RAMP METER SYSTEM TEST PROCEDURES

1. DEVICE NAMING COORDINATION

1.1. The System Integrator shall coordinate with the TMC/ROC to identify the device names for each device.

1.2. The System Integrator shall then send a request to TOTS to identify the network name, IP address, and any pertinent configuration information.

2. EXPLANATION – STAND ALONE TESTING (SALT)

2.1. The System Integrator shall work with the DEVICE VENDOR (if required by the testing form) and complete the NDOT specified SALT tests (non-network) on each unit of equipment after installation.

2.2. Conduct SALT testing on each unit of equipment as outlined on the NDOT provided testing form.

2.3. The System Integrator shall coordinate through the Resident Engineer and the Construction Crew to have an appropriate NDOT representative present for the onsite inspection.

2.4. The System Integrator shall submit the DEVICE vendor commissioning documents with the SALT testing to the Engineer for review and approval.

2.5. Supply a bucket truck and operator, or suitable equivalent equipment necessary to carry out procedures as required by the testing documents, at no direct payment.

RAMP METER SYSTEM (RMS) SALT PROCEDURE

TEST #	SALT TEST PROCEDURE	EXPECTED RESULT	PASS / FAIL
RMS Name:		**IP Address:**	**GPS:**
TOTS Network Name:		**Associated Cabinet Name:**	
Purpose and General Verification			
System Integrator: *This SALT tests the proper installation of a functional RMS. The system integrator will use a laptop to perform this test. Using the manufacture's software, the integrator will be able to verify the RMS is operational.* ***General Verification:*** *For each test below, complete the RMS SALT Matrix, circling the "Pass" or "Fail" in the appropriate cell. Only indicate a "Pass" on this form if the entire matrix column related to the tested function passes for EACH RMS being tested.*			
Equipment Information			
1.	Verify RMS information using the manufacturer software or device label.	**Controller** **Manufacturer: _____** **Model: _____** **Serial Number: _____** **Firmware Ver: _____**	Pass / Fail
2.	Verify ancillary equipment information using the manufacturer software or device label.	All required ancillary equipment information has been recorded using the RMS Ancillary Equipment Information List sheet at the end of the SALT procedure.	Were additional sheets needed? Yes/ No
3.	Manufacturer's commissioning of RMS equipment.	Manufacturer confirmation of full operation of all RMS-associated equipment.	Pass / Fail
Equipment Verification			
4.	Verify RMS components are securely mounted in cabinet.	RMS components are securely mounted in cabinet.	Pass / Fail

TEST #	SALT TEST PROCEDURE	EXPECTED RESULT	PASS / FAIL
5.	Using a meter, verify the system is properly bonded to earth ground.	Meter reading of 5 Ohms or less.	Pass / Fail
6.	Verify Ethernet cable length does not exceed 328 feet from the Controller to the PoE++ injector or PoE++ switch, using either a time domain reflectometer or beginning- and end-foot markers.	The Ethernet cable length is less than 328 feet. **Cable Length:** _____	Pass / Fail
7.	Verify power supply energizes the system.	System is energized.	Pass / Fail
8.	Verify all cabling is labeled with the to/from on each end and at any major transition point and is neatly managed throughout the cabinet.	All premise or inside plant cables originating and ending in the cabinet are properly terminated and labeled. Labeling material rated for Outside Plant (OSP) use. Cables are neatly managed using adjustable hook-and-loop fastener straps.	Pass / Fail
9.	Verify all loop lead-in cables and all loop detector cards are labeled.	All loop lead-in cables and loop detector cards are appropriately labeled.	Pass / Fail
10.	Verify all radar field wires and all radar detector cards are labeled.	All radar field wires and radar detector cards are appropriately labeled.	Pass / Fail
11.	Verify all video image detection system (VIDS) field wires and all VIDS detector cards are labeled.	All VIDS field wires and VIDS detector cards are appropriately labeled.	Pass / Fail
12.	Verify all signal wire field cables are labeled.	All signal wire field cables are appropriately labeled.	Pass / Fail
13.	Verify RMS operations locally via Web User Interface (UI).	RMS turns on/off via Web UI.	Pass / Fail
Loop Detector Amplifier Configuration and Testing			
14.	Verify the number of Detector Amplifier cards.	The number of Detector Amplifier cards equal the number of channels terminated in the cabinet.	Pass / Fail

