination information, the TIME OF DAY to OFFSET fields are automatically transferred from the COORDINATION SHEETS. For special applications, the user will be required to fill in the appropriate sections.

mm) **Time of Day** – Typically auto-entered from the COORDINATION SHEETS for coordination. The format of this field shall be in the 24 hour format (i.e. 06:00 – 13:00). This information represents the time of day at which the special function is required.

nn) **Day of Week** - Typically auto-entered from the COORDINATION SHEETS for coordination. The format of this field shall be in the format MON-FRI, SAT-SUN, etc.

oo) **Maxplan (1 to 8)** - Typically auto-entered from the COORDINATION SHEETS for coordination. The format of this field shall be a maxplan number from 1-8. See MAXPLAN information q) above.

pp) **Cycle (1 to 8)** - Typically auto-entered from the COORDINATION SHEETS for coordination. The format of this field shall be a Cycle number from 1-8.

qq) **Offset (1 to 4)** - Typically auto-entered from the COORDINATION SHEETS for coordination. The format of this field shall be an OFFSET number from 1-4.

rr) **Service Plan (1 to 8)** – Service plans provide additional features that can be used by time of day. Features which are provided by service plans include changing walk and passage times as well as recall phases. Enter the number of the service plan being used (start sequentially from 1). The information relating to the service plan will be added to the next section – ADDITIONAL TIME CLOCK INFORMATION

ss) **Additional Time Clock Information** – Add any additional information required to properly program the traffic controller for the particular time of day operation. Of particular interest would be the details associated with any service plans used in the previous field.

tt) **Engineer of Record** – The professional engineer completing the traffic signal timing sheet shall Sign, date and seal the timing plan in the appropriate location.

uu) **Received and Distributed by MOTI** – The MOTI Traffic Operations Engineer shall receive and distribute the consultant prepared Traffic Signal Timing sheet. Note that the Ministry Engineer does not perform quality audits or detailed review of the timing sheet. Responsibility for the content and any errors and omissions rests with the Engineer of Record.

WORKSHEET: CALCULATION SHEET

The information at the top of this sheet is automatically populated from the TRAFFIC TIMING SHEET and the following describes the remaining fields that are entered or calculated on this spreadsheet.

a) **Posted Speed** – Enter the posted speed of the roadway for each phase.
b) **Approach Grade** – Enter the approach grade for the roadway on each phase.
c) **Clearance Distance** – Enter the clearance distance associated with the phase (refer to the T&E Engineering manual for details for through and left turn phases)
d) **Conflict Distance** – Enter the conflict distance associated with the phase (refer to T& E Engineering manual for details for through and left turn phases)
e) **Walking Speed** – Enter the walking speed for the pedestrian movements as per the Traffic and Electrical Engineering manual or sound engineering judgement. A comment should be made in the OPERATIONAL COMMENTS (Section hh) on the SIGNAL TIMING SHEET worksheet if walking speeds other than the standard are used.
f) **Walking Distance** – Enter the walking distance for each pedestrian movement.
g) **Approach Speed** – Enter the approach speed as per the T&E Engineering manual
h) **Clearance Speed** – Enter the clearance speed as per the T&E Engineering Manual
i) **Conflict Speed** – Enter the conflict speed as per the Traffic and Electrical Engineering Manual.
j) **Clearance Interval** – This interval is the total yellow and red time for the phase and is automatically calculated based on the previous geometric and site information.
k) **Yellow** – This is an automatically calculated value for the yellow portion of the CLEARANCE INTERVAL above and the appropriate red/yellow split clearance interval tables from the Traffic and Electrical Engineering Manual.
l) **Red** – This is an automatically calculated value for the red portion of the CLEARANCE INTERVAL above and the appropriate red/yellow split clearance interval tables from the Traffic and Electrical Engineering Manual.
m) **Ped Walk** – Enter the amount of Walk time required for the phase. Refer to the Traffic and Electrical Engineering Manual for appropriate walk intervals.
n) **Ped Clear** – This is an automatically calculated value for the pedestrian clearance or “flashing don’t walk” based on the geometric and site conditions entered previously and the Traffic and Electrical Engineering Standards manual.
o) **AWF Distance** – Enter the distance from the stop bar to each advance warning sign.
vv) **AWF Time** – This is the advance warning time calculated based on the geometric and operational site conditions entered previously. This field indicates the total AW time for each phase. For programming, additional Channel information is required as described below.
ww) **AWF Time [CH1/CH2]** - If concurrent phases that terminate simultaneously have AWF times that differ by more than 0.5 seconds and the intersection does not have fully protected left turns, cascading AWF must be used to prevent a trap situation.
To accomplish this, channel information must be included. [CH1] shall be the difference between the two concurrent AWF times (e.g. 6.2s – 5.2s= 1.0s) while [CH2] shall be the smaller of the two advance warning times (i.e. therefore the AWF TIME [CH1/CH2] for the above example would be 1.0 in the first box and 5.2 in the second box).
If cascading AWF time is not required, [CH1] & [CH2] shall each represent separate AWF times for individual phases (e.g. CH1/CH2 set to 5.2/-- for phase 2 and --/6.2 for phase 6).

