RITA Intelligent Transportation Systems
Joint Program Office

Cooperative Intersection Collision Avoidance System Limited to Stop Sign and Traffic Signal Violations (CICAS-V)

Task 7

Final System Test Plan and Test Procedures

(Appendix H-1)

September 30, 2008

Crash Avoidance Metrics Partnership (CAMP) Produced
In conjunction with Virginia Tech Transportation Institute for
ITS Joint Program Office
Research and Innovative Technology Administration
U.S. Department of Transportation

CAMP Members:

Mercedes-Benz
General Motors (GM)
Toyota
Honda
Ford

Photos Credits
Photos and Illustration's courtesy of CAMP

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Cooperative Intersection Collision Avoidance System Limited to Stop Sign and Traffic Signal Violations (CICAS-V) - Task 7 Final System Test Plan and Test Procedures		5. Report Date September 30, 2008 6. Performing Organization Code
7. Author(s) Maile, M., Ahmed-Zaid, F., Basnyake, C., Caminiti, L., Kass, S., Losh, M., Lundberg, J., Masselink, D., McGlohon, E., Mudalige, P., Pall C., Peredo, M., Popovic, Z, Stinnett, J., And Vansickle, S.		8. Performing Organization Report No.
9. Performing Organization Name and Address Crash Avoidance Metrics Partnership on behalf of the Vehicle Safety Communications 2 Consortium 39255 Country Club Drive Suite B-40 Farmington Hills, MI 48331		10. Work Unit No. 11. Contract or Grant No. **DTFH61-01-X-00014**
12. Sponsoring Agency Name and Address Federal Highway Administration 1200 New Jersey Avenue S.E. Washington, DC 20590		13. Type of Report and Period Covered Final Task Report 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The objective of the Cooperative Intersection Collision Avoidance System for Violations (CICAS-V) project is to develop and field-test a comprehensive system to reduce the number of crashes at intersections due to violations of traffic control devices (TCDs; i.e., traffic lights and stop signs). The CICAS-V system provides a salient and timely in-vehicle warning to drivers who are predicted to violate a TCD, with the aim of compelling the driver to stop. This document presents test procedures and a test plan to verify that a potential CICAS-V system meets the end system functional goals established in the Concept of Operations document.

17. Key Word	18. Distribution Statement
Objective Test Procedures, Intersection Collision Avoidance, Verification Testing, Systems Engineering, FOT Readiness	No restrictions. This document is available through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	92	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

List of Acronyms

ANSI	American National Standards Institute
ATIS	Advanced Traveler Information System
C2C	Center to Center
CAMP	Crash Avoidance Metrics Partnership
CAN	Controller Area Network. Wired network system common in newer model vehicles.
CICAS	Cooperative Intersection Collision Avoidance System
CICAS-V	Cooperative Intersection Collision Avoidance System for Violations
ConOps	Concept of Operations
DFD	Data Flow Diagrams
DOT	Department of Transportation
DSRC	Dedicated Short Range Communications
DVI	Driver-Vehicle Interface
ESS	Environmental Sensor Stations
ETMCC	External Traffic Management Center Communication
FHWA	Federal Highway Administration
FOT	Field Operational Test
GID	Geometric Intersection Description
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HMI	Human-Machine Interface
ID	Identification or Identifier
IEEE	Institute of Electrical and Electronics Engineers
IGN	Ignition
ISO	International Standards Organization
ITS	Intelligent Transportation Systems
LRMS	Location Referencing Message Specification
MS/ETMCC	Message Sets for External Traffic Management Center Communications
NDGPS	Nationwide Differential Global Positioning System
NHTSA	National Highway Traffic Safety Administration
NMEA	National Marine Electronics Association, Inc.
NTCIP	National Transportation Communications for ITS Protocol
OBE	On-board Equipment
OEM	Original Equipment Manufacturer

POC	Proof of Concept
RSE	Roadside Equipment
RTCM	Radio Technical Commission for Maritime Services
SAE	SAE International, an organization formerly known as Society for Automotive Engineers
SPaT	Signal Phase and Timing
SWC	Single Wire CAN
TCIP	Transit Communications Interface Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TIA	Telecommunications Industry Association
TMDD	Traffic Management Data Dictionary
USDOT	United States Department of Transportation
UTC	Coordinated Universal Time
UUID	Universal Unique Identifier
VAN	Vehicle Area Network
VII	Vehicle Infrastructure Integration
VSC2	Vehicle Safety Communications 2
WAAS	Wide Area Augmentation System
WAV/MP3	Audio file formats
WAVE	Wireless Access in Vehicular Environments
WSA	WAVE Service Announcement

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 Purpose

This document describes test procedures to establish that a potential CICAS-V system meets the end system functional goals established in the Concept of Operations document.

1.2 Scope

The tests described in this document are designed to validate system level functionality of the entire system.

Sub-system performance is not evaluated as part of these procedures. If a sub-system were to fail during a test procedure, but the system successfully warns or does not warn the driver as required by the procedures – the test is considered successful. Likewise, a failure of a sub-system that prevents a warning or warns inappropriately is considered a test failure. A failure of the system to warn when all subsystems are operating correctly is considered a test failure.

1.3 Procedure

The test procedures described in this document are to confirm that CICAS-V system functions as specified in the Performance Specifications Document at the system level. Therefore, the procedures require the tester to only record system level performance details. If a tester chooses to record additional sub-system level performance details to assist in diagnosing certain system or sub-system failures, they may do so to the extent possible without impacting the results of the test.

For the objective test procedures, a successful test is a test in which the procedure is correctly completed and during which the driver is warned or not warned, as required by the test procedure. A warning is defined as the CICAS-V system activating all available warning modalities installed on the given test vehicle within the driver's perception of simultaneity.

Currently, the Performance Specifications Document defines a warning to be a visual, audio, and haptic interface being activated within a 200mS time window. The relative timing of these interfaces will be validated during Task 10 – Subsystem Testing. The presence of all three modalities within the acceptable warning distance is also verified within these objective test procedures in Section 4.

For the objective test procedures, a failed test is a test in which the driver was warned when a warning was not required by the test procedure or a test in which the driver was not warned when a warning was required by the test procedure. A further definition of acceptable warning windows is established in the "Pass and Fail Definitions" section of each test description and in section 1.6.

Test procedures that require a warning in order to pass must be conducted at a closed test facility. Only test procedures that are scripted to end in a non-warning to the driver may be conducted on public roads. Currently, open road testing is not part of the Objective Test Procedures defined in this document.

Each test will involve at least two people: a test driver and test observer. The test driver operates the vehicle as specified by the test procedure while concurrently the test observer observes and records test conditions and results.

1.4 Assumptions

It is assumed that the test observers are not naïve. It is assumed that the test drivers are familiar with the basic CICAS-V system functionality as defined in the Concept of Operations. It is also assumed that the test observers are familiar with the basic operation of the vehicle and CICAS-V system. However, it is not assumed that the test observers and test drivers are knowledgeable of the sub-systems or the design and construction of the CICAS-V system.

1.5 Test Scenarios Overview

The tests specified in this document are grouped into test scenarios. A test scenario defines the test conditions, the test procedure, the expected results, and the number of test runs. A test run is one execution of the test scenario's test procedure.

The tests are divided into Warning, Nuisance Warning and Engineering Tests.

A Warning Test is a test where the objective is to test whether the system issues a correct warning, defined as a necessary warning at the correct distance specified in the warning algorithm table.

A Nuisance Test is a test where the objective is to test whether the system can successfully avoid issuing a warning in a situation where no warning should be given.

An Engineering Test is a test where the objective is to test the limits of the system under unfavorable conditions. This test does not have pass/fail criteria associated with it however the expectation is to test for a warning under extremely adverse conditions to test the limits of the system.

Table 1 is an overview of test scenarios included in this document. Each scenario is presented with its purpose and a reference to the section that details its procedure.

Table 1 – Test Scenarios Overview

Name	Purpose	Section	Kind
Signalized Various Speed Approaches Test	Test whether warning distance is as specified for signalized intersections and given vehicle speed	3.2	Objective Requirement Warning
Edge of Approach Testing for Warning	Test whether expected warning is given when vehicle is driven on edge of lane	3.3	Objective Requirement Warning
Edge of Approach Testing for Nuisance Warning	Test whether nuisance warnings are avoided when vehicle is driven on edge of lane	3.4	Objective Requirement Nuisance
Late Lane Shift Test – Warning	Test whether expected warning is given when shifting from green lane into red lane after red lane's warning distance passed	3.5	Objective Requirement Warning
Late Lane Shift Test – Nuisance Warning	Test whether nuisance warning is avoided when shifting from red lane into green lane before red lane's warning distance passed	3.6	Objective Requirement Nuisance
Multiple Intersections within 300m Radius: Warning Case	Test whether warning appropriate warning is given for approaching intersection in presence of multiple nearby intersections	3.7	Objective Requirement Warning
Multiple Intersections within 300m Radius: No Warning Case	Test whether warning is avoided when approaching intersection in presence of multiple nearby intersections	3.8	Objective Requirement Warning
Dynamic Signal Change to Yellow, Too Late to Warn	Test whether warning is avoided on signal change from green to yellow when red arrives after the stop bar	3.9	Objective Requirement Nuisance
Dynamic Signal to Red, In Time for Warning	Test whether expected warning is given on signal change from green to yellow when red occurs before vehicle passes stop bar.	3.10	Objective Requirement Warning
Dynamic Signal to Green, No Warning Case	Test whether warning is avoided when signal change from red to green before the warning distance	3.11	Objective Requirement Nuisance
Stop Sign Various Approach Speeds Test	Test whether warning distance is as specified for stop sign intersections and given vehicle speed	4	Objective Requirement Warning

SPaT Reflection and Reception	Tests the system performance / system limits when line of sight between intersection and vehicle is obscured by another vehicle	3.12	Engineering Test

1.6 Individual Test Pass and Fail Definitions

A test can be valid or invalid. Only a valid test can pass or fail. The results of an invalid test are not considered for pass/fail evaluation. As such, there are three test outcomes:

1. Invalid
2. Valid and passed
3. Valid and failed

These outcomes are defined in the sections below. Terms "successful" and "passed" are used as synonyms.

1.6.1 Test Validity

At a minimum, the validity of a test will be determined using the following factors:

1. Actual observed vehicle speed as recorded by test equipment
2. GPS coverage

If the vehicle speed is greater or less than the specified test target speed by more than 2.5 mph, the test is considered invalid and will not count toward the tests conducted.

For a test to be valid, minimum GPS system performance must be achieved. If the standard deviation of its GPS position estimate is greater than 1.5 meters in the horizontal plane, or the PDOP is greater than 5.0, or fewer than 5 satellites are used in the computations, then that GPS position estimate shall be considered unacceptable. In these cases, the test is defined as invalid and will not count toward the tests conducted.

There will also be validity criteria specific to each test that are in addition to these basic validity criteria. Some of these are lane change timing, signal change timing, lane edge distance, and following distance. These additional criteria are specified within test procedures in Sections 3 and 4.

1.6.2 Test Success and Failure

The minimum requirements to determine test success or failure are:

- The test must be valid according to Section 1.6.1
- A warning must be issued or not be issued as required by the individual test description
- All warning modalities available on the vehicle being tested must be issued within the perception time of the test driver. Previous CICAS-V testing has found a 200mS modality time span as imperceptible by test subjects

- The warning must be issued after the earliest acceptable distance but before the latest acceptable distance as calculated from the warning table used in the OBE. Section 1 shows representative calculations. The distance from stop bar to be used for this assessment will be calculated from high accuracy test distance ranging equipment described as required infrastructure in this document

Actual observed vehicle speed is recorded during each individual test run. The recorded speed will be used in conjunction with the warning tables developed in Task 3– Human Factors Studies and a 400 ms acceptance window as defined in the CICAS-V Performance Specifications Document.

For example, a test run is to be conducted at 35 mph. The test driver will attempt to maintain a speed of approximately 35 mph. After the test run is complete, the Data Acquisition System (DAS) log will be examined, if the recorded vehicle speed is greater than 37.5 mph or less than 32.5 mph, then the speed is out of range and the test is discarded as invalid regardless of the results. Discarded tests do not count toward the total amount of tests completed. If the test run was completed at 35.5 mph then the test speed is converted to kilometers per hour 35.5 / 0.621 = 57.2 kmph. In order to maintain the most conservative approach, 57.2 kmph is rounded up to the next whole value of 58 kmph when looking up the proper warning distance in the warning algorithm table.

If a given run targeted 45 mph, the actual speed of the vehicle when the warning initiated is noted and the optimum warning distance from the stop bar is determined from the equation used to determine the warning algorithm. For example, a speed of 44 mph is equivalent to 71 kmph. At 71 kmph, the optimum warning distance given by the warning table Signal_WA_641-11 in Appendix H – Distance to Stopbar Warning Distancesis 65.12m from the stop bar. The acceptable warning window for this test will be given by the following equations:

$$\text{Acceptable Variation in Warning} = (71\,\text{km/hr})\left(\frac{200mS}{1000\,{}^{mS}/_{S} * 60\,{}^{S}/_{\min} * 60\,{}^{\min}/_{hr}}\right)(1000\,{}^{m}/_{km})$$

$$\text{Acceptable Variation in Warning} = 3.9444m$$

$$\text{Earliest Acceptable Warning} = \text{Optimum Warning from Task 3} + \text{Acceptable Variation in Warning}$$

$$\text{Earliest Acceptable Warning} = 53.39\text{m} + 3.9444\text{m} = 57.33\text{m}$$

$$\text{Latest Acceptable Warning} = \text{Optimum Warning from Task 3} - \text{Acceptable Variation in Warning}$$

$$\text{Latest Acceptable Warning} = 53.39\text{m} - 3.9444 = 49.46\text{m}$$

If the vehicle recording system indicates that a warning was issued by the OBE while the high accuracy test ranging system indicates the vehicle was between 49.46m and 57.33 from the stop bar, this test was successful. In any other case, this test was a failure.

The above example uses the terms earliest and latest from the driver's perspective. This may not be convention in all documents.

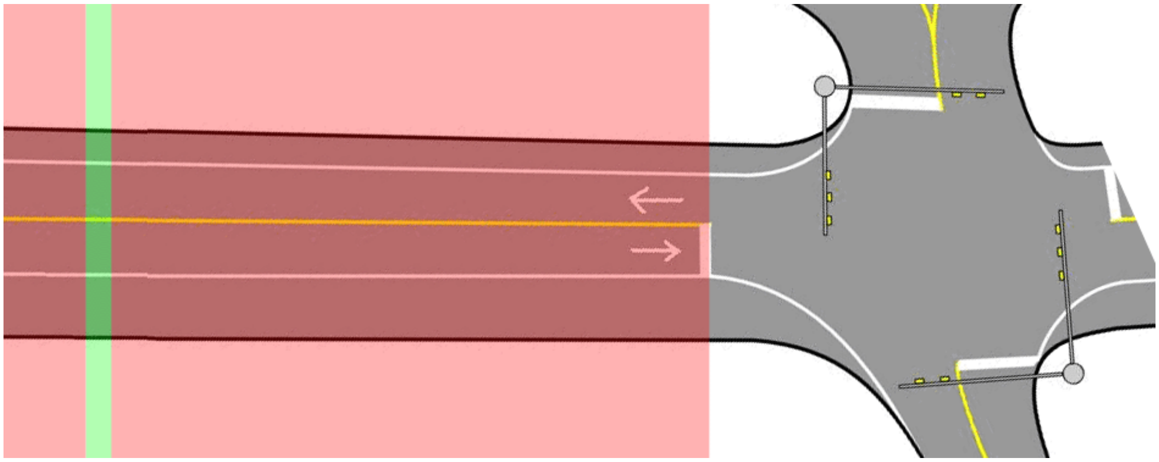

Figure 1 – Basic Acceptable Distance for CICAS-V Warning

Figure 1 shows the acceptable location for a warning to occur. If a warning occurs in the area marked in red, that warning is a failure. Warnings received by the driver in areas defined in green are acceptable. If a warning does not occur by the stop bar, it is considered to have been a missed (failed) warning. The distance from the stop bar to the green optimum warning distance will be defined as an outcome of Task 3 – Human Factors Studies.

Examples of acceptable distances from the stop bar for warning are provided in Table 2 for discussion in this section. The warning tables that are used in this testing are listed in section Appendix H – Distance to Stopbar Warning Distances.