TEST #	SALT TEST PROCEDURE	EXPECTED RESULT	PASS / FAIL
15.	Verify the Detector Amplifier Card is set to the following base settings and adjusted accordingly: Nominal Sensitivity: Medium Frequency (select one): Lo / Med Lo / Med Hi / Hi Mode of Operation: Long Presence (Demand Loops), Short Presence (AQD & Passage Loops)	Base settings are configured as follows: Nominal Sensitivity: Medium Frequency (select one): Lo / Med Lo / Med Hi / Hi Mode of Operation: Presence	Pass / Fail
16.	Complete Attachment 1.1 “Loop Test (With Lead-In)”.	All loops have been tested successfully and the results have been recorded.	Pass / Fail
17.	Verify insulation resistance from lead-in conductor for each lane upstream and downstream. See Test # 16	Insulation resistance meets a minimum of 50 megaohms (MΩ). Recorded observations using Attachment 1.1 titled “Loop Test (With Lead-In)” at the end of the SALT testing procedure.	Pass / Fail
18.	Verify inductance of loop plus lead-in conductor. See Test # 16	Loop inductance falls within 50 to 700 microhenries (µH). Recorded observations using Attachment 1.1 titled “Loop Test (With Lead-In)” at the end of the SALT testing procedure.	Pass / Fail
19.	Complete Attachment 1.2 “Detector Accuracy Form – Volume Testing”.	All loops or lanes have been tested and passed with at least 95% accuracy.	Pass / Fail
20.	Verify the count-detection accuracy of the detector against a manual count. See Test # 19	Recorded observations using Attachment 1.2 titled “Detector Accuracy Form – Volume Testing” at the end of the SALT testing procedure.	Pass / Fail
21.	Complete Attachment 1.3 “Detector Accuracy Form – Speed Testing – Speed Gun”.	All lanes have been tested and passed with at least 90% accuracy.	Pass / Fail

TEST #	SALT TEST PROCEDURE	EXPECTED RESULT	PASS / FAIL
22.	Verify the speed-detection accuracy of the detector against a manual count using a calibrated speed gun. See Test # 21	Recorded observations using Attachment 1.3 titled "Detector Accuracy Form – Speed Testing – Speed Gun" at the end of the SALT testing procedure.	Pass / Fail
23.	Save controller configuration file.	Saved and recorded file name and file path. File Name: _____ File Path: _____	
Radar Configuration and Testing			
24.	Configure the radar detector according to the manufacturer's installation and set-up guide.	The radar detector has been configured according to the manufacturer's installation and set-up guide.	Pass / Fail
25.	Complete Attachment 1.2 "Detector Accuracy Form – Volume Testing".	All lanes have been tested and passed with at least 95% accuracy.	Pass / Fail
26.	Verify the count-detection accuracy of the detector against a manual count. See Test # 25	Recorded observations using Attachment 1.2 titled "Detector Accuracy Form – Volume Testing" at the end of the SALT testing procedure.	Pass / Fail
27.	Complete Attachment 1.3 "Detector Accuracy Form – Speed Testing – Speed Gun".	All lanes have been tested and passed with at least 90% accuracy.	Pass / Fail
28.	Verify the speed-detection accuracy of the detector against a manual count using a calibrated speed gun. See Test # 27	Recorded observations using Attachment 1.3 titled "Detector Accuracy Form – Speed Testing – Speed Gun" at the end of the SALT testing procedure.	Pass / Fail
29.	Save radar configuration file.	Saved and recorded file name and file path. File Name: _____ File Path: _____	

TEST #	SALT TEST PROCEDURE	EXPECTED RESULT	PASS / FAIL
Video Image Detection System Configuration and Testing			
30.	Configure the video image detection system (VID) according to the manufacturer's installation and set-up guide.	The VID is configured according to the manufacturer's installation and set-up guide.	Pass / Fail
31.	Complete Attachment 1.3 Detector Accuracy Form – Speed Testing – Speed Gun".	All lanes should have been tested and passed with at least 90% accuracy.	Pass / Fail
32.	Verify the speed-detection accuracy of the detector against a manual count using a calibrated speed gun. See Test # 31	Recorded observations using Attachment 1.3 titled "Detector Accuracy Form – Speed Testing – Speed Gun" at the end of the SALT testing procedure.	Pass / Fail
33.	Save VID configuration.	Saved and recorded file name and file path. File Name: _____ File Path: _____	
Model 200 Load Switch, Lamps, Switch Pack and Flashers Testing			
34.	Reset the 208 Watchdog card and verify the 208 does not show any errors.	The 208 Watchdog card was reset and does not display any errors.	Pass / Fail
35.	Verify the Ramp Meter Controller time setting.	The Ramp Meter Controller time is accurately set in the HH:MM:SS format.	Pass / Fail
36.	Verify the Ramp Meter Controller date setting.	The Ramp Meter Controller date is accurately set in the DD/MM/YY format.	Pass / Fail

