

SYSTEMS ENGINEERING FUNCTIONAL REQUIREMENTS

for:

WEIGH-IN-MOTION INSTALLATION

MINNESOTA DEPARTMENT OF
TRANSPORTATION

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1.0 SCOPE OF APPLICATION PACKAGE

This document provides *Functional Requirements (FRs)* for standard Weigh-in-Motion installations. A WIM installation uses in-pavement sensors to measure the weights and speed of any vehicle passing over them at highway speed, as well as number and spacing of axles. A roadside processor then instantly classifies the vehicle and determines whether or not it is likely legal in gross vehicle weight, individual axle weight, and axle group weight, focusing on commercial vehicle trucks. The action at the site then depends on the type of WIM installation, as summarized in Section 1.1. Installations may also include a closed circuit television (CCTV) camera viewing trucks as they pass over the road section near the sensors, or a camera to take still images of the passing trucks and license plate to monitor compliance.

The WIM system records information on all vehicles passing over the sensors, thus the detailed data can be archived to compute pavement vehicle loads in, usually, equivalent single axle loads (ESALs). This information is very useful in analyzing expected pavement life and needed rehabilitation, and in evaluating of how well particular pavement designs withstand wear-and-tear for general design purposes. If the site is standalone, the data are stored locally for later transfer to other Mn/DOT (or FHWA) offices. If the site connects to a control center, the data are typically transferred via the communications network in real time.

1.1 WIM for CVO Electronic Clearance with Enforcement

WIM measurements are part of electronic clearance for commercial vehicle operations (CVO), typically resulting in expedited processing of vehicles that have been already certified. These CVO trucks carry an electronic tag that identifies at least the truck and its cargo. The roadside equipment must be able to read the electronic tag, but the WIM equipment independently screens trucks for compliance with legal limits. The WIM sensors might be placed only in the outside lane from which trucks enter a CVO inspection station.

An advanced concept for a “virtual weigh station” uses several WIM sensors and other detectors strategically placed on the road network so that trucks cannot evade inspection and weighing. In another version of WIM, a picture of the likely offending vehicle and weight information is posted on a real time web site to enforcement officers downstream of the site. Those officers would use a snap shot picture of the vehicle to identify it as it approaches, then they would stop the truck and again perform a static weigh-in.

Site data are normally archived for post-processing. With archived data, trends in violation behavior by location, day of week, and time of day can be investigated, and appropriate enforcement targeted to address the times and places most in need of attention.

1.2 Other

[Reserved for new WIM features and their characteristics. Please consult with appropriate Mn/DOT, FHWA, or local staff to develop needed scope description.]

2.0 REFERENCE DOCUMENTS

See *ConOps* Section 2. To that list add:

National ITS Architecture, V 6.1, <http://www.iteris.com/itsarch/index.htm>

3.0 FUNCTIONAL REQUIREMENTS AND VERIFICATION METHOD

Table 1 lists the pertinent Functional Requirements including Verification Method. Table 2 maps the ITS Needs and Services that were identified in the companion *ConOps* document for each feature (Table 2 of that document) to the *FRs* identified here, for traceability from the *ConOps* to the *FRs*.

4.0 SUPPORTING DOCUMENTATION

See associated *Checklist* for additional support documents.

Table 1 Functional Requirements for WIM Installation

<u>ID</u>	<u>Functional Requirement</u>	<u>Verification Method*</u>	<u>Comment</u>
<i>WIM</i>	<i>Weigh-in-Motion for CVO Inspection with Enforcement</i>		
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, axle spacings, and the identification of the vehicle and its cargo.	I, D	
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.	I, D	
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.		
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.		
WIM-5	As specified in the plans, the roadside check facility equipment shall operate as a standalone facility or shall be supervised by a control center. Parameters and settings shall be changeable to alter the sensitivity and operating characteristics of the WIM equipment at the site, and from the control center when included.		

* D - Demonstration
T - Test
A - Analysis
I - Inspection

Table 1 Functional Requirements for WIM Installation (continued)

<u>ID</u>	<u>Functional Requirement</u>	<u>Verification Method*</u>	<u>Comments</u>
WIM-6	The field processor shall generate WIM equipment operational status indicators and failure alarms on the field processor, and to the control center when included.	I, D	
WIM-7	When specified in the plans, the roadside check facility equipment shall request and input electronic screening data from the commercial vehicle's electronic tag data.	I, D	
WIM-8	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 on-board equipment in the commercial vehicle or transmitted to the driver using equipment such as dynamic message signs, red-green lights, flashing signs, etc.	I, D	
WIM-9	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.	I, D	
WIM-10	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.	I, D	
<i>WIM-Oth</i>	<i>Other</i>		
WIM-Oth-1	<i>[Develop as appropriate]</i>		

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Table 2 Mapping of WIM Needs/Services to Functional Requirements

<u>Feature</u>	<u>Needs/Services</u>	<u>ITS Functional Requirements</u>
<i>Weigh-in-Motion for CVO Electronic Clearance with Enforcement</i>	CF01 Minimize delays at weigh stations through additional automation	WIM-1, -2 and -5 thru -9
	CF12 Direct commercial vehicle operators to routes that accommodate size and weight requirements	WIM-1, -2 and -7 thru -9
	CF18 Provide multi-state oversize/overweight permitting	WIM-5, -7 thru -9
	CF02 Provide mobile weigh enforcement	WIM-3, -10
	CF03 Target enforcement at locations with history of violations	WIM-2, -4, and -10
	CF04 Target enforcement on carriers, vehicles and drivers with history of violations	WIM-2, -3, -4, and -10
<i>Other</i>	<i>[Develop as needed]</i>	

Needs/Services per *Minnesota Statewide Regional ITS Architecture*

Needs/Services Key:
CF - Commercial Fleet

See Table 1 for Functional Requirements content.