



Systems Engineering Analysis for Weigh-In-Motion 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 Weigh-in-Motion (WIM) installation to confirm that the system is developed, installed, and operating as specified by the system requirements.

Each WIM installation 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 WIM system, 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 WIM system must do as the basis for further design, procurement, installation, testing and operation. It also presents an assessment of how the WIM system 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 WIM 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 WIM) 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 WIM and data outputs that will be produced by WIM. 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 WIM to verify the quality assurance/quality control and WIM 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 WIM.

Table 1. Model Test Plan

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
WIM	Weigh-in-Motion for CVO Inspection with Enforcement			
WIM-1	The roadside check facility equipment shall detect the presence of commercial vehicles and freight equipment approaching a facility. Sensors can differentiate between different types of vehicles and determine the number of axles, gross vehicle weight, weight per axle, and axle spacings.	<p>Design: Confirm the WIM design includes roadside check facility equipment that detects the presence of commercial vehicles and freight equipment approaching a facility, including vehicle type, number of axles, gross vehicle weight, weight per axle, and axle spacings.</p> <p>Field: Confirm the roadside check facility equipment detects the presence of commercial vehicles and freight equipment approaching a facility, including vehicle type, number of axles, gross vehicle weight, weight per axle, and axle spacings.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
WIM-2	The roadside processor shall check weight compliance per Minnesota statutes in terms of gross vehicle weight, individual axle load, and axle group load within the time period and level of accuracy specified in the plans.	<p>Design: Confirm the WIM design includes a roadside processor that checks weight compliance per Minnesota statutes in terms of gross vehicle weight, individual axle load, and axle group load within the time period and level of accuracy specified in the plans.</p> <p>Field: Confirm the roadside processor checks weight compliance per Minnesota statutes in terms of gross vehicle weight, individual axle load, and axle group load within the time period and level of accuracy specified in the plans.</p>	Pass/Fail	
WIM-3	When specified in the plans, the WIM installation shall include a CCTV camera or still digital photography to capture and instantly make available video or snapshot images of vehicles passing over the WIM sensors.	<p>Design: Confirm, when specified in the plans, that the WIM design includes a CCTV camera or still digital photography to capture and instantly make available video or snapshot images of vehicles passing over the WIM sensors.</p> <p>Field: Confirm, when specified in the plans, that the CCTV camera or still digital photography captures and instantly makes available video or snapshot images of vehicles passing over the WIM sensors.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
WIM-4	The installation shall store detailed records of 1) all vehicles passing over the WIM sensors for use in vehicle classification and post-processing of weight compliance trends and patterns, plus 2) status indicators and alarms.	Field: Confirm the WIM installation stores detailed records of 1) all vehicles passing over the WIM sensors for use in vehicle classification and post-processing of weight compliance trends and patterns, plus 2) status indicators and alarms.	Pass/Fail	
WIM-5	As specified in the plans, the roadside check facility equipment shall operate as a standalone facility. Parameters and settings shall be changeable to alter the sensitivity and operating characteristics of the WIM equipment at the site.	<p>Design: Confirm, as specified in the plans, that the WIM design includes roadside check facility equipment that operates as a standalone facility. Parameters and settings shall be changeable to alter the sensitivity and operating characteristics of the WIM equipment at the site.</p> <p>Field: Confirm, as specified in the plans, that the roadside check facility equipment operates as a standalone facility. Parameters and settings shall be changeable to alter the sensitivity and operating characteristics of the WIM equipment at the site.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
WIM-6	The field processor shall generate WIM equipment operational status indicators and failure alarms on the field processor.	<p>Design: Confirm the WIM design includes a field processor that generates WIM equipment operational status indicators and failure alarms on the field processor.</p> <p>Field: Confirm the field processor generates WIM equipment operational status indicators and failure alarms on the field processor.</p>	Pass/Fail	
WIM-7	When specified in the plans, the roadside check facility equipment shall send a pass/pull-in notification to the commercial vehicle and its driver based on the information received from the vehicle and the measurements taken. The message may be sent to the driver using equipment such as dynamic message signs, red- green lights, flashing signs, etc.	<p>Design: Confirm, when specified in the plans, that the WIM design includes roadside check facility equipment that sends a pass/pull-in notification to the commercial vehicle and its driver based on the information received from the vehicle and the measurements taken. The message may be sent to the driver using equipment such as dynamic message signs, red- green lights, flashing signs, etc.</p> <p>Field: Confirm, when specified in the plans, that the roadside check facility equipment sends a pass/pull-in notification to the commercial vehicle and its driver based on the information received from the vehicle and the measurements taken. The message may be sent to the driver using equipment such as dynamic message signs, red- green lights, flashing signs, etc.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
WIM-8	When specified in the plans, the roadside check facility equipment shall display truck weight compliance information on a dynamic message sign at the site as an information item to drivers.	<p>Design: Confirm, when specified in the plans, that the WIM design includes roadside check facility equipment that displays truck weight compliance information on a dynamic message sign at the site as an information item to drivers.</p> <p>Field: Confirm, when specified in the plans, that the roadside check facility equipment displays truck weight compliance information on a dynamic message sign at the site as an information item to drivers.</p>	Pass/Fail	
WIM-9	When specified in the plans, the roadside check facility equipment shall transmit the information over the internet via a secure web site, for use by weight enforcement officers.	<p>Design: Confirm, when specified in the plans, that the WIM design includes roadside check facility equipment that transmits the information over the internet via a secure web site, for use by weight enforcement officers.</p> <p>Field: Confirm, when specified in the plans, that the roadside check facility equipment transmits the information over the internet via a secure web site, for use by weight enforcement officers.</p>	Pass/Fail	
WIM-10	WIM design shall consider whether nearby CAV roadside units (RSUs) will require direct data feeds from the WIM.	Design: Confirm that the WIM design considers whether nearby CAV roadside units (RSUs) will require direct data feeds from the WIM.	Content Review	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
WIM-11	WIM design shall consider whether nearby CAV roadside units (RSUs) will benefit from shared power or communications with the WIM.	Design: Confirm that the WIM design considers whether nearby CAV roadside units (RSUs) will benefit from shared power or communications with the WIM.	Content Review	
WIM-12	When specified in the plans, WIM shall communicate pass/pull-in messages to the applicable CAV Infrastructure System.	<p>Design: Confirm, when specified in the plans, that the WIM design communicates pass/pull-in messages to the applicable CAV Infrastructure System.</p> <p>Field: Confirm, when specified in the plans, that the WIM communicates pass/pull-in messages to the applicable CAV Infrastructure System.</p>	Pass/Fail	
WIM-Oth	Other			
WIM-Oth-1	[Develop as appropriate]			