The acceptable variations from optimum performance are calculated from the acceptable warning variation of +/- 200mS as described in the Performance Specifications Document. Note: Table 2 as shown is calculated from the initial warning algorithm table defined for baseline deliverable. This table needs to be revised based on the warning table being used

Table 2 -- Range of Acceptable Warning Distances for Key Vehicle Speeds

Vehicle Speed (mph)	Vehicle Speed (kph)	Optimum Distance from Stop Bar Warning is Valid (m)	Acceptable Variation from Optimum Distance (m)	Earliest Acceptable Warning (m)	Latest Acceptable Warning (m)
25	40	20.9	2.2	23.1	18.6
30	48	27.9	2.7	30.6	25.2
35	56	35.9	3.1	39.0	32.7
40	64	44.8	3.6	48.4	41.2
45	72	54.7	4.0	58.7	50.7
50	81	65.5	4.5	70.0	61.0
55	89	77.3	4.9	82.2	72.4

A possible example of the results of testing are shown in Table 3 below. In Run 3, the warning was too late to be valid, so the test failed. In Run 4, the warning did not include the icon or audio so the test was failed. Run 4 is also considered failed due to the late warning. In Run 6, the warning activated too early, so the test failed.

Table 3-- Examples of Passed and Failed Tests

Run	Speed of Vehicle (km/hr)	Optimum Distance to Warn from VTTI (m)	Warning Available	Warning Received	Warning Received Distance From Stop Bar (m)	Test Result
1	72 km/h	54.7	Icon/Brake/Audio	Icon/Brake/Audio	55.4	Pass
2	72 km/h	54.7	Icon/Brake/Audio	Icon/Brake/Audio	51.7	Pass
3	72 km/h	54.7	Icon/Brake/Audio	Icon/Brake/Audio	49.9	Fail
4	72 km/h	54.7	Icon/Brake/Audio	Brake	61.3	Fail
5	72 km/h	54.7	Icon/Brake/Audio	Icon/Brake/Audio	55.5	Pass
6	72 km/h	54.7	Icon/Brake/Audio	Icon/Brake/Audio	61.3	Fail

However, it should be noted that for the Task 11 Objective Tests conducted as part of the CICAS-V deliverables, all three modalities are required for every test defined in this document. Failure of any modality during a valid test is sufficient to fail a given test run.

Additional requirements for test success and failure are defined in the appropriate subsection that describes each test.

1.7 Overall Objective Test Pass and Fail Definition

The success for each test procedure is defined as achieving 6 successful passes of 8 attempts.

The overall project success is defined as achieving success for each of the tests conducted.

For example, see Table 4:

Table 4 - Success Criteria by Test Procedure

Test Name	Speed	Comment	Tests Conducted	Tests Successful	Success Rate	Pass / Fail
Signalized Various Speed Approaches Test	25		8	8	100%	Pass
	35		8	8	100%	Pass
	55		8	7	88%	Pass
Edge of Approach Testing for Warning	35	Right Side	8	7	88%	Pass
Edge of Approach Testing for Nuisance Warning	35	Left Side	8	8	100%	Pass
Late Lane Shift Test	35	Right to Left w/Warning	8	6	75%	Pass
	35	Left to Right w/o Warning	8	6	75%	Pass
SPaT Reflection and Reception	35		8	8	100%	Pass
Multiple Intersections within 300m Radius: Warning Case	35		8	8	100%	Pass
Multiple Intersections within 300m Radius: No Warning Case	35		8	8	100%	Pass
Dynamic Signal Change to Yellow, Too Late to Warn	35		8	8	100%	Pass
Dynamic Signal to Red, In Time for Warning	35		8	6	75%	Pass
Dynamic Signal to Green, No Warning Case	35		8	8	100%	Pass
Stop Sign Various Approach Speeds Test	25		8	8	100%	Pass
	35		8	8	100%	Pass
	55		8	8	100%	Pass
Overall						**Pass**

Test Name	Speed	Comment	Tests Conducted	Tests Successful	Success Rate	Pass / Fail
Signalized Various Speed Approaches Test	25		8	8	100%	Pass
	35		8	8	100%	Pass
	55		8	7	88%	Pass
Edge of Approach Testing for Warning	35	Right Side	8	7	88%	Pass
Edge of Approach Testing for Nuisance Warning	35	Left Side	8	8	100%	Pass
Late Lane Shift Test	35	Right to Left w/Warning	8	6	75%	Pass
	35	Left to Right w/o Warning	8	6	75%	Pass
SPaT Reflection and Reception	35		8	8	100%	Pass
Multiple Intersections within 300m Radius: Warning Case	35		8	8	100%	Pass
Multiple Intersections within 300m Radius: No Warning Case	35		8	8	100%	Pass
Dynamic Signal Change to Yellow, Too Late to Warn	35		8	8	100%	Pass
Dynamic Signal to Red, In Time for Warning	35		8	5	63%	Fail
Dynamic Signal to Green, No Warning Case	35		8	8	100%	Pass
Stop Sign Various Approach Speeds Test	25		8	8	100%	Pass
	35		8	8	100%	Pass
	55		8	8	100%	Pass
Overall						**Fail**

2 Objective Test Procedure Test Requirements

In the follow sections, a description of the general requirements for conducting the tests described in this document are provided in section 2.1. This description is intended to describe the test requirements sufficiently well to allow objective testing to be conducted at any sufficiently equipped vehicle test facility.

Following that description is section 2.2, which describes a specific instance of the general requirements that was developed at the Virginia Tech Transportation Institute (VTTI) during the CICAS-V test program.

2.1 General Requirements

For the objective tests defined in this document to properly conducted, sufficient data collection and roadway infrastructure must be used.

This document section defines the minimum requirements for data collection and infrastructure. In addition, the specific tests scenarios define additional requirements based on the test. In addition to the general requirements provided in section 2.1, a description of a reference test bed is provided in section 2.2. However, system objective testing could be conducted anywhere that meets the general requirements outlined in section 2.1.

2.1.1 Data Collection Equipment Configuration

2.1.1.1 Primary Data Variables Collected

Three primary data elements must be collected for all tests described in this document. They are as follows:

1. A permanent record of the ground truth distance between the front bumper of the vehicle and edge of the stop bar closest to the vehicle
2. A permanent record of the status of the driver warning DVI
3. A permanent record of the vehicle's speed accurate within 0.5 mph

21.1.1..1 Instrumentation Required

In order to record these variables, a test ranging system capable of determining the ground truth distance between the front bumper of the vehicle and the edge of the stop bar closest to the vehicle with 5cm accuracy must be used. Possible implementation techniques include radar ranging, differential GPS, and laser ranging.

Further, a test system capable of recording the status of the DVI of the system is required. Possible implementation techniques include video camera or an oscilloscope.

Currently driven lane, position within lane, traffic signal status, and the distance to the lead vehicle are also to be recorded. The lane information can be recorded from the output of the in-vehicle portion of the CICAS-V system by an in-vehicle data acquisition system (DAS) and can also be confirmed by the forward facing in-vehicle camera. The traffic signal status can be recorded by an in-vehicle system or at the intersection. The distance to the lead vehicle can be captured by a radar located in the test vehicle's front bumper.

Finally, a typical way of recording vehicle speed is to use speed as reported on the vehicle serial data network.

2.1.1.2 Secondary Data Variables Collected

In addition to the three primary data elements, the following data elements are required to be recorded for individual tests defined in this document:

1. Brake status defined as the driver applying pressure to the brake pedal sufficient to activate the rear brake lights
2. GPS number of satellites visible
3. HDOP as calculated by the GPS receiver
4. Intersection selected as computed by the OBE

5. Lane driven as computed by the OBE
6. Traffic signal status as received by the OBE

22.1.1..1 Instrumentation Required

Vehicle brake status can be determined either by accessing the serial data bus or recording the status of the rear brake lights.

DVI audio and haptic status could be determined by time synchronized video recording and g-force recording.

Satellites in view and HDOP could be recorded by a GPS recording device, or by the installed OBE equipment.

Intersection selected, lane driven, and traffic signal reported could be determined by the installed OBE equipment.

2.1.2 Roadway Requirements for Testing

A sufficiently flexible intersection layout must be developed for the controlled test access area so that all test scenarios can be completed without having to unnecessarily reconfigure the intersection.

Minimum requirements for conducting the objective tests include:

1. A controlled access three lane road at least 1000m long marked with standard lane markings and a stop bar. The roadway must safely allow travel at speeds required by the objective tests and allow sufficient distance to safely stop the test vehicle. The road grade must be below 7 % and any curvature must allow safe travel at the maximum test speed. The lane width must be larger than 2.6 m.
2. Valid Geometric Intersection Description (GID) representations of the roadway in the following configurations:
    a. Two lanes of travel in one direction, one lane through, one dedicated left turn and one lane through in opposite direction of travel.
    b. Three through lanes in same direction of travel
    c. GID with Area Alternate Intersection
3. Any infrastructure required for data collection

A Geometric Intersection Description (GID) is required for any intersection at which objective testing will occur. The GID defines a lane level digital map of an intersection. The size of the map in each direction depends on topology, signal reception probability, and other intersections in the vicinity; however, for objective testing GIDs should extend at least 300m. The GID details the location of drivable lanes and provides a means of correlating lanes to signal phase and timing information received separately.

enAn acceptable fictional generic intersection is provided in Figure 2. The 4-way intersection shown has four, four-lane wide arms. The blue lane designations do not represent actual lane markings but instead illustrate potential lanes. With this test intersection configuration, several different GIDs can be configured for testing.

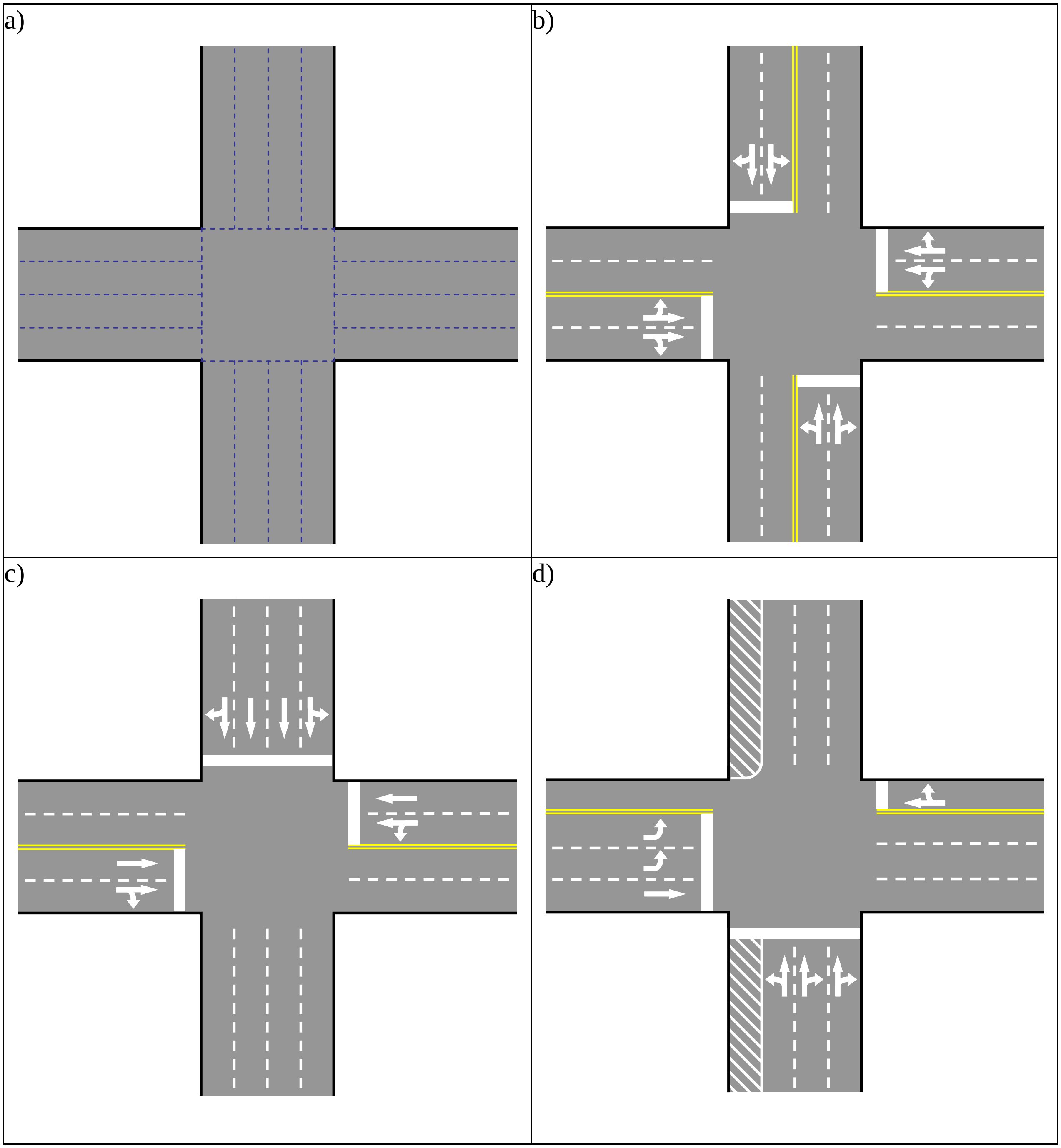

Figure 2 – Four GID Configurations of One Intersection Geometry

2.1.3 Infrastructure Required for Testing

2.1.3.1 Signalized Intersection

For objective tests to be conducted successfully the following infrastructure must be in place:

1. Intersection with traffic controller
2. CICAS-V RSE transmitting SPAT message
3. CICAS-V RSE transmitting DGPS Corrections message
4. CICAS-V RSE transmitting intersection GID message
5. A system capable of determining the distance between the front bumper of the vehicle and edge of the stop bar closest to the vehicle. This system can either be in the infrastructure or on the vehicle (such as precise GPS).
6. Secondary CICAS-V RSE transmitting SPAT messages for multiple intersection tests and OBE to validate reception of those messages.

2.1.3.2 Stop Sign Intersection

The minimum requirements for the test facility are:

1. A stop sign installed
2. Test ranging system capable of determining the distance between the front bumper of the vehicle and edge of the stop bar closest to the vehicle. This requirement may be replaced by installing a ranging system on the vehicle.

For valid stop sign tests to be conducted, the following equipment does not need to be implemented:

1. Intersection with traffic controller
2. CICAS-V RSE transmitting SPAT message
3. CICAS-V RSE transmitting DGPS Corrections message
4. CICAS-V RSE transmitting intersection GID message

2.1.3.3 Public Access Intersection

The requirements for a public access intersection are the same as for respective stop sign and signalized intersections as described above.

Only test procedures that are scripted to end in a non-warning to the driver may be conducted on public roads. Currently, open road testing is not part of the Objective Test Procedures defined in this document; however, it is included here for completeness.

Testing can be conducted at any intersection at which:

1. The necessary mapping and GID creation has been conducted
2. The appropriate public entity has installed the necessary infrastructure

3. The appropriate public entity has given any required approval

2.2 Example of the General Requirements

The following are example acceptable implementations of the general requirements defined in section 2.1. The implementations described below have been constructed at the Virginia Tech Transportation Institute (VTTI), VA, at Oakland County, MI and at Santa Clara County, CA.

2.2.1 Example of a Data Collection Equipment Implementation

2.2.1.1 Primary Data Variables Collected

The primary data elements that must be collected for all tests are: ground truth distance from the test vehicle to stop bar, vehicle speed and status of driver warning DVI. Vehicle speed will be used in all tests to determine test validity and to calculate the acceptable warning window. The VTTI example test site will collect these data elements using the following equipment. Additional primary data elements that have to be collected for validation of the tests are GPS number of satellites visible and HDOP as calculated by the GPS receiver.

To measure the ground truth distance from the vehicle to the stop bar at the VTTI test bed, a Novatel FLEXPAK-G2L-RT2W - L1/L2 DGPS receiver will be connected to the Data Acquisition System (DAS) installed in each vehicle. This unit will receive real time corrections generated at a surveyed Novatel base station located within 300m of the intersection on the roof of the Smart Road Control Room. The location of the base station antenna has been surveyed to a 0.02m standard deviation. The base station will transmit real time corrections data using a Pacific Crest Radio modem at 35-Watts.

During the ICAV project , the VTTI DGPS configuration was verified to be accurate to 0.01m while stationary and 0.05m at vehicle speeds of 70-MPH.

The distance to stop bar will be calculated in real time within the DAS. The distance will be calculated as the position information is received from the GPS system on the serial port of the DAS. The DAS will store the distance values along with the GPS time of week for later processing.

The three modalities of the driver warning will be verified by reviewing the DAS log and time-synchronized video and audio recordings aimed at capturing the visual and audio modes of the warning. The timing of the brake modality of the warning can be extracted from the DAS log and verified by the test observer. For additional information regarding the establishment of DVI modality synchronization please see section 4.2.4.