TEST #	SALT TEST PROCEDURE	EXPECTED RESULT	PASS / FAIL
37.	Verify Model Ramp Meter Controller internal date and time settings are accurate.	Model Ramp Meter Controller internal date and time are accurate.	Pass / Fail
38.	If used for ramp metering, configure the Ramp Meter Controller for ramp operations and the number of lanes to be tested.	The Ramp Meter Controller has been configured for ramp operations with the appropriate number of lanes.	Pass / Fail / N/A
39.	If used for ramp metering, configure the Ramp Meter Controller parameters using a pre-determined 1-, 2-, or 3-lane parameter file.	The Ramp Meter Controller has been configured with the correct lane parameter file.	Pass / Fail / N/A
40.	If used for ramp metering, simulate a metering period as follows: meter for 5 minutes, cease meter for 5 minutes, and resume meter for 5 minutes.	The Ramp Meter Controller resumes expected operation.	Pass / Fail / N/A
41.	Verify the warning light and meter heads begin metering operation at the selected start time.	The flashers engage and within 60 seconds the red lights on both lanes turn on. The metering light indications will then start to alternate at the metering rate directed by NDOT.	Pass / Fail
42.	Verify the “Meter On” sign flashes when activated.	The “Meter On” sign flashes when activated.	Pass / Fail
43.	Verify the “Meter On” sign ceases flashing when deactivated.	The “Meter On” sign ceases flashing when deactivated.	Pass / Fail
44.	Unless directed otherwise by Resident Engineer, turn police switch to deactivate the meter (turn off) prior to the conclusion of this portion of the test.	Signal head display stopped, but metering operations continue to operate as expected.	Pass / Fail / N/A
Verification of Communications Settings			

TEST #	SALT TEST PROCEDURE	EXPECTED RESULT	PASS / FAIL
45.	Verify Communications Settings are set to appropriate values per the IP plan.	**IP: _____** **MASK: _____** **GATEWAY: _____** **UDP/TCP PORT: _____**	Pass / Fail

Signatures

DATE	AGENCY/FIRM	PERFORMED BY (Printed Name) (Integrator)	INTL	AGENCY/FIRM	WITNESSED BY (Print Name) (NDOT)	INTL

Integrator Signature	
NDOT Signature	
TOTS Signature	

Attachment 1.1 Loop Test (With Lead-In)

Note Lane 1 refers to the left/median

Cabinet ID:		**Station:**		**Location:**		**Date:**		**Time:**	

Lane Number	**Insulation Resistance (megaohm, MΩ)**	**Inductance (microhenry, µH)**
Lane 1 upstream		
Lane 1 Downstream		
Lane 2 Upstream		
Lane 2 Downstream		
Lane 3 Upstream		
Lane 3 Downstream		
Lane 4 Upstream		
Lane 4 Downstream		
Lane 5 Upstream		
Lane 5 Downstream		

Signatures

DATE	**AGENCY/FIRM**	**PERFORMED BY** (Printed Name) (Integrator)	**INTL**	**AGENCY/FIRM**	**WITNESSED BY** (Print Name) (NDOT)	**INTL**

Integrator Signature	
NDOT Signature	
TOTS Signature	

Attachment 1.2 Detector Accuracy Form – Volume Testing

Directions:

(1) From the plans, identify the detection lane(s) or lane(s) to be tested.

(2) Record the number of vehicles per minute on both manual and controller counts.

(3) After 15 minutes or 100 vehicles, whichever occurs first, record the total number of vehicles from both hand counts and reported by the detector during the test window.

