



**Systems Engineering Analysis for Road Weather Information System
Test Plan**

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Introduction

This document presents a model test plan to support testing and validation activities during the integration and deployment stages of road weather information systems (RWIS) to confirm that the system is developed, installed, and operating as specified by the system requirements.

Each RWIS deployment will be different, and the testing and validation performed will likely vary depending upon the complexity of the system and the familiarity with the vendor products.

A concept of operations has been developed to present an overview of the current environment, identify the relevant stakeholders, translate current challenges into specific needs, outline the envisioned operational concept, suggest likely roles and responsibilities, describe scenarios for operation of the new RWIS, and present potential risks and recommended mitigation strategies associated with this effort. Systems requirements have also been developed to address the needs identified in the concept of operations. The requirements describe what the RWIS must do as the basis for further design, procurement, installation, testing and operation. It also presents an assessment of how the RWIS fits within the Minnesota ITS Architecture.

The table below provides a series of testing instructions related to the requirements presented above. The intent is that agencies using this model systems engineering document will incorporate these tests into their overall testing and validation plans, adapting them as needed.

Column 3 in the table below describes ‘testing instructions’ for each requirement. The RWIS requirements include a range of requirement types and therefore the testing instructions vary.

The following bullet list explains the approach to different testing instructions:

- *Advisory requirement – no testing required:* This is noted for requirements that are primarily operational advice (e.g. the locating and use of RWIS) and therefore no formal testing is required;
- *Design:* these test instructions are used to describe testing in the form of design reviews or documentation reviews describing RWIS and data outputs that will be produced by RWIS. These are typically not physical tests, but rather reviews of processes or documents;
- *Factory Acceptance Test (FAT):* These represent recommendations for FATs to allow the agency deploying the RWIS to verify the quality assurance/quality control and RWIS operational parameters at the site of manufacturing and assembly. This can involve the procuring agency on-site at the vendor factory testing the actual equipment to be delivered or the reports of previous tests of components, software, or features;
- *Field:* These represent recommendations for tests to be conducted in MnDOT offices or the field to test the actual deployment and functionality of the RWIS.