2.2.1.2 Secondary Data Variables Collected

In addition to the three primary data elements, the following data elements are required to be recorded for individual tests defined in this document:

1. Brake status as defined by the driver applying pressure to the brake pedal sufficient to activate the rear brake lights

2. Intersection selected as computed by the OBE
3. Lane driven as computed by the OBE
4. Traffic signal status as received by the OBE

22.2.1..1 Instrumentation Required

Vehicle brake status will be determined from the vehicle serial bus and recorded by the DAS.

DVI audio status will be determined by time synchronized video recording that will be encoded in MPEG-2 format and stored in the DAS.

DVI haptic status will be determined by recording the vehicle lateral g-force as provided by the vehicle serial data bus to the DAS.

Satellites in view, HDOP, intersection selected, lane driven, and traffic signal reported will be determined by OBE reporting over a serial data bus to the DAS.

2.2.1.3 Additional Tertiary Data Variables Collected

In addition to the primary and secondary variables collected, the DAS will receive and store a number of subsystem outputs from the vehicle and the OBE. Please see Appendix F – Typically Values Stored for Objective Testing for a complete listing of values stored. Other values recorded by the DAS may be used depending on the test description.

2.2.2 Example of a Required Roadway Implementation

2.2.2.1 Intersection Paint and Design

The controlled access intersection is configured at the VTTI Smart Road in Blacksburg, VA. The existing intersection and paint will not be changed. Vehicles may, depending on the test, operate against the designed flow of traffic as indicated by the lane markings. Test vehicles may also travel on the pavement that current lane markings designated as a shoulder. However, the existing markings will still be sufficient for the driver to navigate the vehicle to execute valid test runs.

This document will, at times, refer to lane numbers when describing the test procedure. The lanes referred to are indicated on the image below for reference.

For some tests, it is desirable to have an approach designated as left turn only or right turn only. For these tests, it was decided to use different GID representations of the same fundamental intersection.

The same road pavement and intersection survey points were used; however, they were represented in the GID in different ways.

It was found during preliminary testing that the location of lane edges, as defined by the GID used for the VTTI Smart Road Testing Facility in Blacksburg, VA, can non-negligibly differ from the location of actually painted lane markings. This was found from comparison of vehicle position data reported relative to the GID defined lanes, vehicle video data, and visual observations and manual measurements of vehicle location relative to the actually painted lane markings. The difference between the visually observed lane edge and the lane edge derived from GID maps by the CICAS-V system was found to be in the order of 0.5 m. There were similar differences in flag placement and the distance to stop bar. Correct operation of the CICAS-V system as judged by accurate DGPS distance measurements and recordings of all warning modalities, despite of these GID inaccuracies, is still possible, and would be a sign of system robustness. This is because incorrect operation with respect to lateral positioning would manifest itself with missing or inappropriate warnings while the correctness of timing and location of the desired warnings is defined by, and can be verified by, the longitudinal distance. However, because of these inaccuracies, GID positional data should not be used in determining pass/fail results. All references to lateral distance to lane marking are approximate distances that cannot be verified by examining the data. Longitudinal distances from the stop bar generated by CICAS-V and DGPS will be used to verify correct system operation and warning distance validity. The longitudinal offset between the actual distance to the stop bar and the CICAS-V measured distance was not calculated or known. Based on the GPS error ellipse data, this offset was smaller than 0.5 m.

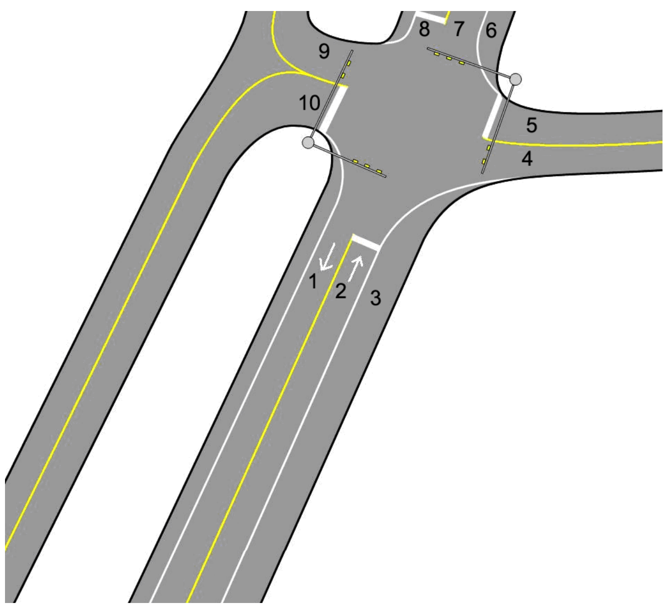

Figure 3 – VTTI Example Implementation Lane Number References

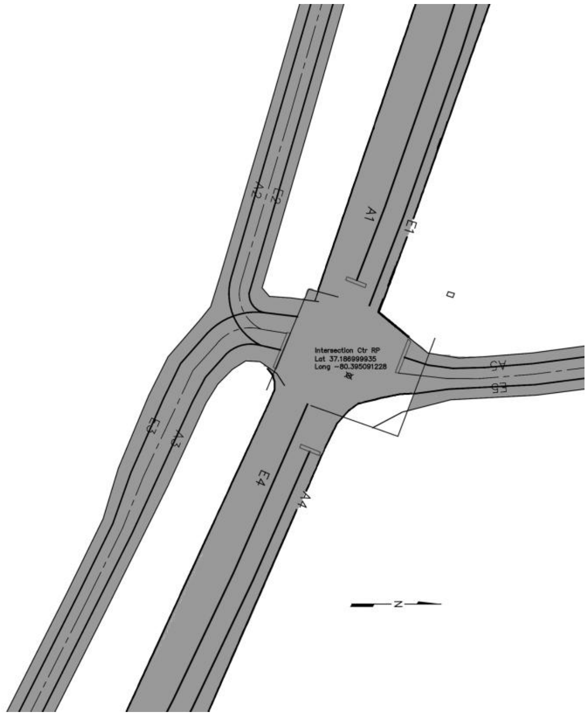

Figure 4 -- VTTI Example Implementation Small Scale Image

2.2.2.2 Example Implementation GID #1, Two Way Traffic with Left Turn Lane GID

For two way traffic with a left turn lane, a separate GID will be used.

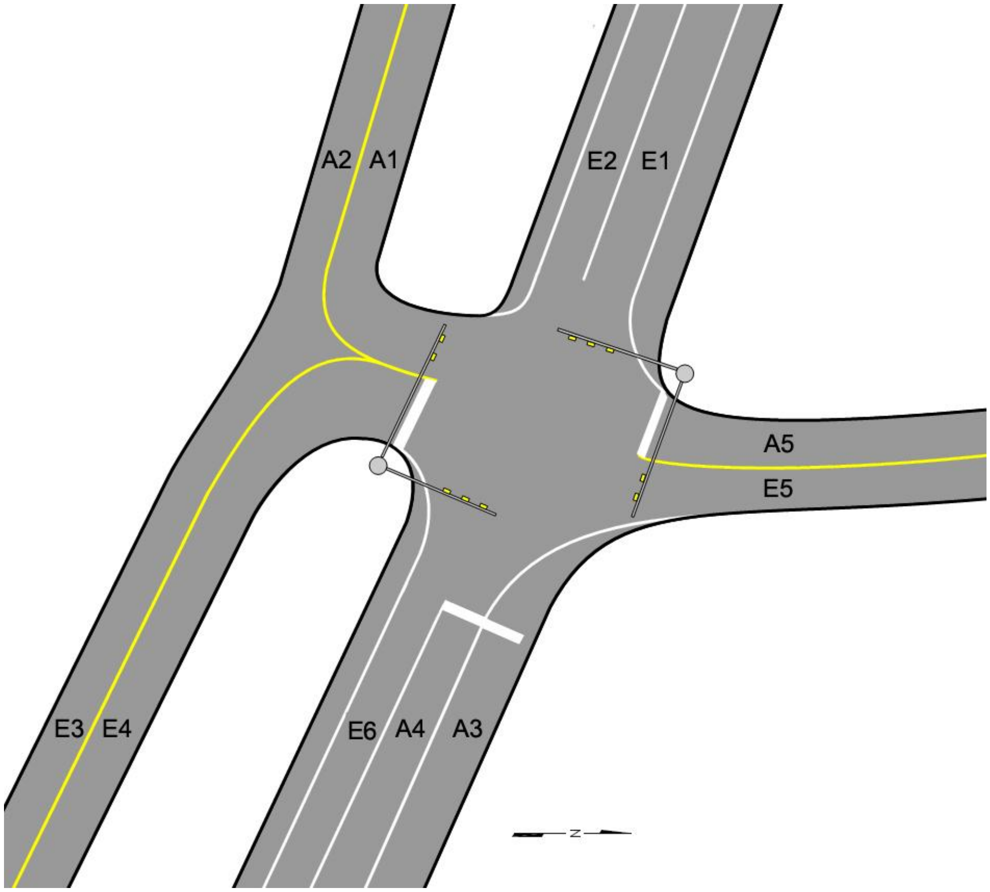

Figure 5 – GID with Two Way Traffic with Left Turn Lane

The GID described in

Figure 5 will be used for tests that require a left turn. Lane A4 will represent a left turn lane, lane A3 will represent a through lane, and lane E6 will represent oncoming traffic. No oncoming traffic will be allowed in this configuration.

Note: current pavement markings at the VTTI Smart Road are not as shown in

Figure 5.

2.2.2.3 Example Implementation GID #2, Three Lanes in Same Direction

This GID represents three traffic lanes without a left turn lane.

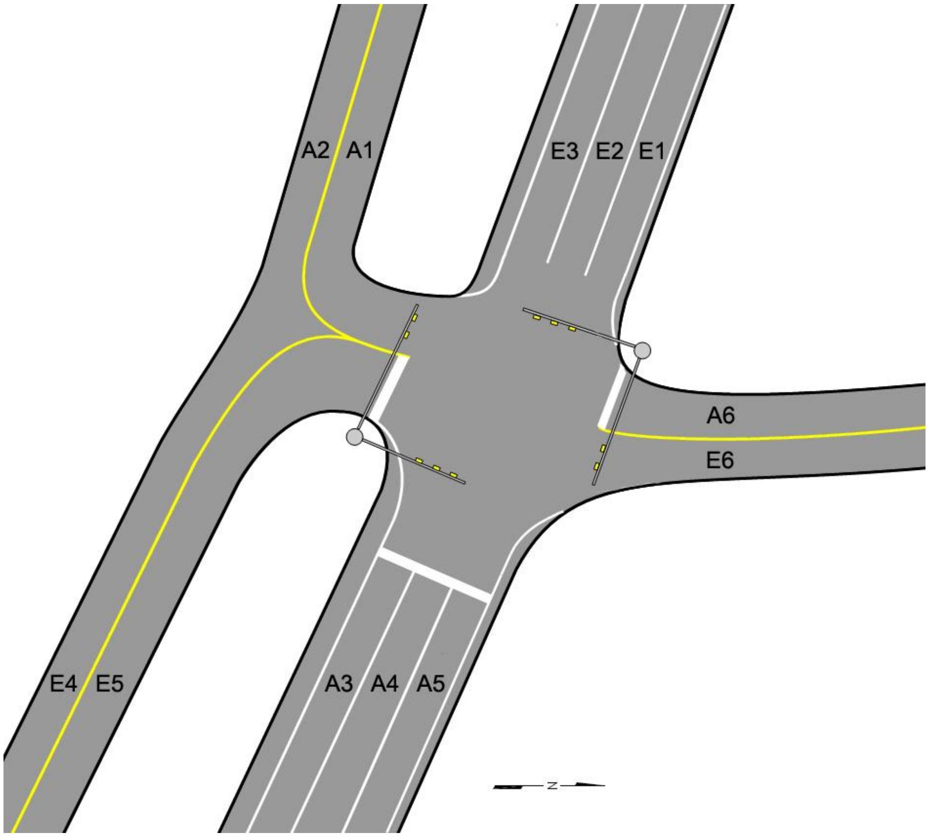

Figure 6 -- GID with Three lanes in the same direction.

As shown in Figure 6, approaches A3, A4, and A5 will represent straight ahead approaches. This GID configuration will be the main test configuration. No oncoming traffic will be allowed in this configuration.

Note: current pavement markings at the VTTI Smart Road are not as shown in Figure 6.

2.2.2.4 Example Implementation GID #3, Alternate Intersection GID

In preceding examples, only a single intersection GID was reported to be within 300m of the vehicle. For this example, a second intersection GID will be reported 250m away from the main intersection center point, and along the path through the main intersection.

It is not required that roads be at the alternate intersection location, just that an intersection is reported in the area GID. However, in the VTTI example implementation, the alternate intersection location is road accessible.

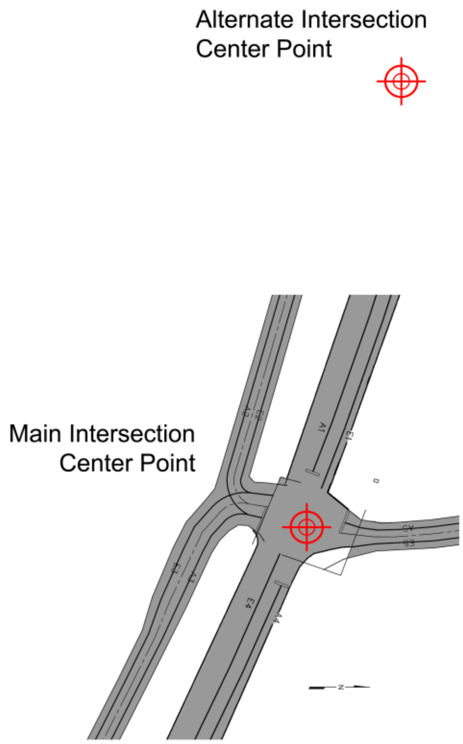

Figure 7 – GID with Area Alternate Intersection

An example of the test setup described in this section 2.1 of this document has been installed at VTTI's Smart Road facility. However, the tests designated in this document could be conducted at a facility similar to the VTTI Smart Road where access can be limited to test vehicles only.

An example of this configuration is shown in Figure 8.

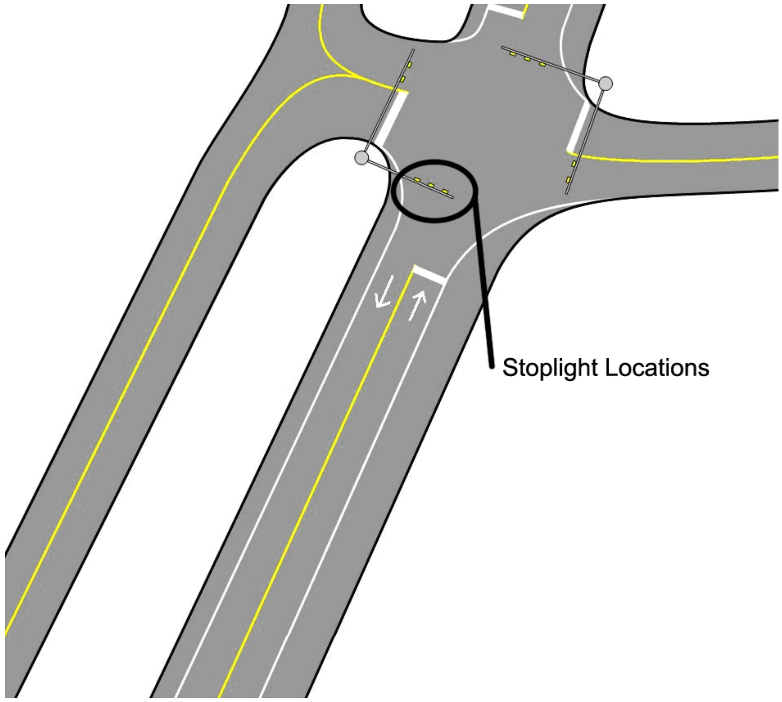

Figure 8 – Location of Intersection Signal Crossbar

2.2.3 Example of the Required Infrastructure for Test

2.2.3.1 Signalized Intersection

The following infrastructure will be put in place at VTTI for objective tests to be conducted:

1. Intersection with traffic controller
2. CICAS-V RSE transmitting SPAT message
3. CICAS-V RSE transmitting DGPS Corrections message
4. CICAS-V RSE transmitting intersection GID message
5. L1/L2 real time GPS correction base station and transmission radio to serve as a high accuracy test ranging system

2.2.3.2 Stop Sign Intersection

An example of a stop sign intersection test setup described in this section 2.1 of this document has been implemented at VTTI's Smart Road facility.

