Arterial Corridor Management (Snelling and Lexington)

System Verification and Acceptance Plan

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1.   Introduction

The City of Saint Paul is seeking to relieve congestion and improve traffic signal operations, incident, emergency, and event management along two arterial corridors located west of downtown Saint Paul. The management of traffic in this area involves transportation agencies at the city, county, and state levels, as well as local law enforcement and businesses that generate traffic during events. Upgrades to the traffic management system include updating communications capabilities and traffic signal equipment, managing traffic incidents, and providing event traffic management. Improving these areas are critical to maintaining a modern transportation system. These improvements will be achieved with the installation of new traffic signal controllers, vehicle detection, advanced traffic management equipment, fiber optic communications, Dynamic Message Signs (DMS), and closed-circuit television (CCTV) cameras.

A general concept of operations was prepared to identify challenges and develop corresponding needs. The needs were identified by key stakeholders and documents relevant to the project. A system requirements document has also been developed to further identify how the stakeholder needs have been correlated with requirements that explain what the Arterial Corridor Management System (ACMS) must do as the basis for further design, procurement, installation, testing and operation. **This document presents a verification and acceptance plan that will be used during the design and construction phases to ensure that the system is procured, installed, and operating as specified by the system requirements.**

This document will summarize the testing required to verify that the needs identified in the Concept of Operations and the System Requirements have been met. This testing will be performed in two phases, as described below.

1. Verification Testing: Verification testing will be performed on system components as they are identified for procurement and incorporated into design. This will confirm that the current products meet the system requirements and will be done mainly through researching product specification documents before the system is purchased. Once the product is purchased and system integration is complete, additional testing will verify that the components have been successfully integrated before being installed in the field.
2. Acceptance Testing: Acceptance testing will take place after the initial system components are installed. System acceptance will confirm that the purchased products fulfill the envisioned use and will be performed when the system is in its final operational environment to allow for demonstrations as the main form of testing. Once the first initial installation is accepted, all remaining installations may proceed.

The City of St. Paul will oversee all verification and acceptance testing. Verification testing will be completed by the design team, while the acceptance testing will be performed by the construction Contractor(s). Each test will be performed with the following parts, described further in Sections 2 and 3.

Verification Testing

1. Product Specification Review: Component Verification
2. Plan Set Review: Construction Verification
3. Integration Demonstration: System Verification

Acceptance Testing

1. 1-day Functional Acceptance Test: Testing will be performed to verify individual component and sub-components of the ACMS.
2. 7-day Performance Acceptance Test: Testing will be performed to verify that the system works as intended
3. 30-day Reliability Acceptance Test: Testing will be performed to verify that the system work as intended over a 30-day period with minor intervention from the client.

For each part, a recommended test environment is noted. Test procedures and verification instructions then describe which system components will be tested or demonstrated to verify the corresponding system requirements. The test procedures also identify the lead testing party and provides recommendations for additional participants that should be present during each test part. Some system components will be validated at more than one point and are noted as such in the test procedures. Test log details are also included to use during testing as formal documentation of whether the system passed or failed to meet requirements. Comments for each test procedure should be entered in the log with enough detail for the Contractor(s) to make product, design, or installation modifications.

2.   Verification Testing

Components for the ACMS will be procured according to the system requirements and final design specifications approved by the City of St. Paul. Verification testing will occur as the components are identified for procurement to ensure requirements are met. Any test procedure that fails during verification testing will be corrected and then presented again to the City of St. Paul for final approval. Once this stage of testing is completed and approved by the City of St. Paul, product procurement may proceed. Each product should also be accompanied by manufacturer documentation of successful Factory Acceptance Testing prior to shipping. The following tables present three test parts, environment, procedures, participants, test procedures, relevant system requirements and logs that will be used for verification testing.

Verification Testing - Part 1: Product Specification Review

Environment: Office

Procedure: As system components are identified and assessed prior to procurement, the Design team and City of St. Paul will review product specifications for requirements verification and approval. Once approved, procurement may proceed. Several tests procedures will be *repeated in the Acceptance Testing. The test log has been separated to reflect multiple instances of testing.*

Participants: Part 1 will be led by the Design team with participation from City of St. Paul.