WORKSHEET: COORDINATION SHEETS 1 - 6

Each of the COORDINATION SHEETS represents one set of coordination timing plan information.

Each sheet may also be used to automatically create Maxplans in the SIGNAL TIMING SHEET for signals that are not coordinated but require time of day maximum green changes beyond MAX II. Most of the information on these sheets is automatically transferred from the SIGANL TIMING SHEET spreadsheet. The following describes the remaining fields that are entered or calculated on this spreadsheet.

a) **Maxplan (1 to 8)** – enter a number from one to eight to identify the Maxplan number for this coordination plan.
b) **Day of Week** – enter the day of the week that this coordination plan will be in effect in the format MON-FRI, SAT-SUN, SUN-SAT, etc.
c) **Time of Day** – enter the time of the day that this coordination plan will be in effect in a 24 hour clock following the format 06:00 – 09:00, 15:00 – 19:00, etc.
d) **Cycle Length** – enter the cycle length for this coordination plan (typically from Synchro analysis)
e) **Offset Time** – enter the offset time for this coordination plan (typically from the Synchro analysis). Note that the Ministry uses the end of main street green (start of main street yellow) as the reference point for coordination.
f) **Total Split** – from the Synchro analysis, enter the total split for each phase. This split will also include any clearance intervals for the phase.
g) **Total Split Green** – this is an automatically calculated value using the Total Split time above and subtracting any clearance intervals and advance warning times for each phase.
h) **Force Off** – this information is automatically calculated based on the operational parameters previously entered as per the Traffic and Electrical Engineering manual. The force off represents the point in the cycle when each phase will be terminated to service the next serviceable phase. Force offs are assigned on a one to one basis; force off 1 is phase 1, force off 2 is phase 2, etc.
i) **Start of Permissive** - this information is automatically calculated based on the operational parameters previously entered as per the Traffic and Electrical Engineering manual. The start of permissive represents the point in the cycle when each phase is permitted to be serviced if a call is present. No permissives are required for the coordinated phase as the signal automatically returns to this phase. Permissives are assigned on a one to one basis; Permissive 1 is phase 1, Permissive 2 is phase 2, etc.
j) **End of Permissive** - this information is automatically calculated based on the operational parameters previously entered as per the Traffic and Electrical Engineering manual. The end of permissive represents the last point in the cycle when each phase is permitted to be serviced if a call is present.
k) **End of Ped Permissive** – the ped permissive automatically commences with the Start of Permissive above, however a separate end of Ped Permissive is calculated. The value of the ped permissive is calculated based on the geometric and operational values previously entered and per the Traffic and Electrical Engineering Manual. See section ii) under the SIGNAL TIMING SHEET programming information.

l) **MAX GREEN** – this is an automatically calculated value that takes the Total Split Green time previously calculated and rounds the values to the nearest second. If the traffic designer wishes to allow non-coordinated phases unused green time, they would modify these Maxplans to allow this. Consult with the RTE prior to implementing such changes. Add a comment to the field to indicate that the auto-calculate values have been modified.

m) **Time Line Diagram** – a time line diagram is automatically calculated for each Coordination Timing Plan by pressing the “Click Here to Graph Force Offs and Permissives” button on the spreadsheet. The information presented on the timing plan should be used to confirm that the values that have been calculated are reasonable.

Figure 1. LMD Signal Timing Sheet (NEMA Dual Ring) - Sample

DATE ISSUED		INTERSECTION	
CONTROLLER TYPE	LMD 8000	LOCATION	
CABINET TYPE		SHEET NUMBER & REVISION	
SEQUENCE	NEMA DUAL RING	PREVIOUS STS DATE	

PHASE NUMBER	1	2	3	4	5	6	7	8
PHASE SETTING	ON	ON	OFF	ON	ON	ON	OFF	ON
DESCRIPTION								
FUNCTION	A2→	A1	B2→	B1	A1→	A2	B1→	B2
OVERLAP								
MINIMUM GREEN								
PASSAGE								
YELLOW								
RED								
MAX I/MAX II								
MAXPLAN (1,2,3,4)								
MAXPLAN (5,6,7,8)								
WALK								
PEDESTRIAN CLEAR								
WALK	STEADY	STEADY		STEADY	STEADY	STEADY		STEADY
RECALL	OFF	EXT		OFF	OFF	EXT		OFF
MEMORY	OFF	OFF		OFF	OFF	OFF		OFF
COORDINATION ON PHASE								
FIRST GREEN DISPLAY								
INTERSECTION FLASH								
AWF TIME [s]		0.0				0.0		
AWF TIME [s] [CH1/CH2]		0.0 0.0				0.0 0.0		

DELAY DETECTION TIMING		PROGRAMMING COMMENTS
		1.
		2.
		3.
		4.
PRE-EMPTION TYPE		OPERATIONAL COMMENTS
DELAY TIME		1.
PRE-EMPTION TIME		2.
VOLUME LOGGING & MOES		3.
SCM		4.