An example of this configuration is shown in Figure 9.

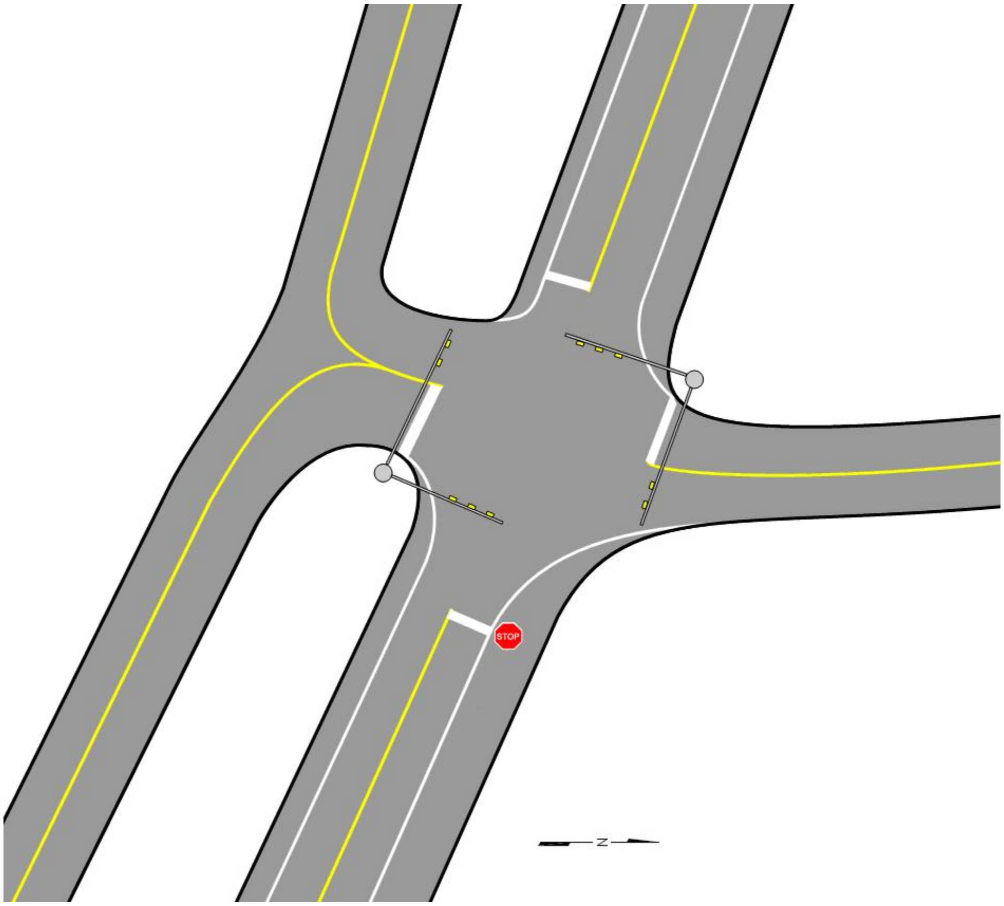

Figure 9 – Location of Intersection Stop Sign

In addition the following infrastructure is also in place for conducting tests:

- Vehicle equipped with an OBE running CICAS-V software and equipped with all three warning modalities.
- L1/L2 real time GPS correction base station and transmission radio for data recording

2.2.3.3 GID and Test Scenario Assignments

Table 5 -- SPaT and GIDs Used in Example Roadway Configuration

Test Scenario		GID Used	SPaT Used	Lane/Road Level GPS	Comment
Name	**Sect.**				
Signalized Various Speed Approaches Test	3.2	GID #2, Three Lanes in Same Direction	Fixed Red for All Approaches	Road	Warning Test
Edge of Approach Testing for Warning	3.3	GID #2, Three Lanes in Same Direction	Fixed Red and Green States	Lane	Warning Test
Edge of Approach Testing for Nuisance Warning	3.4	GID #2, Three Lanes in Same Direction	Fixed Red and Green States	Lane	Nuisance Test
Late Lane Shift Test - Warning	3.5	GID #1, Two Way Traffic with Left Turn Lane GID	Fixed Red and Green States	Lane	Warning Test
Late Lane Shift Test – Nuisance Warning	3.6	GID #1, Two Way Traffic with Left Turn Lane GID	Fixed Red and Green States	Lane	Nuisance Test
Multiple Intersections within 300m Radius: Warning Case	3.7	GID #2, Three Lanes in Same Direction, Main GID; GID #3, Alternate Intersection GID	Fixed Red For All Approaches for Main and Alternate Intersection	Road	Warning Test
Multiple Intersections within 300m Radius: No Warning Case	3.8	GID #2, Three Lanes in Same Direction, Main GID; GID #3, Alternate Intersection GID	Fixed Green for Main, Fixed Red for Alternate Intersection	Road	Nuisance Test
Dynamic Signal Change to Yellow, Too Late to Warn	3.9	GID #2, Three Lanes in Same Direction	Dynamic States Triggered by Vehicle Position	Road	Nuisance Test
Dynamic Signal to Red, In Time for Warning	3.10	GID #2, Three Lanes in Same Direction	Dynamic States Triggered by Vehicle Position	Road	Warning Test
Dynamic Signal to Green, No Warning Case	3.11	GID #2, Three Lanes in Same Direction	Dynamic States Triggered by Vehicle Position	Road	Nuisance Test
Stop Sign Various Approach Speeds Test	4	GID #2, Three Lanes in Same Direction	No SPaT used, stop sign test	Road	Warning Tests
SPaT Reflection and Reception	3.12	GID #1, Two Way Traffic with Left Turn Lane GID	Fixed Red and Green States	Road	Engineering Test

2.2.3.4 Example of Public Access Infrastructure Setup for Testing

Only test procedures that are scripted to end in a non-warning to the driver may be conducted on public roads.

Seven intersections have been prepared as examples of signalized public access infrastructure. These are as follows:

- 10 Mile Rd and Orchard Lake Rd, Farmington Hills, MI
- 12 Mile Rd and Farmington Road , Farmington Hills, MI
- 5th Avenue and El Camino Rd, Redwood City, CA
- N Franklin St and Depot St, Christiansburg, VA
- N Franklin St and Independence Blvd, Christiansburg, VA
- N Franklin St and Peppers Ferry Rd, Christiansburg, VA

2.3 Driving Instructions

2.3.1 Acceleration and Braking Instructions

The driver conducting tests can select the rate of acceleration that allows the tests to be conducted in safety. Speeds that the driver must maintain are indicated in the individual test descriptions below and allowable tolerances are indicated. Whenever feasible the driver will use cruise control to assist in achieving the test target speed.

Once the driver is within 300m of the reference point, as indicated by the test course flags, the driver cannot touch the vehicle brake. If the driver touches the brake pedal after flags indicated being within 300m of the intersection, the test will be considered invalid.

2.3.2 Lane Change Maneuver Instructions

For individual tests that require a lane change maneuver, the following is defined as an acceptable lane change maneuver.

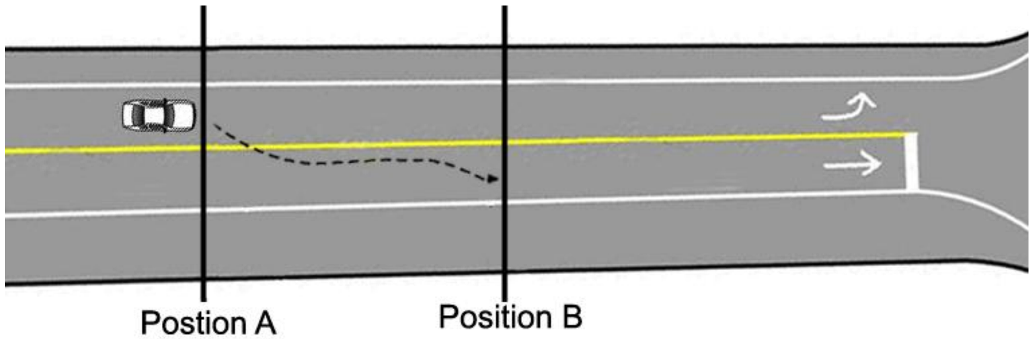

Figure 10 – Acceptable Lane Change Maneuver

Lane shift maneuvers will be conducted such that the distance from position A to position B is 62.5 m for a vehicle speed of 35 mph. This amounts to a 4 s time period for the lane change. Acceptable tolerance for this maneuver is +/- 16 m (1 sec).

The target lateral lane position is centered between the existing lane markers. The tolerance for lateral lane position is to be within 0.5 m of the lane center.

The target lane shift time from position A to position B is four seconds. The acceptable tolerance for the lane shift maneuver is +/- one second.
Lane shift maneuvers may vary depending on the test facility at which these tests are conducted.

3 Test Procedures, Signalized Intersections

3.1 Test assumptions for Signalized Intersections

For CICAS-V testing of signalized intersections, the following statements are assumed to be true for all tests:

- That the driver will be able to respond within the amount of time given by the warning time selected by VTTI. This assumption was tested as part of Task 3 – Human Factor Studies.
- That the vehicle will reliably receive the SPAT message with sufficient time to warn the driver. This assumption will be tested as part of this test; however, additional testing will be conducted as part of the wireless reliability testing as part of Task 10 – Subsystem Testing.
- That GPS performance will meet expected standard performance

In addition to these assumptions, each individual test has assumptions for the given test.

While an RSE transmitting a GID is required, it is not required that the OBE download a new GID for each test run. For the tests described in 4.3 – 4.10, the GID will be preloaded before the first test run and used in all the subsequent test runs for the same test scenario. The exceptions are the high speed runs in sections 4.2 and 5.2 where for each run the system will receive the GID and after the run the GID will be purged from the system, and the Engineering test in section 4.11 where the GID will also be purged after each run within the scenario. This ensures that the OBE will not have a GID resident for each run, which will necessitate it obtaining the GID via transmission from the RSE.

3.2 Various Speed Approaches Test

3.2.1 Background

The operational goal of the CICAS-V as defined in the Concept of Operations is to warn a driver that he/she is about to violate a traffic control device with sufficient time to stop the vehicle.

Correspondingly, to pass this objective test, the system must warn the driver the correct distance from the stop bar as determined in Task 3 – Human Factors Studies. The proper distance from the stop bar varies based on vehicle speed. An illustration of the acceptable warning distance is shown in Figure 11. Areas marked in green are acceptable locations to receive a warning; areas marked in red are not acceptable.

In addition to warning distance accuracy, system level DSRC message reception will be tested as part of this test. It is generally regarded that GID reception at high vehicle speeds is a challenging case; therefore, reception of the GID while the vehicle is travelling at the test highest test speed will be evaluated as well.

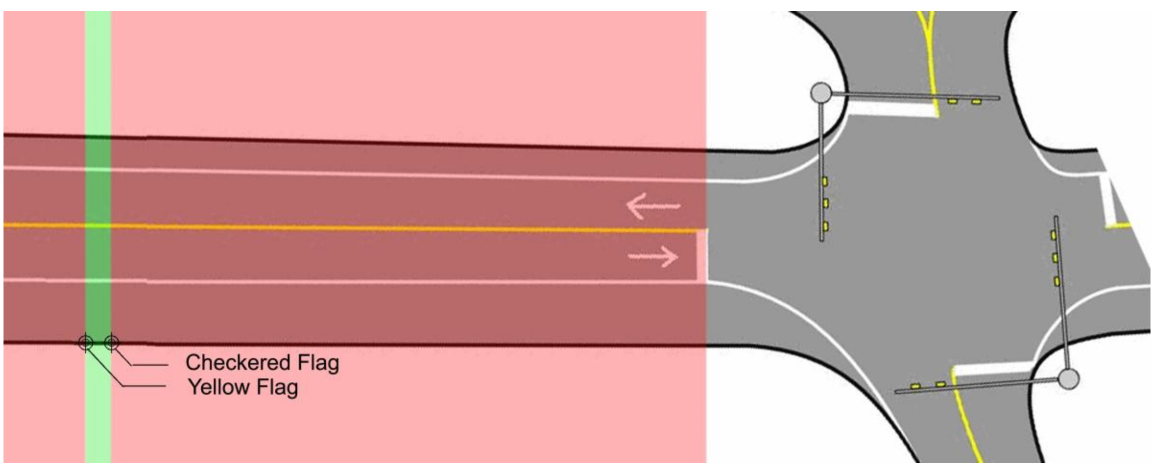

Figure 11 -- Acceptable and Unacceptable Warning Times

3.2.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

3.2.3 Test Setup

The base test configuration for this test requires the infrastructure and setup defined for signalized intersections as defined in section 2.1.

In addition the following setup needs to be achieved.

1. Flags will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their distance from the stop bar. It is assumed that flags will be placed using a L1, GPS handheld receiver. Alternate methods of flag location can be used. Flag locations are:
    a. A red flag 700m from the stop bar
    b. A green flag 300m from the stop bar
    c. A yellow flag placed at the earliest (from the driver's perspective) valid warning point
    d. A checkered flag placed at the last valid (from the driver's perspective) valid warning point
2. The three-lane GID shall be configured and transmitted from the RSE.
3. The SPaT server shall transmit red for all GID approaches.

3.2.4 Pass and Fail Definitions

The standard pass-fail criteria as defined in section 1.6 are to be used unmodified. The flags placed on test course are meant only for general testing guidance, official test results will use L1/L2 DPGS ranging information as recorded by DAS.

3.2.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	Estimated Time
Initial intersection setup (setup and teardown that is required for all objective tests)	1 hour
Various speeds setup	30 minutes
Individual Test Runs (3 minutes per run)	1.2 hours
Total	**2.7 hours**

Initial intersection setup is only required once per day; therefore if multiple tests are conducted per day, the total test time will be less than the sum of the times calculated in this section.

3.2.6 Test Script

The test will be conducted in the following manner:

1. The vehicle will receive the GID prior to moving to the starting point
2. The vehicle will begin at the red flag, in lane #2, 700m from the stop bar
3. If the test run to be conducted is at 55mph, the test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE

and reboot the OBE to standard initialized state. If the test speed is less than 55mph, the test observer will verify for the first run at each speed that the GID file 005.gid is present in the OBE subdirectory /rwflash/giddb/. The 55mph test should be conducted first to ensure that the GID is present for the first test at 35mph or 25mph.

4. The driver will begin moderate acceleration to the target test speed
5. The driver will reach the targeted speed range by the time the vehicle reaches the green flag
6. If cruise control is supported by the vehicle at the target speed, the driver will set cruise control to the middle of the target range
7. The driver will continue toward the stop bar at the target velocity
8. The test observer will note behavior of the DVI, and record state transitions from "off" to "blue" to "red"
9. The test observer will observe and record if all available warning modalities occur beyond the yellow flag but before the checkered flag
10. Should a valid warning occur, the driver will make a controlled stop of the vehicle. It is acceptable for the driver to stop before or after the stop bar.
11. Should a valid warning fail to occur, the driver will proceed to the checked flag at the test speed
12. If no warning occurs beyond the checkered flag, the driver will continue at the defined test speed until the vehicle passes the stop bar
13. Once the driver reaches the stop bar, the driver will make a controlled stop. The driver can stop at any point beyond the stop bar.

3.2.7 Tests to be Conducted

A total of twenty-four (24)-runs will be conducted for this test.

Table 6 -- Speeds at Which to Test Basic Algorithm Warning

Driver Maintained Speed (mi/hr)	Required Distance to Warn (m) depends on the warning algorithm table and precise speed	Number of Times Test Conducted
55 (+/-2.5mph)	Signal_WA_641-11.table	8
35 (+/-2.5mph)	Signal_WA_641-11.table	8
25 (+/-2.5mph)	Signal_WA_641-11.table	8

3.2.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

3.3 Edge of Approach Testing for Warning

3.3.1 Background

The purpose of the test procedures in this section is to verify that the CICAS-V system will provide appropriate warning when the vehicle is driven near the edge of a lane.

In order to conduct this test, the vehicle will be driven within 0.5 meters of the lane edge from the start of the test until the stop bar.