Test Procedures	System Requirement	Test Log	
		Pass/ Fail	Comments
1a. Confirm that the DMS control software is accessible via Internet Explorer or Google Chrome.	1.1		**Part 1 Results**
1b. Confirm that the DMS control software is accessible to users with authorized LAN access via desktop and portable computers.	1.5, 1.6		**Part 1 Results**
1c. Confirm that the DMS control software can simultaneously monitor a minimum of 75 field devices.	1.12		**Part 1 Results**
1d. Confirm that the DMS control software allows the addition of field devices to accommodate future deployments.	1.13		**Part 1 Results**
1e. Confirm that the DMS control software maintains a record of access according to user identities for a minimum of 365 days.	1.15		**Part 1 Results**
1f. Confirm that the DMS control software displays field device locations in a tabular format.	1.20		**Part 1 Results**
1g. Confirm that the DMS control software displays field device operational status in a table. *In Acceptance Test, verify all DMS installed as part of this project are communicating with the DMS control software.*	1.21		**Part 1 Results**
			Acceptance Test Results
1h. Confirm that the DMS control software displays field device locations on a map. *In Acceptance Test, verify all DMS installed as part of this project can be seen on the mapping tool.*	1.22		**Part 1 Results**
			Acceptance Test Results

		Part 1 Results		
1i. Confirm that the DMS control software allows users to click on the DMS and view: device ID, geographic location, date and time of last communication, DMS operational status.	1.26	**Part 1 Results**		
1j. Confirm that DMS control software allow users to post and remove DMS messages remotely.	2.11, 2.13	**Part 1 Results**		
1k. Confirm that DMS control software allow users to post pre-defined messages.	2.14	**Part 1 Results**		
1l. Confirm that DMS allow users to post free-text messages.	2.15	**Part 1 Results**		
1m. Confirm CCTV cable is rated for outdoor use. *In Acceptance Test, confirm CCTV cabling is outdoor rated.*	3.2	**Part 1 Results**		
		Acceptance Test Results		
1n. Confirm DMS control software provides automatic push email alerts to user-defined distribution lists as operational plans are activated.	4.1	**Part 1 Results**		
1o. Confirm DMS control software can automatically push email alerts to user-defined distribution list as operational plans are deactivated.	4.2	**Part 1 Results**		
1p. Confirm DMS control software can automatically push email alert feature can be toggled on/off.	4.3	**Part 1 Results**		

			Part 1 Results	
1q.	Confirm DMS control software can manually push email alerts to user-defined distribution lists.	4.4	**Part 1 Results**	
1r.	Confirm DMS control software capability to create user-defined distribution lists.	4.5	**Part 1 Results**	
1s.	Confirm that traffic signal controller includes **support for Bus Rapid Transit operations.**	5.1	**Part 1 Results**	
1t.	Confirm that traffic signal controller has capability to **record high resolution data that is recorded in at least 0.1 second increments.**	5.2, 5.3	**Part 1 Results**	
1u.	Confirm the traffic signal controllers are **compatible with Econolite Centracs and Adaptive Signal Control Software (ASCS)**. *In Acceptance Test, verify that all signal controllers installed as part of this project are communicating with the existing Econolite Centracs and new ASCS.*	5.4	**Part 1 Results**	
			Acceptance Test Results	
1v.	Confirm that ASCS is capable of controlling a minimum of 75 signals.	6.1	**Part 1 Results**	
1w.	Confirm ASCS is capable of optimizing any combination of cycle, offset, and split times based on current traffic conditions when enabled. *In Acceptance Test, enable the optimization and confirm that cycle, offset, and split are being changed for current traffic conditions.*	6.2	**Part 1 Results**	
			Acceptance Test Results	
1x.	Confirm that ASCS reverts to non-adaptive control when control equipment or standard detection equipment fails. *Reference product specifications to verify this.*	6.3	**Part 1 Results**	
1y.	Confirm that ASCS operates non-adaptively when current traffic	6.4	**Part 1 Results**	
			Acceptance Test Results	

			Part 1 Results	
	conditions meet specific user-defined criteria. *In Acceptance Test, set criteria to begin a pretimed plan when traffic becomes light and confirm operation.*			
1z.	Confirm that ASCS operates adaptively when current traffic conditions meet specific user-defined criteria. *In Acceptance Test, set the operations to optimize cycles when traffic is light and confirm cycle times change.*	6.5	Part 1 Results	
			Acceptance Test Results	
1aa.	Confirm that ASCS operates adaptively to achieve specific requirements in user-defined criteria. *In Acceptance Test, set criteria to optimize cycles for balanced flow and confirm function.*	6.6	Part 1 Results	
			Acceptance Test Results	
1bb.	Confirm that ASCS can coordinate along a user-defined route. *In Acceptance Test, demonstrate two intersections working in coordination with each other using offsets.*	6.7	Part 1 Results	
			Acceptance Test Results	
1cc.	Confirm that ASCS supports executing user-specified adaptive operation strategies to manage queues. *In Acceptance Test, demonstrate adaptive operations changing cycle, offset, or split to manage queues.*	6.8	Part 1 Results	
			Acceptance Test Results	
1dd.	Confirm that ASCS supports SAE J2735 5.9GHz DSRC Communication standard.	6.9	Part 1 Results	