PED PERMISSIVE	AUTO	CYCLE (1 TO 8) 1	2	3	4	5	6	7	8
OFFSET (1 TO 4)									

TIME CLOCK SETTINGS						
TIME OF DAY	DAY OF WEEK	MAXPLAN (1 TO 8)	CYCLE (1 TO 8)	OFFSET (1 TO 4)	SERVICEPLAN (1 TO 8)	ADDITIONAL TIME CLOCK INFORMATION

DESIGNED BY _____ DATE _____

REVIEWED BY _____ DATE _____

RECEIVED & DISTRIBUTED BY MOT _____ DATE _____

ENGINEER OF RECORD _____

How to Complete - Naztec 980 & 981

1. Introduction

The Ministry uses Naztec 980 and 981 traffic controller units supplied by Naztec, Inc and installed in Ministry specific traffic controller cabinets to operate traffic signals. The equipment is sophisticated and requires expert knowledge and skills to correctly program and implement in the field. The Naztec 981 manual has numerous pages of programming information that must be correctly entered in each field controller.

2. The Timing Sheets

The Ministry has developed an excel workbook that can be modified to suit the required sequence. There are not separate workbooks for each sequence as with the LMDs, but the LMD sheets may be a valuable reference for ensuring the Naztec timing sheet is set up correctly. The NEMA Dual Ring sequence is the preferred sequence, unless it will not work for the location in question.

The Naztec workbook is divided into two worksheets as follows:

1. SIGNAL TIMING SHEET
2. CALCULATION SHEET

The SIGNAL TIMING SHEET contains the information required to program the controller on a single sheet of paper.

The CALCULATION SHEET contains the information required to calculate the clearance and advance warning times for the phases. This sheet contains information related to speed limits, clearance distances, approach grades, conflict distances, etc, which are typically a constant once the signal is in operation.

3. The Details

Building in the information from the **Where Do I Start** section, this section describes in detail the various fields in the Traffic Signal Timing Plan Workbook.

WORKSHEET: SIGNAL TIMING SHEET

a) **Date Issued** – Enter the current date in the format *February 5, 2012*
b) **Controller Type** – Currently this will be a Naztec 981 unless otherwise indicated by the RTE.
c) **Cabinet Type** – Enter the cabinet type. Options include S-Rack, M-Rack, P, and M-Shelf. New controllers shall always be either P6 or S-Rack. For existing cabinets, confirm with the RTE as to status and future requirements.
d) **Sequence** – Enter the appropriate SEQUENCE. Typically NEMA DUAL RING should be used. If the NEMA DUAL RING sequence in not appropriate, refer to the Traffic and Electrical Engineering Manual for alternate signal sequences. In particular note that for geometric conflicts for opposing left turns, the controller sequence must be sequential for that side of the barrier (i.e. you must use a 2 OVER 2 PLUS 4, or 4 PLUS 2 OVER 2 sequence)
e) **Intersection** – Enter the intersection location in the format MAIN STREET NAME @ MINOR STREET NAME
f) **Location** – Enter the city name
g) **Sheet Number & Revision** – Enter the electrical drawing series, sheet number and *revision* of the site plan for the signal in the format *TE- 89106-10A.*
h) **Phase Setting** – Enter ON for each phase that will be active. Enter OFF in all other fields.
i) **Description** – Enter the description of the phase in the following format:

- **Highway 19**
- **NB LT**
- **EMERG. PREEMPT #**
- **RAIL CLEARANCE**

Note that the first lines should indicate the Street Name; the next lines should contain the direction and any movement (northbound left turn, etc.); and the following lines should contain any reference to Emergency or Railway preemption as appropriate.

j) **Function** – Enter the phase letter designation as per the Traffic and Electrical Engineering Manual standards (A1, B1>, Ay, C, etc.)
k) **Overlap** – Enter the phase letter designation for any overlap movements including any pedestrian overlaps. (A1, B1>, Ay, C, PA3, etc.)
l) **Minimum Green Time** – this information shall be entered manually; the user shall refer to the Traffic and Electrical Engineering manual for applicable MoTI standards.
m) **Passage** – This information is automatically entered; however the Traffic designer shall select the most appropriate times based on field conditions. See the Traffic and Electrical Engineering Manual for further information.
n) **Yellow** – This information is automatically calculated from the CALCULATION SHEET and is the yellow portion of the intergreen clearance period for each phase.
o) **Red** – This information is automatically calculated for the CALCULATION SHEET and is the red portion of the intergreen clearance period for each phase.