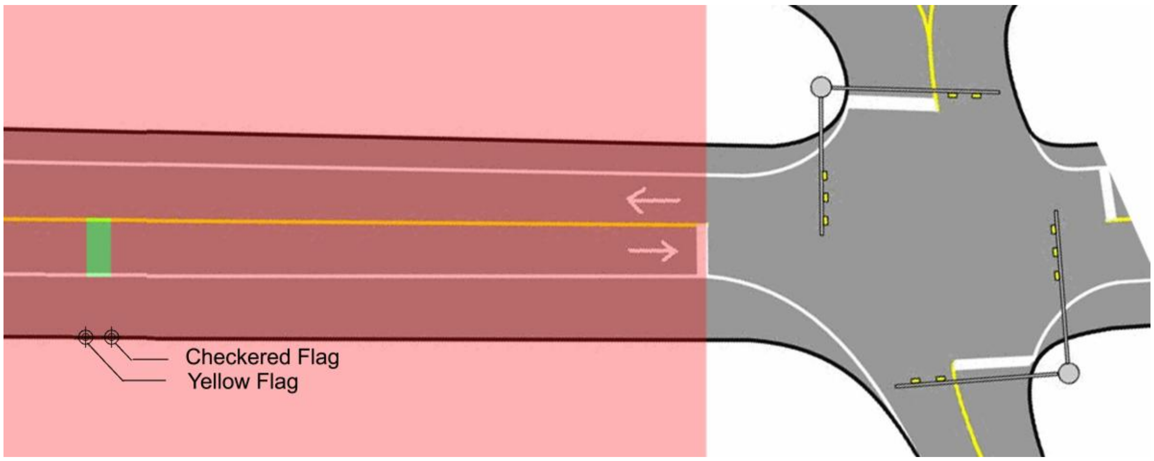

Figure 12 -- Acceptable and Unacceptable Warning Times for Edge of Lane Testing

3.3.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

3.3.3 Test Setup

The base test configuration for this test requires the infrastructure and setup defined for signalized intersections as defined in section 2.1.

In addition the following setup needs to be achieved:

1. Flags will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their distance from the stop bar. It is assumed that flags will be placed using a L1 GPS handheld receiver. Alternate methods of flag location can be used. Flag locations are:
   a. A red flag 700m from the stop bar
   b. A green flag 300m from the stop bar
   c. A yellow flag placed at the earliest (from the driver's perspective) valid warning point

   d. A checkered flag placed at the last valid (from the driver's perspective) valid warning point
2. The driver will adjust both the driver's and passenger's side-view mirrors to allow the driver to observe the vehicle's rear wheels and the lane edge
3. The three-lane GID shall be configured and transmitted from the RSE
4. The test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state
5. The test observer will confirm that the GID file 005.gid is present in the OBE subdirectory /rwflash/giddb/ after the reboot
6. The SPaT server shall be configured to transmit red for the approach of lane two. The SPaT server shall transmit green for all other approaches.

Table 7 -- SPaT Table for Edge of Approach Warning Test (See Figure 6 for Intersection Configuration)

Approach / Lane	**Fixed Value**
A3 / L1	Fixed Green
A4 / L2	Fixed Red
A5 / L3	Fixed Green
All Other Approaches	Fixed Green

3.3.4 Pass and Fail Definitions

The standard pass-fail criteria as defined in section 1.6 are to be used unmodified except that for a test run to be considered valid, the right tire must be within +/-0.25m of 0.25m left of the right lane marking paint. Therefore, the right tire of the vehicle must be between 0.0m and 0.5m left of the right lane marking paint. The flags placed on test course are meant only for general testing guidance, official test results will use L1/L2 DPGS ranging information as recorded by DAS.

3.3.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	**Estimated Time**
Initial intersection setup (setup and teardown that is required for all objective tests)	1 hour
Individual Test Runs (3 minutes per run)	24 minutes
Total	**1.4 hours**

Initial intersection setup is only required once per day; therefore if multiple tests are conducted per day, the total test time will be less than the sum of the times calculated in this section.

3.3.6 Test Script

The test will be conducted in the following manner:

1. The vehicle will receive the GID prior to moving to the starting point
2. The vehicle will begin at the red flag, in lane #2, 700m from the stop bar
3. The driver will adjust both the driver's and passenger's side-view mirrors to allow the driver to observe the vehicle's rear wheels and the right lane edge
4. The driver will begin moderate acceleration to the target test speed
5. The driver will reach the targeted speed range and position the vehicle 0.25m from the right edge of the lane by the time the vehicle reaches the green flag
6. If cruise control is supported by the vehicle at the target speed, the driver will set cruise control to the middle of the target range
7. The driver will continue toward the stop bar at the target velocity
8. The test observer will note behavior of the DVI, and record state transitions from "off" to "blue" to "red." The test observer will observe and record if all available warning modalities occur beyond the yellow flag but before the checkered flag.
9. Should a valid warning occur, the driver will make a controlled stop of the vehicle. It is acceptable for the driver to stop before or after the stop bar.
10. Should a valid warning fail to occur, the driver will proceed to the checked flag at the test speed
11. If no warning occurs beyond the checkered flag, the driver will continue at the defined test speed until the vehicle passes the stop bar
12. Once the driver reaches the stop bar, the driver will make a controlled stop. The driver can stop at any point beyond the stop bar.

3.3.7 Tests to be Conducted

Conduct this test eight (8) times at 35 ± 2.5 mph along right edge of the lane (0.25 ± 0.25 m to the left from the line on the pavement marking the lane's right edge).

Table 8 – Speeds at which to Test Edge of Lane Warnings

Driver Maintained Speed (mi/hr)	Lane Location	Required Distance to Warn (m) depends on the warning algorithm table and precise speed	Number of Times Test Conducted
35 mph (+/- 2.5mph)	Vehicle right tires approximately 0.25m (+/- 0.25m) left from right lane marker	Signal_WA_641-11.table	8

Additional Validation Criteria: The vehicle's position relative to the lane edge must be 0.25 ± 0.25 m to the left from the line on the pavement marking the lane's right edge. Since comparing the DGPS position with GID points is not reliable due to GID inaccuracy, the positioning of the vehicle is to be validated visually by the test observers.

3.3.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

3.4 Edge of Approach Testing for Nuisance Warning

3.4.1 Background

The purpose of the test procedures in this section is to verify that the CICAS-V system will not issue nuisance warnings when the vehicle is driven near the edge of a lane.

In order to conduct this test, the vehicle will be driven within 0.5 meters of the lane edge from the start of the test until the stop bar.

For this test, success is defined as not issuing a warning. As illustrated in Figure 13, if the vehicle is the center lane (lane two), it should not receive a warning.

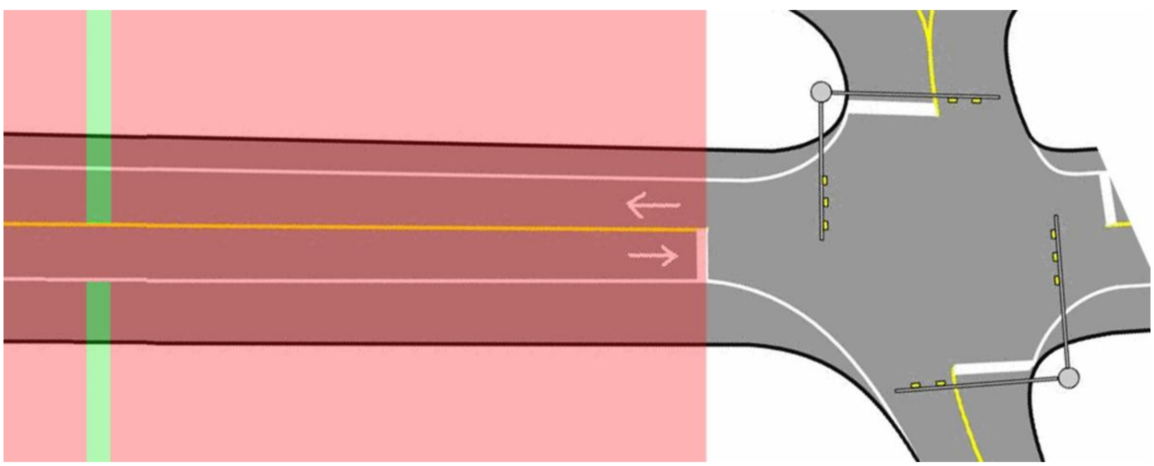

Figure 13 -- Valid Warnings for Edge of Lane Testing

3.4.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

3.4.3 Test Setup

The base test configuration for this test requires the infrastructure and setup defined for signalized intersections as defined in section 2.1.

In addition the following setup needs to be achieved.

1. Flag will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their difference from the stop bar. It is assumed that flags will be placed using a La, GOS-handheld receiver. Alternate methods of flag location can be used. Flag locations are:
   a) A red flag 700m from the stop bar
   b) A green flag 300m from the stop bar
   c) A yellow flag placed at the earliest (from the driver's perspective) valid warning point
   d) A checked flag placed at the last valid (from the driver's perspective) valid warning point
2. The driver will adjust both the driver's and passenger's side-view mirrors to allow the driver to observe the vehicle's rear wheels and the lane edge.
3. The three-lane GID shall be configured and transmitted from the RSE
4. The test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state
5. The test observer will confirm that the GID file 005.gid is present in the OBE subdirectory /rwflash/giddb/ after the reboot
6. The SPaT server shall be configured to transmit green for the approach of lane two. The SPaT server shall transmit red for all other approaches.

Table 9 -- SPaT Table for Edge of Approach Warning Test (See Figure 6 for Intersection Configuration)

Approach / Lane	Fixed Value
A3 / L1	Fixed Red
A4 / L2	Fixed Green
A5 / L3	Fixed Red
All Other Approaches	Fixed Red

3.4.4 Pass and Fail Definitions

The standard pass-fail criteria as defined in section 1.6 are to be used unmodified except that for a test run to be considered valid, the left tire must be within +/-0.25m of 0.25 m right of the left lane marking paint. Therefore, the left tire of the vehicle must be between 0.0 m and 0.5 m right of the left lane marking paint.

3.4.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	Estimated Time
Initial intersection setup (setup and teardown that is required for all objective tests)	1 hour
Individual Test Runs (3 minutes per run)	24 minutes
Total	**1.4 hours**

Initial intersection setup is only required once per day; therefore, if multiple tests are conducted per day, the total test time will be less than the sum of the times calculated in this section.

3.4.6 Test Script

The test will be conducted in the following manner:

1. The vehicle will receive the GID prior to moving to the starting point
2. The vehicle will begin at the red flag, in lane #2, 700m from the stop bar
3. The driver will adjust both the driver's and passenger's side-view mirrors to allow the driver to observe the vehicle's rear wheels and the lane edge
4. The driver will begin moderate acceleration to the target test speed
5. The driver will reach the targeted speed range and position the vehicle 0.25m from the left edge of the lane by the time the vehicle reaches the green flag
6. If cruise control is supported by the vehicle at the target speed, the driver will set cruise control to the middle of the target range
7. The driver will continue toward the stop bar at the target velocity
8. The test observer will note behavior of the DVI, and record any DVI transitions. The test observer will record any warning modalities that occur.
9. Should a warning occur, the test is complete and the driver will make a controlled stop of the vehicle and estimate the distance to the nearby lane edge
10. If no warning occurs, the driver will continue at the defined test speed until the vehicle passes the stop bar
11. Once the driver reaches the stop bar, the driver will make a controlled stop. The driver can stop at any point beyond the stop bar.

3.4.7 Tests to be Conducted

Conduct this test eight (8) times at 35 ± 2.5 mph along the left edge of the lane (0.25 ± 0.25 m to the right from the line on the pavement marking the lane's left edge).

Table 10 – Speeds at which to Test Edge of Lane Nuisance Warnings

Driver Maintained Speed (mi/hr)	Lane Location	Number of Times Test Conducted
35 mph (+/- 2.5mph)	Vehicle left tires approximately 0.25m (+/- 0.25m) right from left lane marker	8

Please note additional validation criteria: The vehicle's position relative to the lane edge must be 0.25 ± 0.25 m to the right from the line on the pavement marking the lane's left edge. Since comparing the DGPS position with GID points is not reliable due to GID inaccuracy, the positioning of the vehicle is to be validated visually by the test observers.

3.4.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

3.5 Late Lane Shift Test - Warning

3.5.1 Background

The purpose of the test procedures in this section is to verify that the CICAS-V system will provide appropriate warning when driver shifts into a lane that should receive a warning after the ideal warning distance for the new lane.

In order to test this condition, the vehicle will be driven in a lane that does not expect a warning until within the warning range. The vehicle will then change lanes into a lane that should expect a warning. The CICAS-V system should issue a warning.

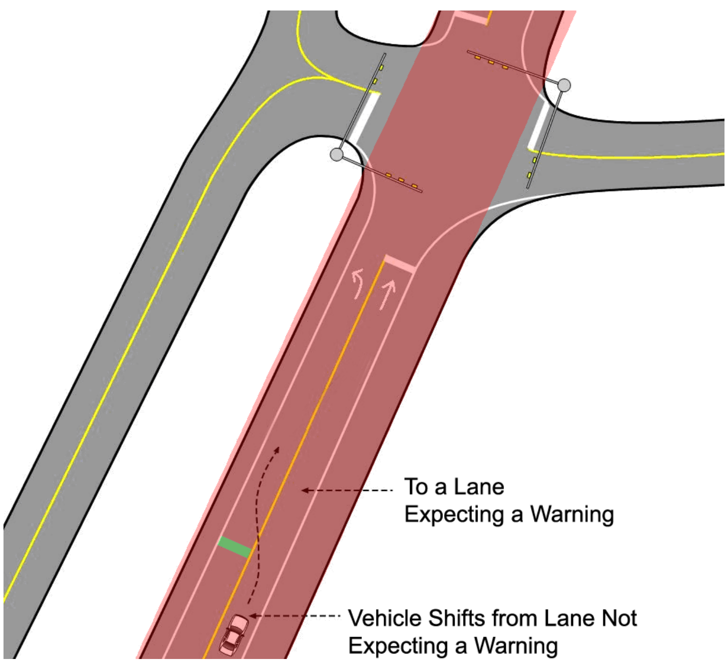

Figure 14 – Late Lane Shift Warning Test #1

3.5.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

3.5.3 Test Setup

The base test configuration for this test requires the infrastructure and setup defined for signalized intersections as defined in section 2.1.

In addition the following setup needs to be achieved.

1. Flags will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their difference from the stop bar. It is assumed that flags will be placed using a L1 GPS handheld receiver. Alternate methods of flag location can be used. Flag locations are:
   a. A red flag 700m from the stop bar
   b. A green flag 300m from the stop bar
   c. A yellow flag placed at the start of the lane change maneuver. This flag will be placed at the warning distance specified in the warning table (Signal_WA_641-11) for the speed of the test run – 1.5 sec * vehicle speed (25 m).
   d. A checkered flag placed at the end of the lane change maneuver. This flag will be placed at the warning distance specified in the warning table for the speed of the test run + 2.5 sec * vehicle speed (87 m). This allows for a 4 sec lane change maneuver.
2. The two lane GID shall be configured and transmitted from the RSE.
3. The test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state.
4. The test observer will confirm that the GID file 005.gid is present in the OBE subdirectory /rwflash/giddb/ after the reboot.
5. The SPaT server shall be configured to transmit green for the approach of lane two and lane three. The SPaT server shall transmit red for the approach of lane one.

Table 11 – SPaT Table for Late Lane Shift Warning Test

Approach/Lane	Fixed Value
A3/L1	Fixed Red
A4/L2	Fixed Green
A5/L3	Fixed Red
All Other Approaches	Fixed Red

3.5.4 Pass and Fail Definitions

The standard pass-fail criteria as defined in section 1.6 are to be used unmodified. In this test, the vehicle should receive a warning – despite having already passed the optimal warning window as defined by Task 3 – Human Factors Studies. The earlier warning should not have been issued because the driver was in a non-warning lane. However, once the driver moves the vehicle into a warning lane – a late warning should be issued up until the stop bar (see note regarding late warning CICAS-V flag).

3.5.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	**Estimated Time**
Initial intersection setup (setup and teardown that is required for all objective tests)	1 hour
Individual Test Runs (3 minutes per run)	24 min
Total	**1.4 hours**

Initial intersection setup is only required once per day; therefore, if multiple tests are conducted per day, the total test time will be less than the sum of the times calculated in this section.

3.5.6 Test Script

1. The vehicle will receive the GID prior to moving to the starting point
2. The vehicle will begin in lane #2 700m from the stop bar
3. The driver will begin moderate acceleration to the target test speed
4. The driver will meet the reach the targeted speed range by the time the vehicle reaches the green flag.
5. The driver will set cruise control to the middle of the target range
6. The driver will continue toward the stop bar at the target velocity
7. The test observer will note behavior of the DVI, and record state transitions from “off” to “blue” to “red.” The test observer will observe and record if all available warning modalities occur beyond the yellow flag but before the checkered flag.
8. The driver will begin the lane change maneuver at the yellow flag and complete the maneuver by the checkered flag.
9. The test observer will note and record any warning modalities that occur before arriving at the stop bar.
10. Should a valid warning occur, the driver will make a controlled stop at anytime.
11. Should there be no warning; the driver will proceed to the stop bar. Once past the stop bar, the driver can stop the vehicle.