		Part 1 Results	
1ee. Confirm capability to automatically analyze and report volume and travel time metrics. *In Acceptance Test, demonstrate analysis and reporting capabilities.*	7.1		
		Acceptance Test Results	
1ff. Confirm capability to select segments/corridors to analyze and report volume and travel time metrics. *In Acceptance Test, select a sample segment or corridor and run a report for a specified time and date range, confirming volume and travel time metrics are shown.*	7.2	**Part 1 Results**	
		Acceptance Test Results	
1gg. Confirm capability to generate volume, speed, and travel time reports based on user-chosen time and date ranges. *In Acceptance Test, select a sample segment or corridor and run a report for a specified time and date range, confirming volume, speed, and travel time metrics are shown for the specified time and date.*	7.3	**Part 1 Results**	
		Acceptance Test Results	

Verification Testing - Part 2: Plan Set Review

Environment: City of St. Paul Meeting Room

Procedure: After detailed design is complete, the City of St. Paul will review with the design team a completed plan set for the system installation to validate requirements and approve. Once approved, procurement may proceed. Review and approval of plan sets will occur in preparation for a bid letting that will procure equipment for the integration demonstration. This test part emphasizes the need for all plans to be reviewed and approved prior to field installation of equipment. Several tests procedures will be *repeated in the Acceptance Testing. The test log has been separated to reflect both instances of testing.*

Participants: Part 2 will be led by the Design Contractor and should include, at a minimum, City of St. Paul. Additional participants may include St. Paul Police Department, Minnesota Department of Transportation (MnDOT), Ramsey County, and Metro Transit.

Test Procedures	System Requirement	Test Log	
		Pass/Fail	Comments
2a. Confirm that DMS will **be overhead mounted to accommodate installation site characteristics.** *In Acceptance Test, visually confirm that DMS are overhead mounted.*	2.6	Part 2 Results	
		Acceptance Test Results	
2b. Confirm that DMS operates on **120/240 Volts AC**. *In Part 2, power from local utility should be verified on plan set. In Acceptance Test, confirm in cabinet/breaker that DMS is using 120/240V AC power.*	2.9	Part 2 Results	
		Acceptance Test Results	
2c. Confirm that DMS is **protected from degradation of power with voltage surge suppression**. *In Acceptance Test, verify that DMS is powered through a surge suppression device.*	2.10	Part 2 Results	
		Acceptance Test Results	

Verification Testing - Part 3: Integration Demonstration

Environment: City of St. Paul Facility

Procedure: Once the system components have been procured and integrated, the Construction Contractor(s) will demonstrate the system integration for City of St. Paul prior to initial installation. The demonstration will take place at a St. Paul facility to simulate the installation environment. The Construction Contractor(s) will integrate at least one DMS, at least one traffic signal controller, and the corresponding control and signal performance measure software. All system features (e.g. posting DMS messages, analyzing signal performance measures, CCTV pan/tilt/zoom, adaptive signal control software functions, etc.) should be activated and observed for requirements validation and approval during the demonstration. Once approved, the remaining integration may proceed. Several tests procedures will be *repeated in the Acceptance Testing. The test log has been separated to reflect both instances of testing.*

Participants: Part 3 will be led by the Construction Contractor(s) and should include, at a minimum, City of St. Paul. Additional participants may include St. Paul Police Department.

Test Procedures	System Requirement	Test Log	
		Pass/ Fail	Comments
3a. Confirm that the DMS control software allows **authorized user access to field devices operated by City of St. Paul**.	1.9, 1.16, 1.17, 1.18, 1.19, 1.27, 1.28, 1.29, 1.30, 1.31, 1.32	**Part 3 Results**	
3b. Confirm that DMS control software allows **auto-brightness** settings in varying light.	2.1 2.2	**Part 3 Results**	
3c. Confirm that DMS allows for full color display. *Send a test message of solid color to the DMS.*	2.3, 2.4	**Part 3 Results**	
		Acceptance Test Results	
3d. Confirm that DMS allows for remote messages both pre-defined and free-text. *Send both a pre-defined and free-text test message via web browser & then remove it.*	2.11, 2.12, 2.13, 2.14, 2.15	**Part 3 Results**	
		Acceptance Test Results	
3e. Confirm that DMS stores a log of message history.	2.16	**Part 3 Results**	