p) **Max 1/Max 2** – This information must be entered by the traffic designer. The Max 1 is the default maximum green value for each phase as calculated through a Synchro analysis. Max 1/2 is superseded by any ALT TIMING PLAN(s) in effect during that portion of the day. MAX 2 provides an alternative maximum plan for use at other time periods.

q) **Alt Timing Plan (1,2,3,4) MAX I/II** – These maximum green times shall only reference green times related to a specific TIME OF DAY plan listed at the bottom of the sheet. Previously this section would also list the green times associated with coordinated splits, however all coordinated green times should be incorporated into the split table at the bottom of the sheet. These values should match the green times listed in the TIME CLOCK SETTINGS under ALT PLAN 1 TO 4.

r) **Walk** – This information is automatically entered from the CALCULATION SHEET and represents the amount of Walk time required for the phase. Refer to the Traffic and Electrical Engineering Manual for appropriate walk intervals.

s) **Pedestrian Clearance** - This information is automatically entered from the CALCULATION SHEET and represents the amount of Pedestrian Clearance or flashing Don't Walk time required for the phase. Refer to the Traffic and Electrical Engineering Manual for appropriate walk intervals.

t) **Recall** – This field indicates the type of recall for each phase. Options include OFF, EXT, MAX, CNA1. The field should be set to OFF for any movements that are not the resting phases; EXT for resting phases; MAX for movements with no actuation (pushbuttons or loops); CNA1 for pedestrian signals (see Traffic and Electrical Engineering Manual).

u) **Memory** – This field allows a call to be placed in the controller and locked in until that phase is serviced. It is used on occasion when vehicles consistently stop past the stop bar which does not allow a call to be placed to the controller. For most applications this should be set to OFF.

v) **Coordination Phase** – Mark an **XXXX** in the phases that are coordinated if applicable. Typically these would be the main street movements.

w) **First Green Display** – Mark an **XXXX** in the first serviceable phase after the signal comes out of flash. The FIRST GREEN DISPLAY would typically be the first through movement(s) on the cross street. Note that on earlier timing sheets, the term FOP or Full Operation Point was used which is the phase before the FIRST GREEN DISPLAY (when using older timing sheets, corrections must be made to reflect FIRST GREEN DISPLAY).

x) **Intersection Flash** – This is the flashing operation of the signal when a malfunction has occurred, or the signal is first powering up. Typically for Urban locations, the intersections flash all red. Rural locations usually flash yellow on the main street and red on the cross street. The Yellow flash is typically only used for simple phasing arrangements (2 or 3 phase) with no fully-protected left turns and usually no more than a three lane cross section on any roadway.

y) **AWF Time** – This is the advance warning time. This information should be automatically calculated, rounded up and inserted from the CALCULATION SHEET. This field indicates the total amount of advance warning time that should be allocated to each phase. If concurrent phases that terminate simultaneously have advance warning times that differ these values should remain as calculated (See Traffic and Electrical Engineering Manual).

z) **Delay Detection Timing** – This section identifies any delays or extensions that need to be added to any specific loops as per the Traffic and Electrical Engineering Manual. Typical delays and how they should be listed include:

- Left Turn Clip L5, L6 - 3 SEC LT CLIP
- Right Turn Clip L4 - 3 SEC RT CLIP
- Advance Left Turn L8 - 10 SEC ALT
- Right Turn L2 - 5 SEC RT
- Advance Loops L12, L13 - 5 SEC EXT
- queue Loops L1, L3 - 5 SEC QUEUE

Note that all protected permissive left turn movements (advanced left turns) on the MAIN STREET must have a 10-second delay per c) above.

aa) **Pre-Emption Type** – This section is used to identify the type of emergency preemption equipment being used. Options include SONIC (sound activated), OPTICOM (Strobe activated), EMTRAC (radio activated) and Direct (tied to a fire hall or municipal preemption system such as in Richmond) as well as others. Enter the appropriate type.

bb) **Delay Time** – Enter the amount of time that the Ministry controller should wait to initiate preemption phasing once a call has been received from the preemption system. This is typically used for direct connections tied to a fire hall, however the emergency department should be advising of any delay time requirements. If there is no delay time enter 0.

cc) **Pre-Emption Time** – This is the length of time that the preemption will be in effect once the controller has cycled to the appropriate phase. This feature is typically used for direct connections tied to a fire hall and for some older systems. For newer systems that preempt the signal for as long as the sensors are activated such as Opticom and SONIC Systems enter “Sensor Actuated” in this field.

dd) **Volume Logging and MOES** – The ministry controllers log traffic volumes and some measures of effectiveness. This field should be set to **ON 15 MIN** which means the controller will perform volume counts and record MOES 24 hours per day at 15 minute intervals.