3.5.7 Tests to be Conducted

Conduct this test eight (8) times at 35 miles per hour (+/-2.5mph) starting from the right lane and making shift to the left lane.

Table 12 – Speeds at which to Test Late Lane Change Warnings

Driver Maintained Speed (mi/hr)	Lane Shift Description	Required Distance to Warn (m) depends on the warning algorithm table and precise speed	Number of Times Test Conducted
35mph(+/- 2.5mph)	Vehicle shifts from lane #2 to lane #1 after the ideal warning point (see Test #1 image). A warning is expected.	Signal_WA_641-11.table	8

Note additional validation criteria: The vehicle's position relative to the lane edges and warning distances, as measured by the reference DGPS system and visual observation, must meet the test set-up conditions 1(c) and (d) from Section 3.5.3.

3.5.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

3.6 Late Lane Shift Test – Nuisance Warning

3.6.1 Background

The purpose of the test procedures in this section is to verify that the CICAS-V system will appropriately not warn when driver shifts into a new lane that should not receive a warning before the ideal warning distance for the old lane.

In order to test this condition, the vehicle will be driven in a lane that does expect a warning until within the warning range. The vehicle will then change lanes into a lane that should not expect a warning. The CICAS-V system should not issue a warning.

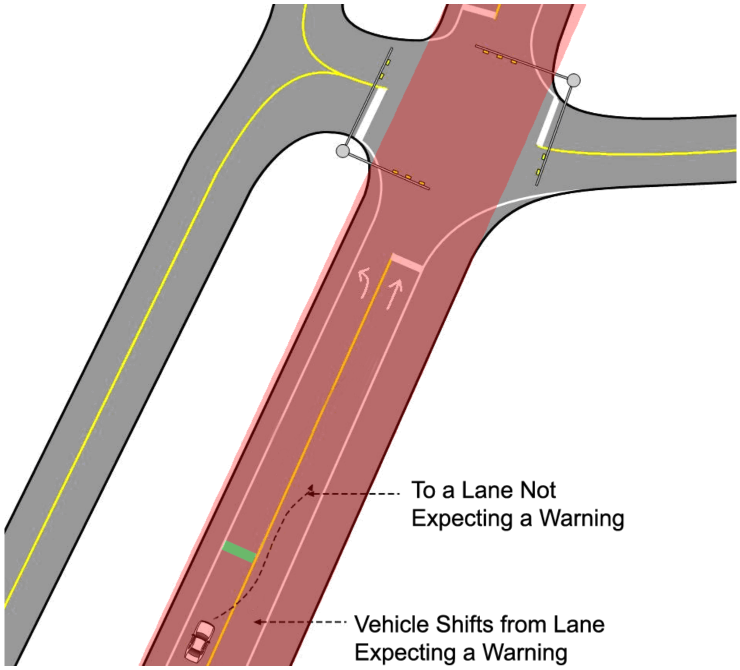

Figure 15 – Late Lane Shift Warning Test #2

3.6.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

3.6.3 Test Setup

The base test configuration for this test requires the infrastructure and setup defined for signalized intersections as defined in section 2.1.

In addition the following setup needs to be achieved:

1. Flags will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their difference from the stop bar. It is assumed that flags will be placed using a L1, GPS-handheld receiver. Alternate methods of flag location can be used. Flag locations are:
    a. A red flag 700m from the stop bar
    b. A green flag 300m from the stop bar
    c. A yellow flag placed at the start of the lane change point (70 m before the checkered flag, this allows for a 4 sec lane change maneuver)
    d. A checkered flag placed at the earliest valid (from the driver's perspective) valid warning point
2. The two lane GID shall be configured and transmitted from the RSE.
3. The test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state.

4. The test observer will confirm that the GID file 005.gid is present in the OBE subdirectory /rwflash/giddb/ after the reboot.
5. The SPaT server shall be configured to transmit green for the approach of lane two and lane three. The SPaT server shall transmit red for the approach of lane one.

Table 13 – Spat Table for Late Lane Shift Nuisance Test

Approach/Lane	Fixed Value
A3/L1	Fixed Red
A4/L2	Fixed Green
A5/L3	Fixed Red
All Other Approaches	Fixed Red

3.6.4 Pass and Fail Definitions

The standard pass-fail criteria as defined in section 1.6 are to be used unmodified. In this test, the vehicle should not receive a warning.

3.6.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	Estimated Time
Initial intersection setup (setup and teardown that is required for all objective tests)	1 hour
Individual Test Runs (3 minutes per run)	24 min
Total	**1.4 hours**

Initial intersection setup is only required once per day; therefore if multiple tests are conducted per day, the total test time will be less than the sum of the times calculated in this section.

3.6.6 Test Script

1. The vehicle will receive the GID prior to moving to the starting point
2. The vehicle will begin in lane #1 700m from the stop bar
3. The driver will begin moderate acceleration to the target test speed
4. The driver will meet the reach the targeted speed range by the time the vehicle reaches the green flag
5. The driver will set cruise control to the middle of the target range
6. The driver will continue toward the stop bar at the target velocity
7. The test observer will note behavior of the DVI and record any DVI state transitions
8. The driver will begin the lane change maneuver at the yellow flag and complete it by the checkered flag

9. The test observer will note and record any warning modalities that occur before arriving at the stop bar
10. Should a warning occur, the driver will make a controlled stop at anytime
11. Should there be no warning; the driver will proceed past the stop bar. Once past the stop bar, the driver can stop the vehicle.

3.6.7 Tests to be Conducted

Conduct this test eight (8) times at 35 miles per hour (+/-2.5mph) starting from the left lane and making shift to the right lane.

Table 14 – Speeds at which to Test Late Lane Change Warnings

Driver Maintained Speed (mi/hr)	Lane Shift Description	Number of Times Test Conducted
35 mph (+/- 2.5mph)	Vehicle shifts from lane #1 to lane #2 before the ideal warning point (see Test #2 image). A warning is not expected.	8

Note additional validation criteria: The vehicle's position relative to the lane edges and warning distances, as measured by the reference DGPS system, must meet the test set-up conditions 1(c) and (d) from Section 3.6.3.

3.6.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

3.7 Multiple Intersections within 300m Radius: Warning Case

3.7.1 Background

Identifying an intersection that is approaching is the subject of previous DOT research projects such as the Event Horizon project. Therefore, research efforts to identify the next approaching intersection was limited. However, for an FOT to be effective, a minimum level of intersection identification performance must be achieved. The goal of this objective test is to test for this level of performance. This will be accomplished by creating a second intersection (called "alternate intersection" for this test) with a GID and SPaT server some distance from a real test intersection. There does not need to be a road infrastructure for the "second" intersection.

There are two tests of system behavior while in vicinity of multiple intersections. This test (Section 3.7), when it passes, demonstrates that the warning is received appropriately in vicinity of another intersection. For this, the main intersection is configured to transmit red for all approaches. The alternate intersection equipment is technically limited to sending red to all approaches. This test, when successful, shows that the system still identifies the geometry of the appropriate intersection, by giving warning within the expected distance window, despite simultaneously receiving the information from the alternate intersection.

The second test of multiple intersections, see Section 3.8, demonstrates that the different signal phase state and timing of one intersection does not interfere with that of another, when it passes.

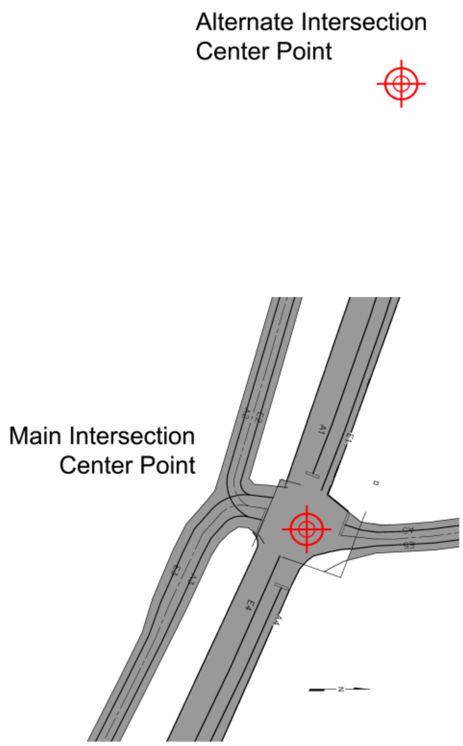

Figure 16 -- Two Intersection GIDs in Close Proximity

3.7.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

3.7.3 Test Setup

The base test configuration for this test requires the infrastructure and setup defined for signalized intersections as defined in section 2.1.

1. Flags will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their distance from the stop bar. It is assumed that flags will be placed using a L1, GPS-handheld receiver. Alternate methods of flag location can be used. Flag locations are:

    a. A red flag 700m from the stop bar
    b. A green flag 300m from the stop bar
    c. A yellow flag placed at the earliest (from the driver's perspective) valid warning point
    d. A checkered flag placed at the last valid (from the driver's perspective) valid warning point.
2. The three lane GID shall be configured and transmitted from the RSE for the actual intersection.
3. The two lane GID shall be configured and transmitted from the RSE for the alternate intersection. A vehicle can be used to emulate the infrastructure of a DGPS base station and RSE. The vehicle can provide power to the WSU for transmissions as well as provide a ground plane for the DSRC antenna.
4. The center of the alternate intersection (GID reference point) should be inline with the vehicles intended direction of travel, but further from the vehicle start point than the test intersection. The GID transmitted for the alternate intersection should not overlap the actual intersection lanes.
5. DGPS corrections need not be valid. Therefore a surveyed reference point is not needed.
6. The SPaT server for the actual intersection shall be configured to transmit red for all GID approaches.
7. The SPaT server for the alternate intersection GID shall be configured to transmit red for all GID approaches
8. A PC equipped to monitor DSRC reception will be located before the earliest (from the driver's perspective) valid warning point

Table 15 – SpaT Table for Multiple Intersection Warning

Approach/Lane	Fixed Value
A3/L1	Fixed Red
A4/L2	Fixed Red
A5/L3	Fixed Red
All Other Approaches	Fixed Red

Note: This table applies to both the primary intersection and the alternate intersection.

3.7.4 Pass and Fail Definitions

The standard pass-fail criteria as defined in section 1.6 are to be used unmodified. The flags placed on test course are meant only for general testing guidance. Official test results will use L1/L2 DPGS ranging information as recorded by DAS.

3.7.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	Estimated Time
Initial intersection setup (setup and teardown that is required for all objective tests)	2 hours
Individual Test Runs (3 minutes per run)	24 minutes
Total	**2.4 hours**

Initial intersection setup is only required once per day. Therefore, if multiple tests are conducted per day, the total test time will be less than the sum of the times calculated in this section.

3.7.6 Test Script

The test will be conducted in the following manner:

1. The vehicle will receive the GID prior to moving to the starting point
2. The vehicle will begin at the red flag, in lane #2, 700m from the stop bar
3. The GIDs will be preloaded for this test
4. The driver will begin moderate acceleration to the target test speed
5. The driver will reach the targeted speed range by the time the vehicle reaches the green flag
6. If cruise control is supported by the vehicle at the target speed, the driver will set cruise control to the middle of the target range
7. The driver will continue toward the stop bar at the target velocity
8. The test observer will note behavior of the DVI, and record state transitions from “off” to “blue” to “red.” The test observer will record any warning modalities that occur.
9. The test observer will record if any warning modalities occur beyond the yellow flag but before the checkered flag.
10. A test observer will use a PC equipped for DSRC reception, and located before the earliest (from the driver’s perspective) valid warning point, to monitor the percentage of packets that are coming from the alternate intersection. If there are no packets from the alternate intersection, then this test observer will pronounce the run as invalid and request another run in its place.
11. Should a valid warning occur, the driver will make a controlled stop of the vehicle. It is acceptable for the driver to stop before or after the stop bar. This is the expected outcome.
12. Should a warning not occur, the driver will proceed to the checked flag at the test speed
13. If no warning occurs beyond the checkered flag, the driver will continue at the defined test speed until the vehicle passes the stop bar. This outcome fails this test.
14. Once the driver reaches the stop bar, the driver will make a controlled stop. The driver can stop at any point beyond the stop bar.
15. If warning is received the test is successful

3.7.7 Tests to be Conducted

Conduct this test eight (8) times at 35 miles per hour (+/-2.5mph).

Table 16 – Speeds at which to Test Multiple GIDs within 300m

Driver Maintained Speed (mi/hr)	Required Distance to Warn (m)	Number of Times Test Conducted
35mph (+/-2.5 mph)	Signal_WA_641-11.table	8

Note additional validation criteria: the alternate SPaT and alternate GID have to be received before the vehicle enters the warning zone for that speed. The SPaT presence will be verified by a PC located before the earliest (from the driver's perspective) valid warning point equipped with a packet sniffer. The GID presence will be verified by its presence in the OBE GID database.

3.7.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

3.8 Multiple Intersections within 300m Radius: No Warning Case

3.8.1 Background

This is the second multiple intersections test. It continues the mission of Section 3.7.

The main intersection phasing is all green for this test, while the alternate intersection remains at all red. This test, when successful, shows that the red phasing of the alternate intersection does not cause a warning in the green main intersection, further demonstrating that the system identified the correct intersection.

3.8.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

3.8.3 Test Setup

The base test configuration for this test requires the infrastructure and setup defined for signalized intersections as defined in section 2.1.

1. Flags will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their distance from the stop bar. It is assumed that flags will be placed using a L1, GPS-handheld receiver. Alternate methods of flag location can be used. Flag locations are:
    a. A red flag 700m from the stop bar
    b. A green flag 300m from the stop bar
    c. A yellow flag placed at the earliest (from the driver's perspective) valid warning point

d. A checkered flag placed at the last valid (from the driver's perspective) valid warning point

2. The three lane GID shall be configured and transmitted from the RSE for the actual intersection
3. The two lane GID shall be configured and transmitted from the RSE for the alternate intersection. A vehicle can be used to emulate the infrastructure of a DGPS base station and RSE. The vehicle can provide power to the WSU for transmissions as well as provide a ground plane for the DSRC antenna.
4. The center of the alternate intersection (GID reference point) should be inline with the vehicles intended direction of travel, but further from the vehicle start point than the test intersection. The GID transmitted for the alternate intersection should not overlap the actual intersections lanes.
5. DGPS corrections need not be valid. Therefore, a surveyed reference point is not needed.
6. The SPaT server for the actual intersection shall be configured to transmit green for all GID approaches.
7. The SPaT server for the alternate intersection GID shall be configured to transmit red for all GID approaches.
8. A PC equipped to monitor DSRC reception will be located before the earliest (from the driver's perspective) valid warning point

Table 17 - SPaT Table for Multiple Intersection No Warning Test

Approach/Lane	**Fixed Value**
A3/L1	Fixed Green
A4/L2	Fixed Green
A5/L3	Fixed Green
All Other Approaches	Fixed Green
Secondary Intersection	
Approach/Lane	**Fixed Value**
A3/L1	Fixed Red
A4/L2	Fixed Red
A5/L3	Fixed Red
All Other Approaches	Fixed Red

3.8.4 Pass and Fail Definitions

The standard pass-fail criteria as defined in section 1.6 are to be used unmodified. The flags placed on test course are meant only for general testing guidance. Official test results will use L1/L2 DPGS ranging information as recorded by DAS.

3.8.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	**Estimated Time**
Initial intersection setup (setup and teardown that is required for all objective tests)	1 hour
Individual Test Runs (3 minutes per run)	24 minutes
Total	**1.4 hours**

Initial intersection setup is only required once per day. Therefore. if multiple tests are conducted per day, the total test time will be less than the sum of the times calculated in this section.

3.8.6 Test Script

The test will be conducted in the following manner:

1. The vehicle will receive the GID prior to moving to the starting point
2. The vehicle will begin at the red flag, in lane #2, 700m from the stop bar.
3. The GIDs will be preloaded for this test
4. The driver will begin moderate acceleration to the target test speed
5. The driver will reach the targeted speed range by the time the vehicle reaches the green flag
6. If cruise control is supported by the vehicle at the target speed, the driver will set cruise control to the middle of the target range
7. The driver will continue toward the stop bar at the target velocity
8. The test observer will note behavior of the DVI, and record any DVI state transitions. The test observer will record any warning modalities that occur.
9. The test observer will record if any warning modalities occur beyond the yellow flag but before the checkered flag
10. A test observer will use a PC equipped for DSRC reception, and located before the earliest (from the driver's perspective) valid warning point, to monitor the percentage of packets that are coming from the alternate intersection. If there are no packets from the alternate intersection, then this test observer will pronounce the run as invalid and request another run in its place.
11. Should a warning occur, the driver will make a controlled stop of the vehicle. It is acceptable for the driver to stop before or after the stop bar. This outcome is a failure.