		Part 3 Results	
3f. Confirm that CCTV provides 3 individually configurable full resolution video streams at 30 FPS (NTSC) in all resolutions up to 704x480 pixels or 25 FPS (PAL) in all resolutions up to 704x576 pixels.	3.3		
3g. Confirm that CCTV can transmit video over web browser. *Demonstrate web browser interface with CCTV controls.*	3.8	Part 3 Results	
		Acceptance Test Results	
3h. Confirm that CCTV logins have different access levels of view, view/control, and view/control/maintain.	3.9, 3.10, 3.11	Part 3 Results	
3i. Confirm traffic controller is compatible with Econolite Centracs and ASCS.	5.5	Part 3 Results	
		Acceptance Test Results	
3j. Confirm that ASCS reverts to non-adaptive control when control equipment or standard detection equipment fails. *Remove or disable a detector from one leg of the intersection while adaptive is enabled and confirm that ASCS disables adaptive operation.*	6.3	Part 3 Results	
		Acceptance Test Results	

3.   Acceptance Testing

This stage of testing will include a functional (1-day) test and a reliability (30-day) test to be conducted at the initial installation location. The functional test will be conducted to demonstrate that all system requirements are adequately met. For the remaining installation, reliability tests will be conducted to validate that the systems are properly installed and operate as required. The following tables present two test parts, environment, procedures, validation instructions, relevant system requirements and log that will be used for system acceptance testing.

Acceptance Testing - Part 1: Factory Acceptance Testing (1-Day)
Environment: Installation Sites
Procedure: The 1-day Factory Acceptance Testing will be performed prior to installation. These tests and demonstrations will be performed on a mock set up located at the City of St. Paul to verify that the system will perform as anticipated. These tests will include reviewing product cut sheets and product demonstrations.
Participants: This test will be led by the Construction Contractor(s) and should include City of St. Paul. Additional participants may include St. Paul Police Department.
Validation Instructions
1. **Repeat test procedures 1g, 1h, 1o, 1w, 1y, 1z, 1aa-1cc, and 1ee-1gg** as described in Part 1 of the Verification Testing. Record results in test log also provided under Part 1.

Acceptance Testing - Part 2: Functional Demonstration (7-Day)
Environment: Installation Sites
Procedure: Once the installation is complete, the Construction Contractor(s) will schedule 7-day functional demonstration to allow for City of St. Paul observation under dawn/dusk lighting and peak/off-peak traffic conditions. The demonstration will require at least one vehicle to drive around the installation sites and observe component activations for requirements validation and approval. Authorized access from computers at City of St. Paul will be required to operate and observe control software performance for validation and approval. *These test procedures will be conducted in three parts. The instructions and test log have been included in the previous test cases respectively to reflect the multiple instances of testing.*
Participants: This test will be led by the Construction Contractor(s) and should include City of St. Paul. Additional participants may include St. Paul Police Department.
Validation Instructions
2a. Repeat ALL validation steps as described in Part 2 of the Verification Testing. Record results in test log also provided under Part 2.
2b. Repeat ALL validation steps as described in Part 3 of the Verification Testing. Record results in test log also provided under Part 3.

Acceptance Testing Part 3: Reliability Demonstration (30-Day)

Environment: City of St. Paul Traffic Management Center

Procedure: Following completion of the 7-day Performance Acceptance Test, the City of St. Paul will monitor the operation of all system components for 30 days to demonstrate system reliability. The City of St. Paul will document the system performance of all subcomponents including DMS, CCTV, traffic signal controllers, and the corresponding control and adaptive signal control software by remote daily inspection using device control software, inspection of logs, and maintenance activity. The City of St. Paul will record all events during this time including maintenance, communications errors, power loss, and other issues that might occur. Each event shall be classified as a minor event or a major event. These events and the associated action are described below:

- **Major Event:** An event that results in a loss of power, communications, or functionality of a device(s) or system that lasts longer than 2 hours or requires on-site maintenance. A Major Event during the 30-day reliability period will result in the 30-day reliability test starting over.
- **Minor Event:** An event that results in a loss of power, communications, or functionality of a device(s) or system that lasts less than 2 hours and is resolved without any interaction with the system by the City or the Contractor. Minor events shall be documented. Any device(s) or system that records more than three (3) minor events during the 30-day reliability test will warrant the reliability test to be restarted.

Participants: This part will be led by City of St. Paul with participation from the Design Team. Any interaction with the system by the Contractor will result in the 30-day acceptance test restarting.

Test Date	Verify DMS Operations	Verify Traffic Controller Operations	Verify CCTV Operations	Verify ASCS Operations	Notes
Day 1					
Day 2					
Day 3					
Day 4					
Day 5					
Day 6					
Day 7					
Day 8					
Day 9					
Day 10					
Day 11					
Day 12					
Day 13					
Day 14					
Day 15					
Day 16					
Day 17					
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Day 20					
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Day 27					
Day 28					
Day 29					
Day 30					