ee) **Programming Comments** – These comments are meant to assist the Regional Electrical Maintenance personnel in programming the controller specifically for the site. Typically comments are related to railway preemption parameters but may include items such as:

a. ENABLE SIMULTANEOUS GAP – PASSAGE CAN RESET
b. RR PRE-EMPTION ENTRY PHASE MINIMUM GREEN = 4.0 SECS
c. STEP 1 OF RR / EMERGENCY PRE-EMPTION IS ALL RED = 2.0 SECS.
d. STEP 2 OF RR PRE-EMPTION IS PHASE B1 & B1-> GREEN = 22 SECS.
e. STEP 3 OF RR PRE-EMPTION IS SERVICE PHASE A1 & A2.
f. "NO LEFT TURN" SIGN ON DURING RR CLEARANCE & PRE- EMPTION.

ff) **Operational Comments** – these comments are meant as information to assist future Regional Traffic Engineers when modifying the traffic signal timings. If there are more PROGRAMMING COMMENTS than space available, you may also use this section for additional comments. Typically comments in this section include:

a. SIGNAL COORDINATED WITH BRECHIN, HAMMOND BAY AND STEWART.
b. CONTROLLER HAS TELEPHONE CONNECTION
c. PEDESTRIAN WALKING SPEED 1.0 M/S DUE TO SCHOOL
d. TIME FROM RR PRE-EMPTION CALL UNTIL RR LIGHTS FLASH = 17 SECS.
e. TIME FROM RR PRE-EMPTION CALL UNTIL TRAIN CROSSES VALLEY DRIVE = 41 SECS.

gg) **Time Clock Settings** – this field is used for coordination or individual TIME OF DAY plan information. The user will be required to fill in the appropriate sections base on the TIME OF DAY plan(s) or coordination plan(s) used.

hh) **Time of Day** – this field is manually entered based on the TIME OF DAY or coordination plan(s). The format of this field shall be in the 24 hour format (i.e. 06:00 – 13:00). This information represents the time of day at which the special function is required.

ii) **Day of Week** - this field is manually entered and reference the day(s) of the week the special function is required. The format of this field shall be in the format MON-FRI, SAT-SUN, etc.

jj) **Pattern # (1 to 48)** - the pattern number references the specific CYCLE, OFFSET and SPLIT associated with the coordinated plan.

kk) **Cycle Length** - this field is manually entered and shall indicate the cycle length for the associated coordination plan. This shall be set to ZERO if the controller is in FREE operation.

ll) **Offset Value** - this field is manually entered and shall indicate the offset value associated with the coordinated plan. If the controller is running in FREE operation, this field shall be merged with the SPLIT # field and shall say “NO COORDINATION”

mm) **SPLIT # (1 to 48)** – this field references the split number of the split table associated with the Pattern, Refer to oo) for split table information. If the controller is running in FREE operation, this field shall be merged with the OFFSET VALUE field and shall say “NO COORDINATION”

nn) **Max (I/II)** – This column will be filled in with I or II and will be used in conjunction with an ALT TIMING PLAN to reference a specific TIME OF DAY plan.

oo) **ALT PLAN 1 to 4** – This column will be filled in with the maximum green time to suit the TIME OF DAY plan used.

pp) **Split Table** – for coordination information. The user will be required to fill in the appropriate fields for each phase of the coordinated plan. By default there are 3 split tables on the sheet. If additional split tables are require they may be inserted below Split No. 3.

qq) **Time** – this field is manually entered and is the total split for a particular phase. Split times will be calculated as per the Traffic and Electrical Engineering Manual.

rr) **Max Reduce** – this field is used for signals that have Transit Signal Priority and shall only be used in conjunction with a coordination plan.

ss) **Max Extend** – this field is used for signals that have Transit Signal Priority and shall only be used in conjunction with a coordination plan. If MAX EXTEND is required at a traffic signal running in FREE mode, it shall be incorporated into the PROGRAMMING COMMENTS.

tt) **Coordination** – this field represents the phase(s) used as the offset reference and shall be indicated with "**X**".

uu) **Mode** – This field indicates the recall settings programmed when the split table is active. Typically, this is set to MAX for the coordinated phase and NON for un-coordinated phases.

vv) **Engineer of Record** – the professional engineer completing the traffic signal timing sheet shall sign, date and seal the timing plan in the appropriate location.

ww) **Received and Distributed by MoTI** – The MoTI Traffic Operations Engineer shall receive and distribute the consultant prepared Signal Timing Sheet. Note that the Ministry Engineer does not perform quality audits or detailed review of the timing sheet. Responsibility for the content and any errors and omissions rests with the Engineer of Record.