12. Should a warning not occur, the driver will proceed to the checked flag at the test speed
13. If no warning occurs beyond the checkered flag, the driver will continue at the defined test speed until the vehicle passes the stop bar. This is the expected outcome.
14. Once the driver reaches the stop bar, the driver will make a controlled stop. The driver can stop at any point beyond the stop bar.
15. If no warning is received the test is successful.

3.8.7 Tests to be Conducted

Conduct this test a total of eight (8) times at 35 miles per hour (+/-2.5mph).

Table 18 – Speeds at which to Test Multiple GIDs within 300m

Driver Maintained Speed (mi/hr)	Required Distance to Warn (m)	Number of Times Test Conducted
35mph (+/-2.5 mph)	Signal_WA_641-11.table	8

Note additional validation criteria: The alternate SPaT and alternate GID have to be received before the vehicle enters the warning zone for that speed. The SPaT presence will be verified by a PC equipped with a packet sniffer before the warning zone. The GID presence will be verified by its presence in the OBE GID database.

3.8.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

3.9 Dynamic Signal Change to Yellow, Too Late to Warn

3.9.1 Background

The purpose of the test procedures in this section is to verify that the CICAS-V system will not issue an incorrect warning when a vehicle is approaching a green light which will turn yellow by the time the driver reaches the warning distance.

To test this behavior, the vehicle approaches the intersection while the traffic control device is green. The traffic control device will be instructed to begin the yellow phase before the vehicle reaches the warning distance for the given speed. The light should be yellow until after the vehicle crosses the stop bar.

For this test, success is defined as not issuing a warning. As illustrated in Figure 17, there is no valid location for a warning.

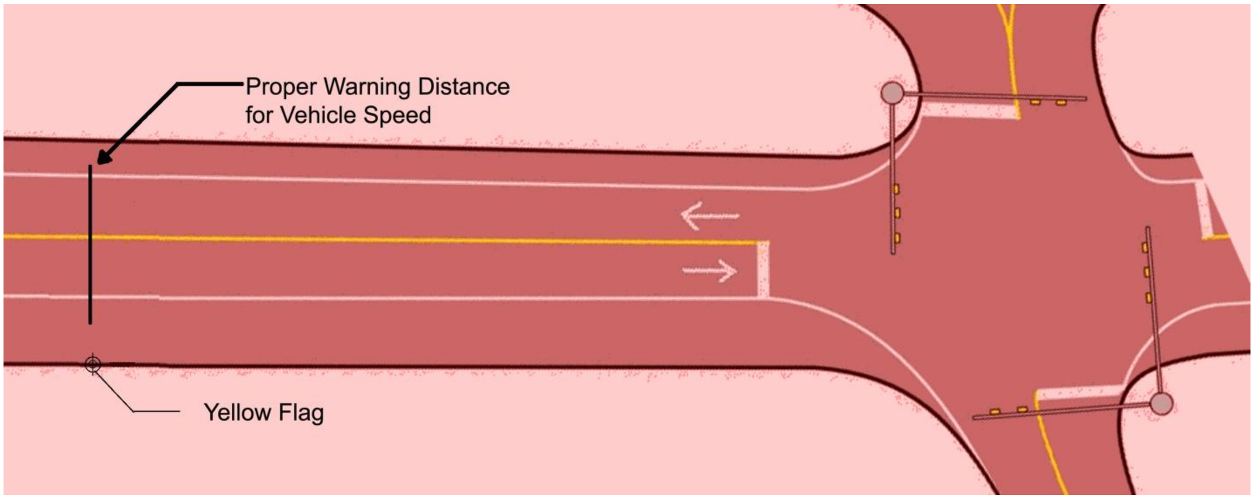

Figure 17 – Signal Change Green to Yellow, No Warning Expected

The intersection and vehicle shall be equipped with software that will trigger an intersection phase change before the proper warning distance. The traffic control device must remain in yellow stage until the vehicle clears the stop bar. This software will be configured to trigger the phase change based on vehicle's perception of time-to-intersection (TTI). In this case, the TTI trigger should account for the total latency involved in sending the command, receiving it, and implementing it by the RSE. The TTI trigger should also include a margin of safety for unknowns such as cruise control speed variability and for the vehicle to observably clear the stop bar. Accounting for latency increases the TTI trigger value while accounting for the margin of safety reduces it,compared to the yellow duration. The TTI trigger can be calculated as: TTI trigger = (yellow duration) + (latency) – (margin). Experimentally, latency was found to be 0.2 s and a comfortable margin was found to be 0.4 s (approximately a car length at the given speed). For a yellow duration of 3.6 s, this means that the TTI trigger command used by the in-vehicle light-controller device for this test should be ≤ 3.4 s for the yellow to turn to red just after the vehicle passes the intersection.This trigger TTI also satisfies the condition of the change from green to yellow being before the warning distance, since at 37.5 mph (= 60 kph = 16.7 m/s) the warning distance according to the warning table 641-11 is 46.27 m, which at that speed is 2.78 s is less than the expected change from green to yellow at 3.4 - 0.2 = 3.2 s.

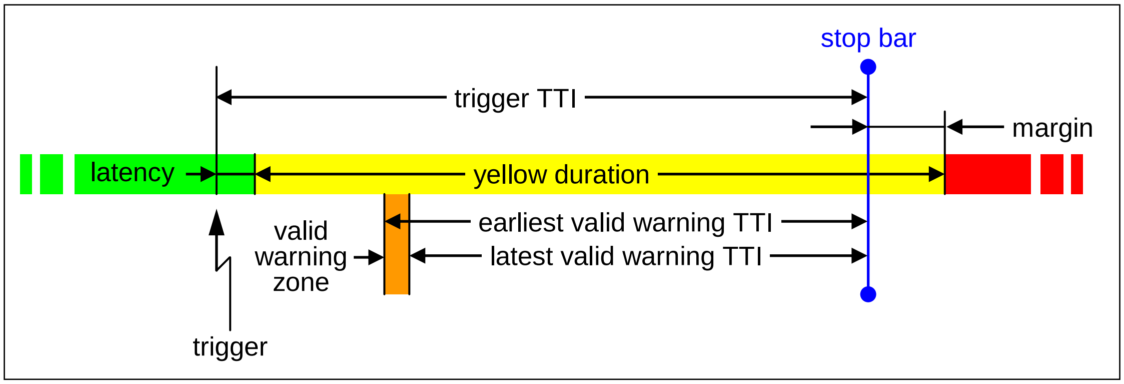

Figure 18 - Timing of Traffic Light Phase Change from Green to Yellow

3.9.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

3.9.3 Test Setup

The base test configuration for this test requires the infrastructure and setup defined for signalized intersections as defined in section 2.1.

In addition the following setup needs to be achieved:

1. Flags will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their distance from the stop bar. It is assumed that flags will be placed using a L1, GPS-handheld receiver. Alternate methods of flag location can be used. Flag locations are:
   a. A red flag 700 m from the stop bar
   b. A green flag 300 m from the stop bar
   c. A yellow flag placed at the earliest (from the driver's perspective) valid warning point
   d. A checkered flag placed at the last valid (from the driver's perspective) valid warning point
   e. A blue flag placed 60.0 m from the stop bar (based on 3.6 s yellow duration at 37.5 mph, as related to Section 3.9.1) to visualize the approximated earliest valid change from green to yellow. (The latest valid change from green to yellow is already marked by the yellow flag.)
2. The three lane GID shall be configured and transmitted from the RSE
3. The test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state
4. The test observer will confirm that the GID file 005.gid is present in the OBE subdirectory /rwflash/giddb/ after the OBE is rebooted
5. The in-vehicle signal-phase-controller software will be configured to trigger the phase change based on vehicle's perception of time-to-intersection (TTI). The phase change command triggered by software is expected to be transmitted to

RSE over radio. The trigger TTI to be used is 3.4 s, as determined in Section 3.9.1.

3.9.4 Pass and Fail Definitions

The standard pass-fail criteria as defined in section 1.6 are to be used unmodified. For this test, success is defined as not issuing a warning. Should a warning occur during this test, the test is considered to have failed. The flags placed on test course are meant only for general testing guidance, official test results will use L1/L2 DPGS ranging information as recorded by DAS.

Should the traffic signal fail to transition into the appropriate status at the expect time, the test will be considered invalid. The OBE output to the DAS will be used as the record of the signal status.

3.9.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	Estimated Time
Initial intersection setup (setup and teardown that is required for all objective tests)	1 hour
Individual Test Runs (3 minutes per run)	24 minutes
Total	**1.4 hours**

Initial intersection setup is only required once per day. Therefore, if multiple tests are conducted per day, the total test time will be less than the sum of the times calculated in this section.

3.9.6 Test Script

The test will be conducted in the following manner:

1. The vehicle will receive the GID prior to moving to the starting point
2. The vehicle will begin at the red flag, in lane #2, 700m from the stop bar
3. The test observer will ensure that in-vehicle software is configured to trigger the signal phase change at the appropriate time as detailed in Section 3.9.1
4. The driver will begin moderate acceleration to the target test speed
5. If cruise control is supported by the vehicle at the target speed, the driver will set cruise control to the middle of the target range
6. The driver will reach the targeted speed range by the time the vehicle reaches the yellow flag
7. The test observer will record if the proper traffic control device phase shift occurs
8. The test observer will note behavior of the DVI, and record any DVI state transitions. The test observer will record any warning modalities that occur.
9. Should a warning occur, the test is complete and the driver will make a controlled stop of the vehicle and estimate the distance to the stop bar

10. If no warning occurs, the driver will continue at the defined test speed until the vehicle passes the stop bar
11. Once the driver reaches the stop bar, the driver will make a controlled stop. The driver can stop at any point beyond the stop bar

3.9.7 Tests to be Conducted

Conduct this test eight (8) times at 35 miles per hour (+/- 2.5mph).

Table 19 – Speed at which to Test Dynamic Signal to Red

Driver Maintained Speed (mi/hr)	Required TTI Trigger (s) for Phase Change from Green to Yellow	Number of Times Test Conducted
35mph (+/- 2.5 mph)	2.78 s < trigger TTI ≤ 3.4 s	8

Note additional validation criteria: time to intersection (TTI) at the change of phase from green to yellow and TTI at the change of phase from yellow to red. A necessary condition for runs in this test to be valid is that the change of phase from green to yellow occurs before the earliest acceptable warning distance for the given speed. For the speed of 37.5 mph and warning table 641-11, this occurs at TTI of 2.78 s. Another necessary condition for runs in this test to be valid is that the measured time to intersection (TTI) when the phase changes from green to yellow must be less than measured duration of yellow phase to ensure passing the stop bar still under yellow. As determined earlier (Section 3.9.1), to achieve this, the trigger TTI used by the in-vehicle light-controller device is to be ≤ 3.4 s for this test.

3.9.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

3.10 Dynamic Signal to Red, In Time for Warning

3.10.1 Background

The purpose of the test procedures in this section is to verify that the CICAS-V system will issue a warning when a traffic control device changes to the red state prior to the vehicle reaching the stop bar.

To test this behavior, the vehicle begins approaching the intersection while the traffic control device is green. The traffic control device will be instructed to change to the yellow phase while the vehicle approaches the intersection. Finally, prior to the vehicle reaching the stop bar, the traffic control device will change to the red state.

For this test, success is defined as issuing a warning. As illustrated in Figure 19, the warning should be issued at the appropriate distance for the observed vehicle speed.

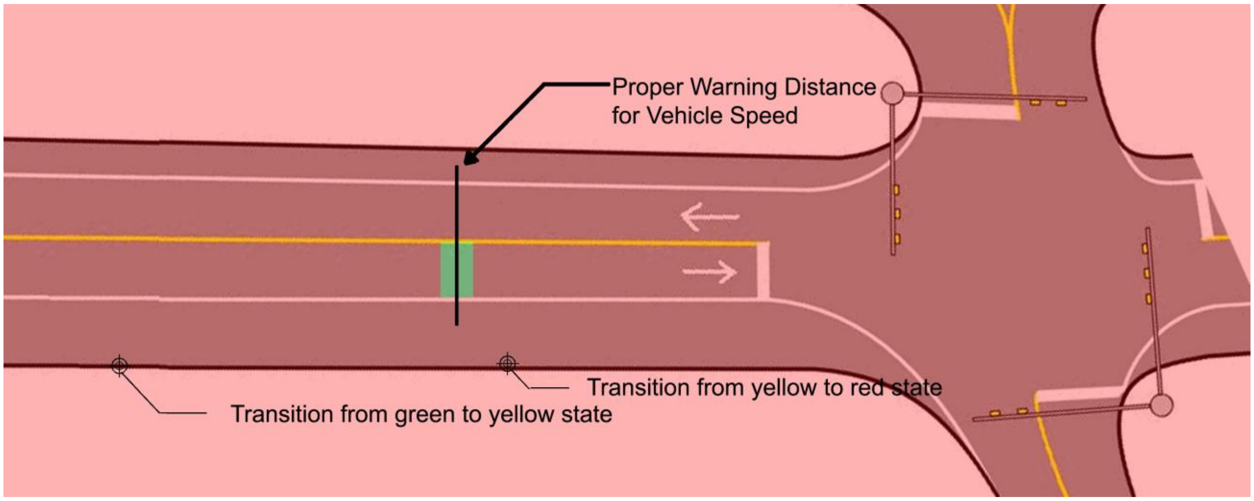

Figure 19 -- Valid Warnings for Dynamic Change to Red, Warning Expected

The intersection and vehicle shall be equipped with software that will trigger an intersection phase change from green to prior to the warning distance defined in the warning algorithm table. The light should change to red before the vehicle reaches the stop bar. In addition, it is required that the traffic control device remains in the red state until the vehicle reaches to stop bar. This software will be configured to trigger the phase change based on vehicle's perception of time-to-intersection (TTI). In this case, the TTI trigger should account for the total latency involved in sending the command, receiving it, and implementing it by the RSE. The TTI trigger should also include a margin of safety for unknowns such as cruise control speed variability and for the light to change to red while the vehicle is still observably before the stop bar. Accounting for the latency and margin in this case increases the TTI trigger value compared to the yellow duration. The TTI trigger can then be calculated as: TTI trigger = (latency) + (yellow duration) + (margin). Experimentally, latency was found to be 0.2 s and a comfortable margin was found to be 0.2 s (approximately a car length at the given speed). For a yellow duration of 3.6, this means that the TTI trigger command used by the in-vehicle light-controller device, for this test, where the yellow is to turn to red just before the vehicle reaches the stop bar, is to be ≥ 4.0 s. In order to ensure that the light change from yellow to red occurs after the latest valid warning TTI, the trigger TTI should be less than ((latest valid warning TTI) + (yellow duration)) which is equal to ((641-11 warning distance at 32.5 mph)/(32.5 mph) + (yellow duration)). Since 32.5 mph = 52 kph = 14.52 m/s, this becomes ((641-11 warning distance at 52 kph)/(14.52 m/s) + 3.6 s) = ((34.57 m)/ (14.52 m/s) + 3.6 s) = (2.4 s + 3.6 s) = 6.0 s. Putting those together gives 4.0 s ≤ trigger TTI < 6.0 s.

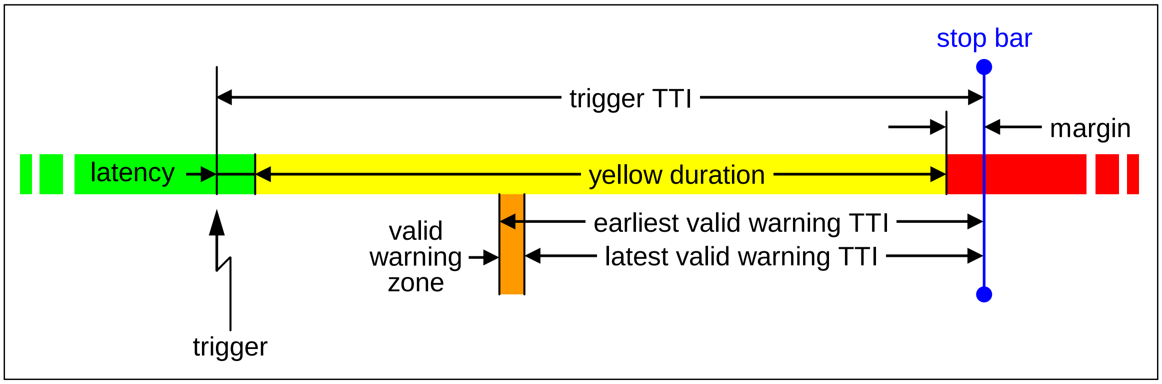

Figure 20 - Timing of Traffic Light Phase Change from Green to Red

3.10.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

3.10.3 Test Setup

The base test configuration for this test requires the infrastructure and setup defined for signalized intersections as defined in section 2.1.