(4) Depending on the detector type, accuracy calculations will vary. Refer to manufacturer's documentation, otherwise accuracy is computed as follows:

$$\text{Accuracy} = 100 - \left(100 * \frac{Total\ Manual\ Count - Total\ Detector\ Count}{Total\ Manual\ Count}\right)$$

(5) All testing shall be performed during free flow traffic conditions.

(6) If a lane fails (less than 95% accuracy), it shall be recalibrated and retested.

Cabinet ID:		**Station:**		**Location:**		**Date:**		**Time:**	

	Lane Number (Direction: NB/ EB / SB / WB)									
	Lane 1 (_____)		**Lane 2 (_____)**		**Lane 3 (_____)**		**Lane 4 (_____)**		**Lane 5 (_____)**	
Minute	Manual	Detector	Manual	Detector	Manual	Detector	Manual	Detector	Manual	Detector
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
Total										
Accuracy (%)										
Pass/Fail										

Signatures

DATE	**AGENCY/FIRM**	**PERFORMED BY** (Printed Name) (Integrator)	**INTL**	**AGENCY/FIRM**	**WITNESSED BY** (Print Name) (NDOT)	**INTL**

Integrator Signature	
NDOT Signature	
TOTS Signature	

Attachment 1.3 Detector Accuracy Form – Speed Testing – Speed Gun

Directions:

(1) From the plans, identify the detection lane(s) or lane(s) to be tested.

(2) Record speeds (raw data), using a recently calibrated speed gun and the detector, on a separate paper in addition to submitting this form. Note location, date, and time on raw data record sheet.

(3) After 5 minutes or 20 vehicles have passed, whichever occurs first, stop recording speeds. Calculate the average speed of the vehicles for EACH minute and record in the “Manual” column. Record the average speed per minute of the period reported by the detector or ramp meter controller and record in the “Detector” column.

(4) Depending on the detector type, accuracy calculations will vary. Refer to manufacturer’s documentation, otherwise accuracy is computed as follows:

$$\text{Accuracy} = 100 - \left(100 * \frac{Manual\ Speed - Detector\ Speed}{Manual\ Speed}\right)$$

(5) All testing shall be performed during free flow traffic conditions.

(6) If a lane fails (less than 90% accuracy), it shall be recalibrated and retested.

Cabinet ID:		**Station:**		**Location:**		**Date:**		**Time:**	
	Lane Number (Direction: NB / EB / SB / WB)								
	Lane 1 (_____)		**Lane 2 (_____)**		**Lane 3 (_____)**		**Lane 4 (_____)**		**Lane 5 (_____)**	
Minute	Manual (MPH)	Detector (MPH)	Manual (MPH)	Detector (MPH)	Manual (MPH)	Detector (MPH)	Manual (MPH)	Detector (MPH)	Manual (MPH)	Detector (MPH)
1										
2										
3										
4										
5										
Accuracy (%)										
Pass/Fail										

Signatures						
DATE	**AGENCY/FIRM**	**PERFORMED BY** (Printed Name) (Integrator)	**INTL**	**AGENCY/FIRM**	**WITNESSED BY** (Print Name) (NDOT)	**INTL**

Integrator Signature	
NDOT Signature	
TOTS Signature	

Ramp Meter System (RMS) Ancillary Equipment Information List

If additional sheets are required for recording the ancillary equipment for a Ramp Meter System, print and number the sheets in numerical order in the space provided above and staple/paperclip as a packet.

If fields are identical, it is acceptable to indicate as such:

EXAMPLE ONLY – Information in this table is purely fictitious and may not accurately represent real information found on the device label				
Equipment Type	**Manufacturer**	**Model**	**Manufacture Date (MM/DD/YYYY)**	**Serial Number**
Battery	Battery Manufacturer 1	Battery Model 1A	01/01/2050	FG812678G
“ “	“ “	Battery Model 1B	01/05/2050	FH812854U
“ “	Battery Manufacturer 2	Battery Model 2D	01/05/2051	EB493248J
Photovoltaic Module	Solar Company	Module Model 1SOL	06/21/2040	SOL45892454966564
Solar Charge Controller	Charge Controller Company	Controller Model COM8430	“ “	COM456495541

RMS Name:		**IP Address:**		**GPS:**	
TOTS Network Name:		**Associated Cabinet Name:**			

Equipment Type	**Manufacturer**	**Model**	**Manufacture Date (MM/DD/YYYY)**	**Serial Number**

Cabinet Name: _____ **Page __ Of __**

3. EXPLANATION - SUBSYSTEM TESTING (SST)

3.1. At the beginning of the SST phase, the System Integrator shall submit, in PDF format and original signed hard copies of the certified SALT results for approval by the Engineer.