WORKSHEET: CALCULATION SHEET

The information at the top of this sheet is automatically populated from the TRAFFIC TIMING SHEET and the following describes the remaining fields that are entered or calculated on this spreadsheet.

a) **Posted Speed** – Enter the posted speed of the roadway for each phase.
b) **Approach Grade** – Enter the approach grade for the roadway on each phase.
c) **Clearance Distance** – Enter the clearance distance associated with the phase (refer to the Traffic and Electrical Engineering Manual for details for through and left turn phases)
d) **Conflict Distance** – Enter the conflict distance associated with the phase (refer to T& E Engineering manual for details for through and left turn phases)
e) **Walking Speed** – Enter the walking speed for the pedestrian movements as per the Traffic and Electrical Engineering manual or sound engineering judgment. A comment should be made in the OPERATIONAL COMMENTS (Section ff) on the SIGNAL TIMING SHEET worksheet whether non-standard 1.2 m/s walking speeds are being used.
f) **Walking Distance** – Enter the walking distance for each pedestrian movement.
g) **Approach Speed** – Enter the approach speed as per the Traffic and Electrical Engineering Manual
h) **Clearance Speed** – Enter the clearance speed as per the Traffic and Electrical Engineering Manual
i) **Conflict Speed** – Enter the conflict speed as per the Traffic and Electrical Engineering Manual.
j) **Clearance Interval** – This is an automatically calculated clearance interval for the phase based on the previous geometric and site information. This represents the total yellow and red time for the phase.
k) **Yellow** – This is an automatically calculated value for the yellow portion of the CLEARANCE INTERVAL above and the appropriate red/yellow split clearance interval tables from the Traffic and Electrical Engineering Manual.
l) **Red** – This is an automatically calculated value for the red portion of the CLEARANCE INTERVAL above and the appropriate red/yellow split clearance interval tables from the Traffic and Electrical Engineering Manual.
m) **Ped Walk** – Enter the amount of Walk time required for the phase. Refer to the Traffic and Electrical Engineering Manual for appropriate walk intervals.
n) **Ped Clear** – This is an automatically calculated value for the pedestrian clearance or “flashing don’t walk” based on the geometric and site conditions entered previously and the Traffic and Electrical Engineering Standards manual.
o) **AWF Distance** – This is an automatically calculated value for a typical AWF installation. Should a geometric conflict exist with this distance, then the value should be manually entered for the specific advance warning sign.
p) **AWF Time** – This is the advance warning time. This information is automatically calculated based on the geometric and operational site conditions entered previously as well as the Traffic and Electrical Engineering manual. This field indicates the total amount of advance warning time that should be allocated to each phase. This value may have a decimal; however, when it is automatically transferred to the SIGNAL TIMING SHEET it will be rounded up to the nearest whole number.

Figure 2. Naztec Signal Timing Sheet - Blank

DATE ISSUED		INTERSECTION	
CONTROLLER TYPE	NAZTEC 980	LOCATION	
CABINET TYPE		SHEET NUMBER & REVISION	
SEQUENCE		PREVIOUS STS DATE	

PHASE NUMBER	1	2	3	4	5	6	7	8
PHASE SETTING								
DESCRIPTION								
FUNCTION								
OVERLAP								
MINIMUM GREEN	6	10		7	6	10		7
PASSAGE								
YELLOW								
RED								
MAX 1/MAX 2								
ALT TIMING PLAN (1,2,3,4) MAX I								
ALT TIMING PLAN (1,2,3,4) MAX II								
WALK	-----	7	-----	7	-----	7	-----	7
PEDESTRIAN CLEAR	-----		-----		-----		-----	
RECALL		EXT				EXT		
MEMORY								
COORDINATION ON PHASE								
FIRST GREEN DISPLAY								
INTERSECTION FLASH								
AWF TIME [s]								

DELAY DETECTION TIMING		PROGRAMMING COMMENTS	
		1.	
		2.	
		3.	
		4.	
PRE-EMPTION TYPE		OPERATIONAL COMMENTS	
DELAY TIME		1.	
PRE-EMPTION TIME		2.	
VOLUME LOGGING AND MOES		3.	
SIMULTANIOUS GAP OUT		4.	

TIME CLOCK SETTINGS

TIME OF DAY	DAY OF WEEK	PATTERN # (1 TO 48)	CYCLE LENGTH	OFFSET VALUE	SPLIT # (1 TO 32)	MAX (I/II)	ALT PLAN 1 TO 4	Additional Time Clock Information

SPLIT TABLE

NO.	Phase	1	2	3	4	5	6	7	8
1	Time	-	-	-	-	-	-	-	-
	Max Reduce	-	-	-	-	-	-	-	-
	Max Extend	-	-	-	-	-	-	-	-
2	Time	-	-	-	-	-	-	-	-
	Max Reduce	-	-	-	-	-	-	-	-
	Max Extend	-	-	-	-	-	-	-	-
3	Time	-	-	-	-	-	-	-	-
	Max Reduce	-	-	-	-	-	-	-	-
	Max Extend	-	-	-	-	-	-	-	-
Coordination		-	-	-	-	-	-	-	-
Mode		NON	MIN	NON	NON	NON	MIN	NON	NON

DESIGNED BY _____ DATE _____

REVIEWED BY _____ DATE _____

RECEIVED & DISTRIBUTED BY MOTI _____ DATE _____ ENGINEER OF RECORD _____

How to Complete - Cobalt

For all new projects, the Ministry uses Cobalt traffic controller units supplied by Econolite. Engineering Services is currently developing Signal Timing Sheet templates, samples, and guidance for Cobalt Controllers. This document will be updated when this material becomes available.