Table 1. Model Test Plan

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
RWIS	Road Weather Information System			
Sensors				
RWIS-1	The field element shall include surface and sub-surface environmental sensors that measure road surface temperature, moisture, icing, salinity, and other measures, as specified in the plans.	<p>Design: Confirm the field element design includes surface and sub-surface environmental sensors that measure road surface temperature, moisture, icing, salinity, and other measures, as specified in the plans.</p> <p>Field: Confirm the surface and sub-surface environmental sensors measure road surface temperature, moisture, icing, salinity, and other measures, as specified in the plans.</p>	Pass/Fail	
RWIS-2	The field element shall include environmental sensors that measure weather conditions including temperature, wind, humidity, precipitation, and visibility, as specified in the plans.	<p>Design: Confirm the field element design includes environmental sensors that measure weather conditions including temperature, wind, humidity, precipitation, and visibility, as specified in the plans.</p> <p>Field: Confirm the environmental sensors measure weather conditions including temperature, wind, humidity, precipitation, and visibility, as specified in the plans.</p>	Pass/Fail	
RWIS-3	The field element shall include sensors that measure water level and temperature, as specified in the plans.	<p>Design: Confirm the field element design includes sensors that measure water level and temperature, as specified in the plans.</p> <p>Field: Confirm the sensors measure water level and temperature, as specified in the plans.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
RWIS-4	When specified in the plans, the field element shall collect traffic data vehicle speed, length, and classification.	<p>Design: Confirm the field element design includes sensors to collect traffic data on vehicle speed, length, and classification, as specified in the plans.</p> <p>Field: Confirm, when specified in the plans, that the field element collects traffic data vehicle speed, length, and classification.</p>	Pass/Fail	
RWIS-5	When specified in the plans, the field element shall include a pan-tilt-zoom CCTV camera.	<p>Design: Confirm, when specified in the plans, that the field element design includes a pan-tilt-zoom CCTV camera.</p> <p>Field: Confirm, when specified in the plans, that the pan-tilt-zoom CCTV camera operates to provide still images to central office staff.</p>	Content Review	
RWIS-6	When specified in the plans, the field element shall share power and communications with other device subsystems such as CORS GPS stations, soil temperature/moisture grids, traffic information systems, and weigh-in-motion stations.	<p>Design: Confirm, when specified in the plans, that the field element design accounts for shared power and communications with other device subsystems such as CORS GPS stations, soil temperature/moisture grids, traffic information systems, and weigh-in-motion stations.</p> <p>Field: Confirm, when specified in the plans, that the field element shares power and communications with other device subsystems such as CORS GPS stations, soil temperature/moisture grids, traffic information systems, and weigh-in-motion stations.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
<i>Control and Monitoring</i>				
RWIS-7	The field element's environmental sensors shall be remotely controlled by a maintenance center, an RWIS control center, a traffic management center, or a maintenance and construction vehicle, as specified in the plans.	Field: Confirm the field elements can be remotely controlled by the controlling center or maintenance vehicle. Elements include some or all of the following: surface and sub-surface environmental sensors, environmental sensors, water level and temperature sensors, traffic sensors, and CCTV cameras.	Pass/Fail	
RWIS-8	The field element shall provide environmental sensor equipment operational status to the controlling center or maintenance vehicle.	Field: Confirm the field element provides environmental sensor equipment operational status to the controlling center or maintenance vehicle.	Pass/Fail	
RWIS-9	The field element shall provide environmental sensor equipment fault indication to the controlling center or maintenance vehicle.	Field: Confirm the field element provides environmental sensor equipment fault indication to the controlling center or maintenance vehicle.	Pass/Fail	
<i>Data Flow and Interface</i>				
RWIS-10	When specified in the plans, the field element shall remotely aggregate environmental sensor data with environmental data collected from maintenance and construction vehicles.	<p>Design: Confirm, when specified in the plans, that the field element design aggregates environmental sensor data from maintenance and construction vehicles.</p> <p>Field: Confirm, when specified in the plans, that the field element remotely aggregates environmental sensor data with environmental data collected from maintenance and construction vehicles.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
RWIS-11	When specified in the plans, the field element shall provide weather and road surface condition data via serial port or ethernet using standard protocols such as NTCIP 1204 or TCP/IP.	<p>Design: Confirm, when specified in the plans, that the field element design indicates the use of NTCIP 1204 or TCP/IP or other standards for communication protocols.</p> <p>FAT: Collect testing documentation from equipment vendor verifying the use of NTCIP 1204, TCP/IP, or other communications protocols.</p> <p>Field: Confirm, when specified in the plans, that the field element provides weather and road surface condition data via serial port or ethernet to the controlling center using standard protocols such as NTCIP 1204 or TCP/IP.</p>	Pass/Fail	
RWIS-12	The field element shall provide weather and road surface condition data to various centers and systems as specified in the plans. Data recipients may include the MnDOT MDSS, Minnesota 511, the national Clarus system, the National Weather Service, and Private VAMS.	Field: Verify the communication of data, as specified in the plans, from field equipment through the operation of software from various centers and systems that may include MnDOT MDSS, Minnesota 511, the national Clarus system, the National Weather Service, and Private VAMS.	Pass/Fail	
RWIS-13	When specified in the plans, the field element shall provide traffic and weather data to the University of Minn. Duluth Transportation Data Research Laboratory and the MnDOT Office of Transportation Data and Analysis.	Field: Verify the communication of data, as specified in the plans, from field equipment through the operation of software from the University of Minn. Duluth Transportation Data Research Laboratory and the MnDOT Office of Transportation Data and Analysis.	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
RWIS-CAV	CAV Infrastructure Systems			
RWIS-CAV-1	RWIS design shall consider whether nearby CAV roadside units (RSUs) will require direct data feeds to and from the RWIS.	Design: Confirm that the RWIS design considers whether nearby CAV roadside units (RSUs) will require direct data feeds to and from the RWIS.	Content Review	
RWIS-CAV-2	RWIS design shall consider whether nearby CAV roadside units (RSUs) will benefit from shared structure, power or communications with the RWIS.	Design: Confirm that the RWIS design considers whether nearby CAV roadside units (RSUs) will benefit from shared structure, power or communications with the RWIS.	Content Review	
RWIS-CAV-3	When specified in the plans, RWIS shall communicate road conditions and alert messages to the applicable CAV Infrastructure System.	Design: Confirm, when specified in the plans, that the RWIS design communicates road conditions and alert messages to the applicable CAV Infrastructure System. Field: Confirm, when specified in the plans, that the RWIS communicates road conditions and alert messages to the applicable CAV Infrastructure System.	Pass/Fail	
RWIS-CAV-4	When specified in the plans, RWIS shall receive BSM messages from applicable CAV Infrastructure System.	Field: Confirm, when specified in the plans, that the RWIS receives BSM messages from applicable CAV Infrastructure System.	Pass/Fail	
RWIS-Oth	Other			
RWIS-Oth-1	[Develop as appropriate]			