



**Systems Engineering Analysis for Railroad-Highway Grade Crossing  
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 a railroad-highway grade crossing system to confirm that the system is developed, installed, and operating as specified by the system requirements.

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

**Table 1. Model Test Plan**

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
<b>GCP-FLS</b>	<b>Railroad Flashing-Light Signals</b>			
GCP-FLS-1	The field element shall close the railroad- highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using post-mounted flashing-light signals at a minimum, plus other devices as specified in the plans.	Design: Confirm the field element design closes the railroad- highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using post-mounted flashing-light signals at a minimum, plus other devices as specified in the plans.  Field: Confirm the field element closes the railroad- highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using post-mounted flashing-light signals at a minimum, plus other devices as specified in the plans.	Pass/Fail	
GCP-FLS-2	The activation of the flashing-light signals shall be coordinated with the approaching train message from the track circuit to provide adequate warning in advance of train arrival at the crossing.	Field: Confirm the activation of the flashing-light signals is coordinated with the approaching train message from the track circuit to provide adequate warning in advance of train arrival at the crossing.	Pass/Fail	
GCP-FLS-3	The activation timing shall provide either constant warning time or variable warning time in accordance with the plans.	Field: Confirm the activation timing provides either constant warning time or variable warning time in accordance with the plans.	Pass/Fail	
GCP-FLS-4	Active grade crossing warning shall be in effect until the train(s) leave the grade crossing area.	Field: Confirm that active grade crossing warning is in effect until the train(s) leave the grade crossing area.	Pass/Fail	
GCP-FLS-5	To the maximum extent possible, active grade crossing warning shall use fail- safe design and operations principles.	Design: Confirm, to the maximum extent possible, active grade crossing warning uses fail- safe design and operations principles.	Content Review	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
GCP-FLS-6	<p>The field element shall monitor the status of the railroad-highway grade crossing equipment, including the current state, mode of operation, equipment condition, and failure alarms. This information shall be forwarded to the rail wayside equipment.</p>	<p>Design: Confirm the field element design monitors the status of the railroad-highway grade crossing equipment, including the current state, mode of operation, equipment condition, and failure alarms. This information shall be forwarded to the rail wayside equipment.</p> <p>Field: Confirm the field element monitors the status of the railroad-highway grade crossing equipment, including the current state, mode of operation, equipment condition, and failure alarms. This information shall be forwarded to the rail wayside equipment.</p>	Pass/Fail	
GCP-FLS-7	<p>When specified in the plans, the field element shall transmit current state, mode of operation, equipment condition, and failure alarms to the rail operations center. This may include the current status of the tracks, whether a train is approaching, and how long the crossing will be closed.</p>	<p>Design: Confirm, when specified in the plans, that the field element design transmits current state, mode of operation, equipment condition, and failure alarms to the rail operations center. This may include the current status of the tracks, whether a train is approaching, and how long the crossing will be closed.</p> <p>Field: Confirm, when specified in the plans, that the field element transmits current state, mode of operation, equipment condition, and failure alarms to the rail operations center. This may include the current status of the tracks, whether a train is approaching, and how long the crossing will be closed.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
GCP-FLS-8	When specified in the plans, the field element shall transmit current state, mode of operation, equipment condition, and failure alarms to the traffic management center. This may include the current status of the tracks, whether a train is approaching, and how long the crossing will be closed.	<p>Design: Confirm, when specified in the plans, that the field element design transmits current state, mode of operation, equipment condition, and failure alarms to the traffic management center. This may include the current status of the tracks, whether a train is approaching, and how long the crossing will be closed.</p> <p>Field: Confirm, when specified in the plans, that the field element transmits current state, mode of operation, equipment condition, and failure alarms to the traffic management center. This may include the current status of the tracks, whether a train is approaching, and how long the crossing will be closed.</p>	Pass/Fail	
GCP-FLS-9	When specified in the plans, the field element shall control dynamic message signs (DMS) and other traveler information devices in the vicinity of the railroad-highway grade crossing to advise drivers, bicyclists, and pedestrians of approaching trains.	<p>Design: Confirm, when specified in the plans, that the field element design controls dynamic message signs (DMS) and other traveler information devices in the vicinity of the railroad-highway grade crossing to advise drivers, bicyclists, and pedestrians of approaching trains.</p> <p>Field: Confirm, when specified in the plans, that the field element controls dynamic message signs (DMS) and other traveler information devices in the vicinity of the railroad-highway grade crossing to advise drivers, bicyclists, and pedestrians of approaching trains.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
GCP-FLS-10	When specified in the plans, the field element shall determine whether the railroad-highway grade crossing is blocked by traffic in the roadway or by some other obstruction, then notify the traffic management center and/or the rail operations center.	<p>Design: Confirm, when specified in the plans, that the field element design determines whether the railroad-highway grade crossing is blocked by traffic in the roadway or by some other obstruction, then notify the traffic management center and/or the rail operations center.</p> <p>Field: Confirm, when specified in the plans, that the field element determines whether the railroad-highway grade crossing is blocked by traffic in the roadway or by some other obstruction, then notify the traffic management center and/or the rail operations center.</p>	Pass/Fail	
GCP-FLS-11	When specified in the plans, the traffic management center and/or the rail operations center shall archive status data received on railroad-highway grade crossing equipment, including state, mode of operation, equipment condition, and failure alarms.	Advisory requirement – no testing required	N/A	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
GCP-FLS-12	When specified in the plans, the field element shall collect pedestrian images and pedestrian sensor data, and respond to pedestrian crossing requests via display, audio signal, or other manner.	<p>Design: Confirm, when specified in the plans, that the field element design collects pedestrian images and pedestrian sensor data, and respond to pedestrian crossing requests via display, audio signal, or other manner.</p> <p>Field: Confirm, when specified in the plans, that the field element collects pedestrian images and pedestrian sensor data, and respond to pedestrian crossing requests via display, audio signal, or other manner.</p>	Pass/Fail	
<b>GCP-CFL</b>	<b>Railroad Cantilever Flashing-Light Signals</b>			
GCP-CFL-1	When specified in the plans, the field element shall close the railroad-highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using cantilever-mounted flashing-light signals. Post-mounted flashing-light signals shall also be provided when also specified in the plans.	<p>Design: Confirm, when specified in the plans, that the field element design closes the railroad-highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using cantilever-mounted or post-mounted flashing-light signals.</p> <p>Field: Confirm, when specified in the plans, that the field element closes the railroad-highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using cantilever-mounted or post-mounted flashing-light signals.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
<b>GCP-SRG</b>	<b>Standard Railroad Gates</b>			
GCP-SRG-1	When gates are specified in the plans, the field element shall close the railroad- highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using approach side gates in addition to flashing-light signals.	<p>Design: Confirm, when gates are specified in the plans, that the field element design closes the railroad- highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using approach side gates in addition to flashing-light signals.</p> <p>Field: Confirm, when gates are specified in the plans, that the field element closes the railroad- highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using approach side gates in addition to flashing-light signals.</p>	Pass/Fail	
GCP-SRG-2	When specified in the plans, pedestrian gates shall be included in addition to vehicle gates.	<p>Design: Confirm, when specified in the plans, that design includes pedestrian gates in addition to vehicle gates.</p> <p>Field: Confirm, when specified in the plans, that pedestrian gates are installed and operational in addition to vehicle gates.</p>	Pass/Fail	
GCP-SRG-3	The lowering of the gates shall be coordinated with, and follow, the initiation of flashing-light signal activation.	Field: Confirm the lowering of the gates is coordinated with, and follows, the initiation of flashing-light signal activation.	Pass/Fail	



ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
<b>GCP-FQG</b>	<b>Four Quadrant Gates</b>			
GCP-FQG-1	When four quadrant gates are specified in the plans, the field element shall close the railroad-highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using approach side and exit side gates, in addition to flashing-light signals.	<p>Design: Confirm, when four quadrant gates are specified in the plans, that the field element design closes the railroad-highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using approach side and exit side gates, in addition to flashing-light signals.</p> <p>Field: Confirm, when gates are specified in the plans, that the field element closes the railroad-highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing using approach side and exit side gates, in addition to flashing-light signals.</p>	Pass/Fail	
GCP-FQG-2	The lowering of the exit side gates shall lag the lowering of the approach side gates to allow vehicles to safely clear the grade crossing area.	<p>Design: Confirm, when specified in the plans, that the field element design for lowering of the exit side gates lags the lowering of the approach side gates to allow vehicles to safely clear the grade crossing area.</p> <p>Field: Confirm, when specified in the plans, that lowering of the exit side gates lag the lowering of the approach side gates to allow vehicles to safely clear the grade crossing area.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
<b>GCP-TSPr</b>	<b>Traffic Signal Preemption</b>			
GCP-TSPr-1	When Traffic Signal Preemption is shown in the plans, the field element shall close the railroad-highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing by preempting adjacent traffic signals with prescribed sequencing and timing.	<p>Design: Confirm, when specified in the plans, that the field element design closes the railroad-highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing by preempting adjacent traffic signals with prescribed sequencing and timing.</p> <p>Field: Confirm, when specified in the plans, that the field element closes the railroad-highway grade crossing when a train is approaching with enough time for travelers to safely clear the crossing by preempting adjacent traffic signals with prescribed sequencing and timing.</p>	Pass/Fail	
GCP-TSPr-2	Preemption shall be in addition to other active grade crossing warning.	<p>Design: Confirm, when specified in the plans, that field element design includes traffic signal preemption in addition to other active grade crossing warning.</p> <p>Field: Confirm, when specified in the plans, that traffic signal preemption is implemented in addition to other active grade crossing warning.</p>	Pass/Fail	

ID	System Requirement	Testing Instructions	Type of Result	Comments / Notes
GCP-TSPPr-3	When specified in the plans, the field element shall support the integrated control of adjacent traffic signals to clear an area in advance of an approaching train and to manage traffic around the grade crossing.	<p>Design: Confirm, when specified in the plans, the field element design supports the integrated control of adjacent traffic signals to clear an area in advance of an approaching train and to manage traffic around the grade crossing.</p> <p>Field: Confirm, when specified in the plans, the field element supports the integrated control of adjacent traffic signals to clear an area in advance of an approaching train and to manage traffic around the grade crossing.</p>	Pass/Fail	
<b>GCP-CAV</b>	<b>CAV Infrastructure Systems</b>			
GCP-CAV-1	When specified in the plans, the field element shall communicate crossing status to the applicable CAV Infrastructure System.	<p>Design: Confirm, when specified in the plans, that the field element design communicates crossing status to the applicable CAV Infrastructure System.</p> <p>Field: Confirm, when specified in the plans, that the field element communicates crossing status to the applicable CAV Infrastructure System.</p>	Pass/Fail	
<b>GCP-Oth</b>	<b>Other</b>			
GCP-Oth-1	[Develop as appropriate]			