Wrapping Up

Once a timing sheet has been completed as per these guidelines, the engineer of record should:

1) Print off a copy of all applicable sheets (do not print shading/colouring; set print to black and white under PAGE SETUP - SHEET options)
2) The Designer and Reviewer shall sign the first sheet
3) The Engineer of Record shall Seal all of the sheets
4) Submit the signed and sealed copy to the Ministry RTE along with a digital version of the workbook, any other calculations used in the design, and all Synchro files.

The engineer of record is referred to the Traffic and Electrical Engineering manual Section 200 (and associated technical Bulletins) for further details on submitting traffic signal design documentation to the Ministry.

Summary of Requirements

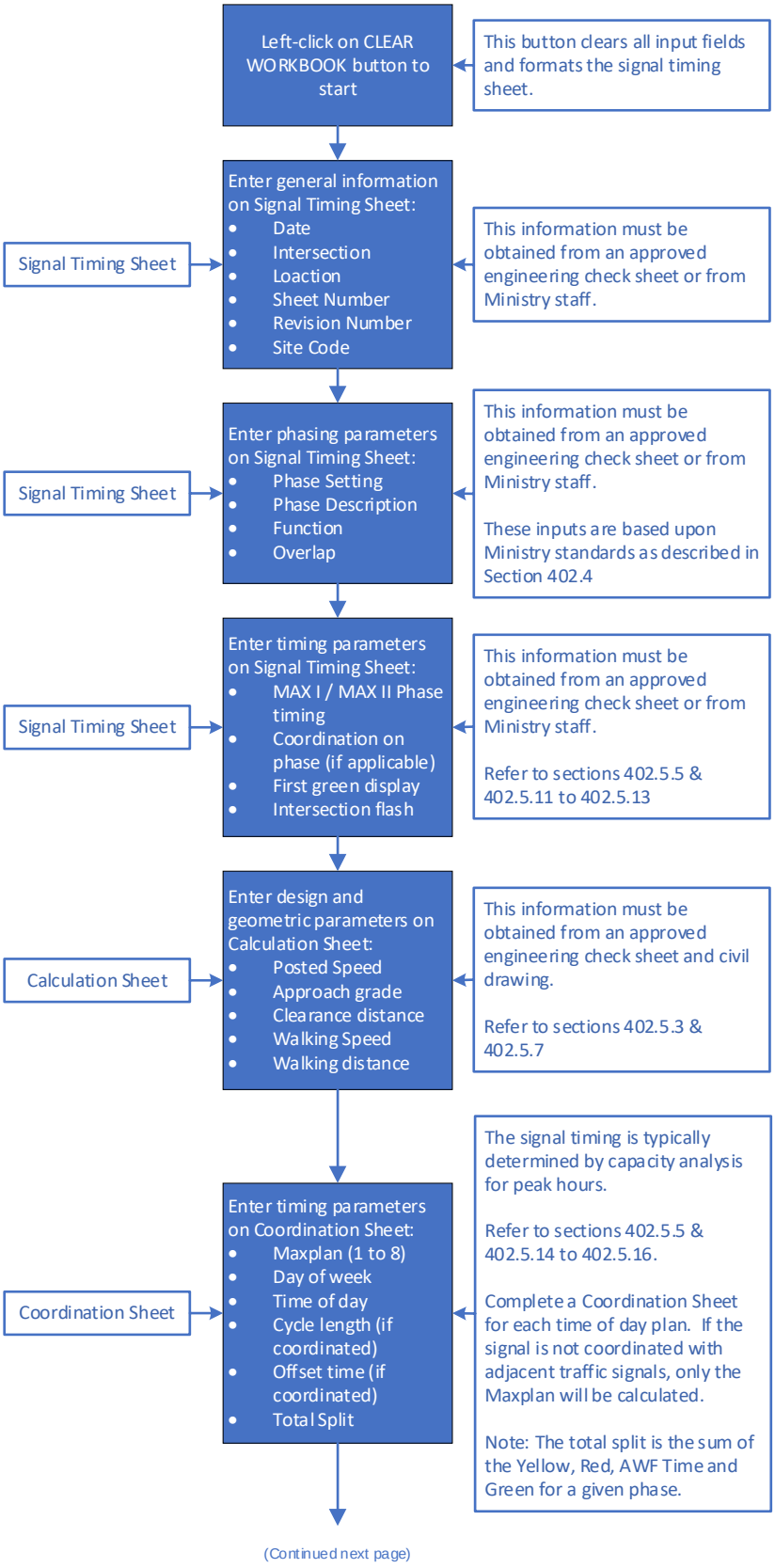
Prior to submitting the Traffic Engineering Checklist to the Ministry for distribution, the consultant shall ensure that:

1) These guidelines have been followed in their entirety
2) The Signal Timing Sheet has been signed and sealed by the Engineer of Record (either on hard copy or with a registered EGBC Digital Seal)
3) A digital copy of the above sealed document has been submitted
4) The workbooks or calculations used in the signal design are attached
5) A digital copy of all modelling files (Synchro) has been attached
6) A marked-up drawing showing all clearance and conflict distance measurements is attached

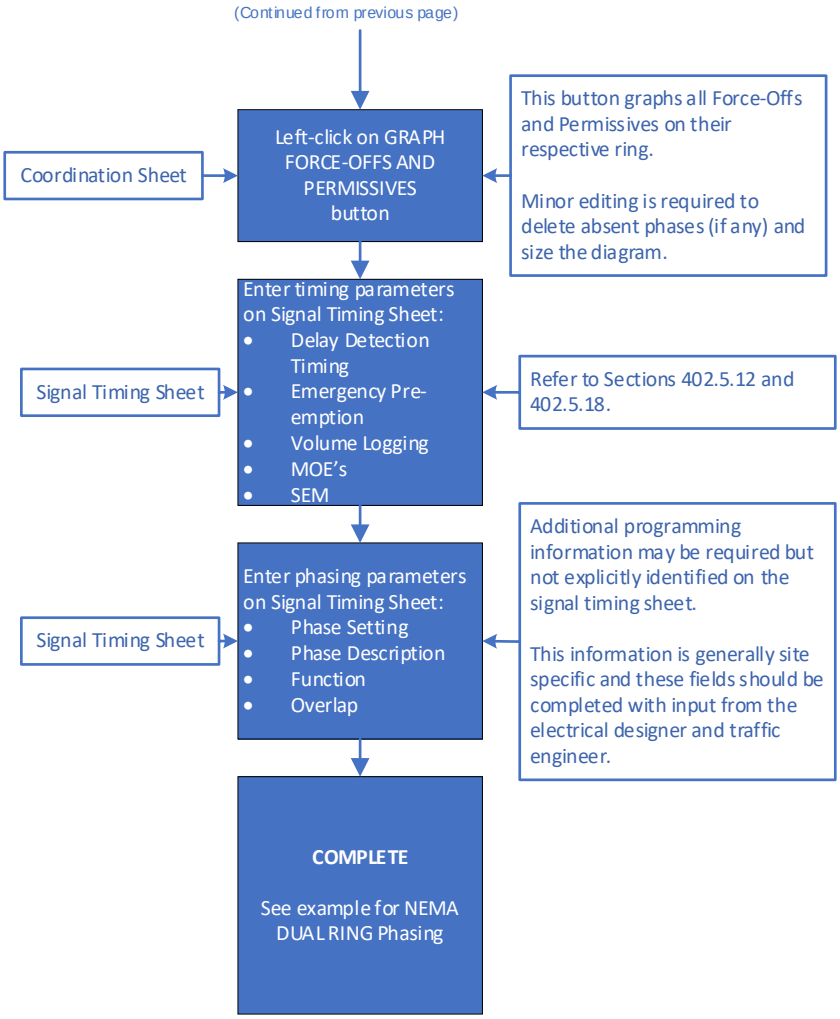
Figure 3. Signal Timing Sheet Completion Flowchart

SIGNAL TIMING SHEET FORMAT

The following flow chart is meant to assist with the completion of a signal timing sheet. Additional reference is made to Section 400 of the Ministry's Electrical and Traffic Engineering Manual.



(Continued next page)


(Continued from previous page)
Left-click on GRAPH FORCE-OFFS AND PERMISSIVES button
Coordination Sheet
This button graphs all Force-Offs and Permissives on their respective ring.
Minor editing is required to delete absent phases (if any) and size the diagram.
Enter timing parameters on Signal Timing Sheet:
Delay Detection Timing
Emergency Pre-emption
Volume Logging
MOE's
SEM
Signal Timing Sheet
Refer to Sections 402.5.12 and 402.5.18.
Enter phasing parameters on Signal Timing Sheet:
Phase Setting
Phase Description
Function
Overlap
Signal Timing Sheet
Additional programming information may be required but not explicitly identified on the signal timing sheet.
This information is generally site specific and these fields should be completed with input from the electrical designer and traffic engineer.
COMPLETE
See example for NEMA DUAL RING Phasing