3.2. The Engineer shall approve all SALT testing prior to the System Integrator starting the SST testing.

3.3. Conduct SST testing in accordance with NDOT's testing documentation for all field and related equipment once the system has been interconnected to form a complete subsystem (i.e. Network connectivity).

3.4. The SST test shall demonstrate connectivity to all field equipment utilizing NDOT's current freeway management system.

3.5. The SST test consists of a 45-day period of operations without major failure of equipment. The Resident Engineer can require the SST be restarted if any major failure occurs. A major failure for the Ramp Meter Controller / Ramp Meter System is defined as:

3.5.1. Any failure of the equipment associated with the PRIMARY FUNCTION of the Ramp Meter Controller.

3.6. Demonstrate that the total system (hardware, firmware, software, materials, and construction) are properly installed, free from problems, exhibits stable and reliable performance, and meets project requirements.

3.7. Once per week, the System Integrator shall demonstrate that all system functions tested in the SST are operational and meets requirements.

3.8. The System Integrator shall coordinate through the Resident Engineer and the Construction Crew to have an appropriate NDOT representative present for the onsite inspection.

3.9. The System Integrator must provide proof that each device has been tested each week for the duration of the testing period witnessed by an NDOT representative.

3.10. The testing time must be scheduled a minimum of one week prior and coordinated and approved by the Resident Engineer and the Construction Crew.

RAMP METER SYSTEM (RMS) SST PROCEDURE

TEST #	SST TEST PROCEDURE	EXPECTED RESULT	PASS / FAIL

RMS Name:		**IP Address:**		**GPS:**	
TOTS Network Name:		**Associated Cabinet Name:**			

Purpose and General Verification

System Integrator: *This SST tests the proper installation of a functional RMS. The system integrator will use an Operator Workstation at the TMC/ROC to perform this test.*

General Verification*: For each test below, complete the RMS SST Matrix, circling the "Pass" or "Fail" in the appropriate cell. Only indicate a "Pass" on this form if the entire matrix column related to the tested function passes for EACH RMS being tested.*

System RMS Information

1.	Verify network connectivity by issuing a ping test from the RMS workstation located at the TMC/ROC.	RMS responds to the ping test.	Pass / Fail
2.	Verify system turns on by issuing a command to turn "on" the system through the Freeway Management System (FMS).	System responds and turns on.	Pass / Fail
3.	Verify field device operation with system turned on from TMC/ROC.	Visual confirmation of field device activation.	Pass / Fail
4.	Verify system turns off by issuing a command to turn "off" the system through the Freeway Management System (FMS).	System responds and turns off.	Pass / Fail
5.	Verify field device operation with system turned off from TMC/ROC.	Visual confirmation of field device deactivation.	Pass / Fail
6.	Verify access to the Web User Interface (UI) from the TMC/ROC.	Web User Interface (UI) is accessible.	Pass / Fail
7.	Using Web User Interface (UI) issue command to actuate the field device.	Visual confirmation of field device activation.	Pass / Fail

8.	Using Web User Interface (UI) issue command to de-actuate the field device.	Visual confirmation of field device deactivation.	Pass / Fail
9.	Verify the RMS controller is configured to use an NTP server as the source of time and date.	RMS controller is configured to use an NTP server.	Pass / Fail
10.	Verify scheduling of operations can be set from the TMC/ROC.	Warning light and meter heads activate when the schedule begins. Warning lights and meter heads deactivate when the schedule ends.	Pass / Fail

SST DAY	**DATE**	**PERFORMED BY**(Integrator)	**INTL**	**WITNESSED BY**(NDOT)	**INTL**
1					
8					
15					
22					
29					
36					
45					

Signatures

DATE	**AGENCY/FIRM**	**PERFORMED BY** (Printed Name) (Integrator)	**INTL**	**AGENCY/FIRM**	**WITNESSED BY** (Print Name) (NDOT)	**INTL**

Integrator Signature	
NDOT Signature	
TOTS Signature	