In addition the following setup needs to be achieved:

1. Flags will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their distance from the stop bar. It is assumed that flags will be placed using a L1, GPS-handheld receiver. Alternate methods of flag location can be used. Flag locations are:
    a. A red flag 700m from the stop bar
    b. A green flag 300m from the stop bar
    c. A yellow flag placed at the earliest (from the driver's perspective) valid warning point
    d. A checkered flag placed at the last valid (from the driver's perspective) valid warning point
    e. A blue flag placed at the 100 m away from the stop bar (based on 6.0 s TTI at 37.5 mph, as related to Section 3.10.1) to visualize the approximated earliest valid change from green to yellow, for the yellow duration of 3.6 s
    f. A black flag placed at the 55.2 m away from the stop bar (based on 4.0 s minus latency of 0.2 s which is 3.8 s TTI, at 32.5 mph, as related to Section 3.10.1) to visualize the approximated latest valid change from green to yellow, for the yellow duration of 3.6 s
2. The three lane GID shall be configured and transmitted from the RSE
3. The test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state
4. The test observer will confirm that the GID file 005.gid is present in the OBE subdirectory /rwflash/giddb/ after the OBE is rebooted

5. The in-vehicle signal-phase-controller software will be configured to trigger the phase change based on vehicle's perception of time-to-intersection (TTI). The phase change command triggered by software is expected to be transmitted to RSE over radio. The trigger TTI to be used is 4.0 s, as determined in Section 3.10.1.

3.10.4 Pass and Fail Definitions

The standard pass-fail criteria as defined in section 1.6 are to be used unmodified. The flags placed on test course are meant only for general testing guidance. Official test results will use L1/L2 DPGS ranging information as recorded by DAS.

Should the traffic signal fail to transition into the appropriate status at the expect time, the test will be considered invalid. The OBE output to the DAS will be used as the record of the signal status.

3.10.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	Estimated Time
Initial intersection setup (setup and teardown that is required for all objective tests)	1 hour
Individual Test Runs (3 minutes per run)	24 minutes
Total	**1.4 hours**

Initial intersection setup is only required once per day. Therefore, if multiple tests are conducted per day, the total test time will be less than the sum of the times calculated in this section.

3.10.6 Test Script

The test will be conducted in the following manner:

1. The vehicle will receive the GID prior to moving to the starting point
2. The vehicle will begin at the red flag, in lane #2, 700m from the stop bar
3. The test observer will ensure that in-vehicle software is configured to trigger the signal phase change at the appropriate time as detailed in Section 3.10.1
4. The driver will begin moderate acceleration to the target test speed
5. If cruise control is supported by the vehicle at the target speed, the driver will set cruise control to the middle of the target range
6. The driver will continue toward the stop bar at the target velocity
7. The test observer will observe that the traffic control device changes state from green to yellow to red
8. The test observer will note behavior of the DVI, and record state transitions from “off” to “blue” to “red.” The test observer will record any warning modalities that occur.

9. Should a warning occur, the test is complete and the driver will make a controlled stop of the vehicle and estimate the distance to the stop bar
10. If no warning occurs, the driver will continue at the defined test speed until the vehicle passes the stop bar
11. Once the driver reaches the stop bar, the driver will make a controlled stop. The driver can stop at any point beyond the stop bar.

3.10.7 Tests to be Conducted

Conduct this test eight (8) times at 35 miles per hour (+/- 2.5mph).

Table 20 – Speed at which to Test Dynamic Signal to Red

Driver Maintained Speed (mi/hr)	Required TTI Trigger (s) for Phase Change from Green to Yellow	Required Distance to Warn (m) depends on the warning algorithm table and precise speed	Number of Times Test Conducted
35mph (+/-2.5 mph)	$4.0 \text{ s} \leq \text{trigger TTI} < 6.0 \text{ s}$	Signal_WA_641-11.table	8

Note additional validation criteria: time to intersection (TTI) at the change of phase from green to yellow and TTI at the change of phase from yellow to red. A necessary condition for runs in this test to be valid is that the change of phase from green to yellow occurs early enough to ensure that, for the given yellow duration, the change from yellow to red occurs after the latest valid warning distance and before the stop bar. As determined in Section 3.10.1, this trigger TTI is to be ≥ 4.0 s and < 6.0 s. The change from yellow to red must occur before the vehicle reaches the stop bar which implies an actual TTI for the change of yellow to red of > 0 s.

3.10.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

3.11 Dynamic Signal to Green, No Warning Case

3.11.1 Background

The purpose of the test procedures in this section is to verify that the CICAS-V system will not issue an incorrect warning when a vehicle is approaching a red light which will turn green by the time the driver arrives at the stop bar.

To test this behavior, the vehicle approaches the intersection while the traffic control device is red. The traffic control device will transition to green prior to the proper warning distance for the observed vehicle speed. The traffic control device will remain in the green state until the vehicle passes the stop bar.

For this test, success is defined as not issuing a warning. As illustrated in Figure 21 and Figure 22, the vehicle shall not receive a warning.

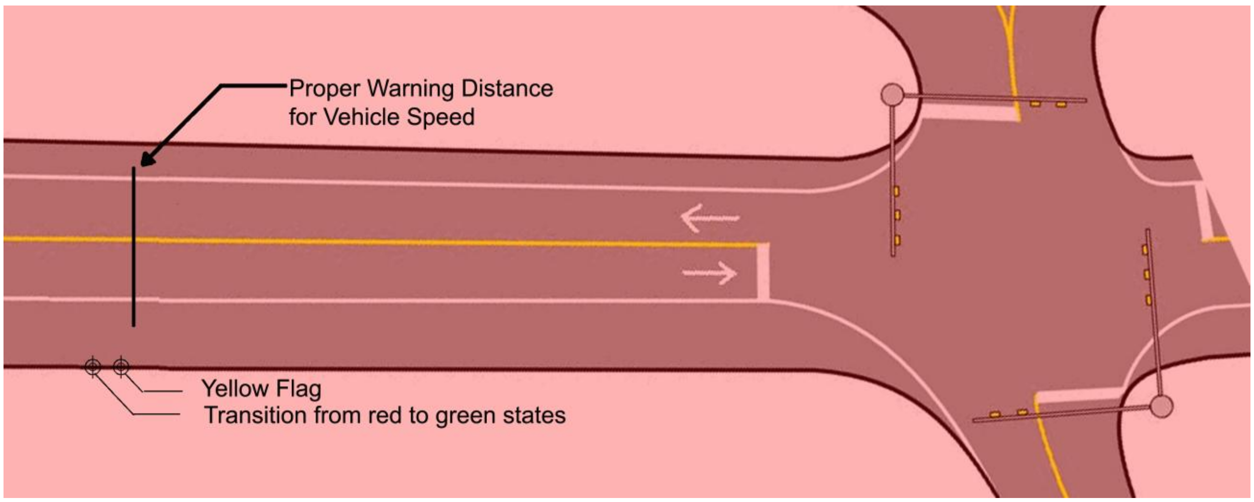

Figure 21 – Dynamic State Change to Green, No Warning Expected

The intersection and the vehicle shall be equipped with software to trigger the transition of the traffic control device from the red state to green state prior to the warning distance for the observed vehicle speed. The traffic control device must change states a minimum of 200 ms prior to the earliest valid warning distance for the observed vehicle speed to account for the phase recognition latency of the CICAS-V system. The earliest valid warning distance occurs at the highest valid vehicle speed of 37.5 mph (= 60 kph = 16.76 m/s). According to the warning table 641-11, the warning distance at this speed is 46.27 m. At this distance, the time to intersection (TTI) is 2.78 s. There is also the latency between triggering the request to change the phase and its actual servicing. This was experimentally determined to be 0.2 s. Adding the latencies and the earliest warning TTI gives 2.78 + 0.2 + 0.2 = 3.18 s as the minimum trigger TTI. This is illustrated in Figure 24. The maximum trigger TTI is not specified exactly but in line with the other procedures should be TTI (37.5 mph) + 0.4 s (latencies) which amounts to 3.32 sec.

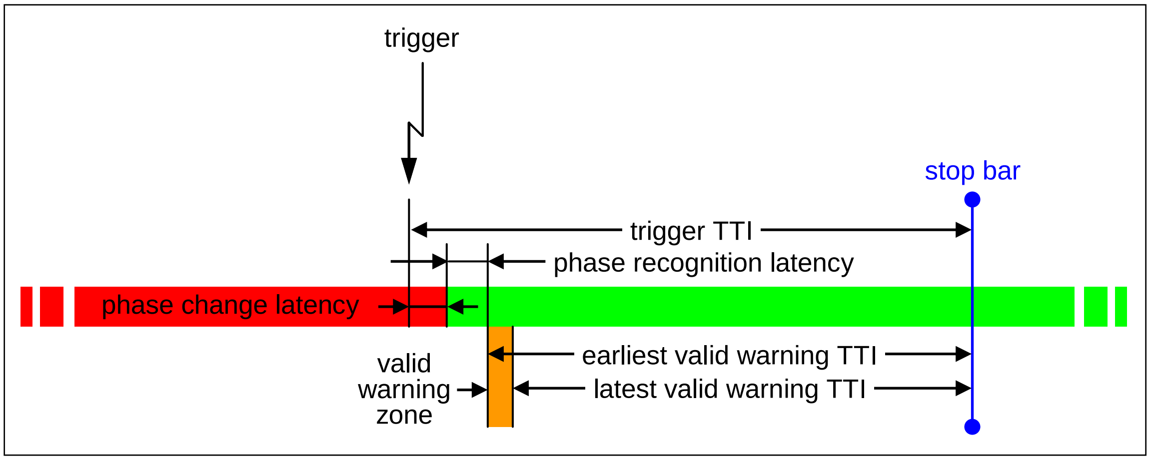

Figure 22 - Timing of Traffic Light Phase Change from Red to Green

3.11.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

3.11.3 Test Setup

The base test configuration for this test requires the infrastructure and setup defined for signalized intersections as defined in section 2.1.

In addition the following setup needs to be achieved:

1. Flags will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their distance from the stop bar. It is assumed that flags will be placed using a L1, GPS-handheld receiver. Alternate methods of flag location can be used. Flag locations are:
    a. A red flag 700 m from the stop bar
    b. A green flag 300 m from the stop bar
    c. A yellow flag placed at the earliest (from the driver's perspective) valid warning point
    d. A checkered flag placed at the last valid (from the driver's perspective) valid warning point

    (The earliest valid change from red to green is already marked by the green flag. The latest valid change from red to green is already marked by the yellow flag)
2. The three-lane GID shall be configured and transmitted from the RSE
3. The test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state
4. The test observer will confirm that the GID file 005.gid is present in the OBE subdirectory /rwflash/giddb/ after the OBE is rebooted
5. The in-vehicle signal-phase-controller software will be configured to trigger the phase change from red to green based on vehicle's perception of time-to-intersection (TTI). The phase change command triggered by software is expected

to be transmitted to RSE over radio. The trigger TTI to be used is 3.0 s, as determined in Section 3.11.1.

3.11.4 Pass and Fail Definitions

The standard pass-fail criteria as defined in section 1.6 are to be used unmodified. For this test, success is defined as not issuing a warning. Should a warning occur during this test, the test is considered failed. The flags placed on test course are meant only for general testing guidance. Official test results will use L1/L2 DPGS ranging information as recorded by DAS.

Should the traffic signal fail to transition into the appropriate status at the expected time, the test will be considered invalid. The OBE output to the DAS will be used as the record of the signal status.

3.11.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	Estimated Time
Initial intersection setup (setup and teardown that is required for all objective tests)	1 hour
Individual Test Runs (3 minutes per run)	24 minutes
Total	**1.4 hours**

Initial intersection setup is only required once per day. Therefore, if multiple tests are conducted per day, the total test time will be less than the sum of the times calculated in this section.

3.11.6 Test Script

The test will be conducted in the following manner:

1. The vehicle will receive the GID prior to moving to the starting point.
2. The vehicle will begin at the red flag, in lane #2, 700m from the stop bar
3. The test observer will ensure that in-vehicle software is configured to trigger the signal phase change at the appropriate time as detailed in Section 3.11.3
4. The driver will begin moderate acceleration to the target test speed
5. If cruise control is supported by the vehicle at the target speed, the driver will set cruise control to the middle of the target range
6. The position of the vehicle will be in the center of the approach lane
7. The driver will continue toward the stop bar at the target velocity
8. The test observer will observe that the traffic control device changes state from red to green
9. The test observer will note behavior of the DVI, and record any DVI state transitions. The test observer will record any warning modalities that occur.

10. Should a warning occur, the test is complete and the driver will make a controlled stop of the vehicle and the test is considered failed
11. If no warning occurs, the driver will continue at the defined test speed until the vehicle passes the stop bar
12. Once the driver reaches the stop bar, the driver will make a controlled stop. The driver can stop at any point beyond the stop bar.

3.11.7 Tests to be Conducted

Conduct this test a total of eight (8) times at 35 miles per hour (+/- 2.5mph).

Table 21 – Speeds at which to Test Dynamic Signal Change to Green Nuisance Warnings

Driver Maintained Speed (mi/hr)	Required TTI Trigger (s) for Phase Change from Green to Yellow	Number of Times Test Conducted
35mph (+/- 2.5 mph)	3.32 s ≥ trigger TTI > 3.18 s	8

Note additional validation criteria: time to intersection (TTI) at the change of phase from red to green. A necessary condition for runs in this test to be valid is that the change of phase from red to green is triggered by in-vehicle software at or before 3.18 s TTI, but no earlier than 18 s TTI, as determined in Section 3.11.3.

3.11.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

3.12 SPaT Reflection and Reception – Engineering Test

3.12.1 Background

The purpose of the test procedures in this section is to test the performance limits of the CICAS-V system under unfavorable wireless conditions. This test is therefore an Engineering Test and has no pass/fail criteria. It is very important that the DSRC reception is consistent when there is road clutter in the area of the test vehicles. If DSRC messages are not received at critical times, the vehicle may violate the signal without getting a warning.

In order to test this condition, the CICAS-V equipped vehicle will be driven behind a leading tractor trailer combination while logging data on the DAS in a lane that expects a warning. See Figure 23. The CICAS-V system should issue a warning despite the presence of the large vehicle provided that the minimum requirements for packet reception are met.

This objective test is not as straightforward as the other test procedures since the CICAS-V system is designed to work with less than optimal communication situations but the vehicle has to receive a minimum number of packets (SPaT, GID, GPSC) to function correctly. Even though the likelihood of the reception is high in the minimum packet reception probability requirement, it cannot be guaranteed that the packets will be received.

Since it is very challenging to exactly create the situation where the minimum communication requirements are met, the system performance limits will be established after analysis of the data stored in the DAS to determine whether the minimum requirements were met.

3.12.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

3.12.3 Test Setup

The base test configuration for this test requires that the infrastructure and setup be defined for signalized intersections as defined in section 2.1 except for the additional need for the presence of a large, commercial vehicle.

In addition to the standard intersection configuration, the following setup needs to be prepared:

1. Flags will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their distance from the stop bar. It is assumed that flags will be placed using a L1, GPS-handheld receiver. Alternate methods of flag location can be used. Flag locations are:
    a. A red flag 700m from the stop bar
    b. A green flag 300m from the stop bar
    c. A yellow flag placed at the earliest (from the driver's perspective) valid warning point
    d. A checkered flag placed at the last valid (from the driver's perspective) warning point
2. The three lane GID shall be configured and transmitted from the RSE
3. The test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state
4. The observer will be equipped with a handheld, laser range-finder device to continuously observe the distance from the vehicle to the rear of the truck
5. The SPaT server shall be configured to transmit red for all GID approaches

Figure 23 -- SPaT Reception Test

3.12.4 Pass and Fail Definitions

This test does not have the standard pass/fail criteria. It is intended to identify the system limits and the performance of the system by evaluating/analyzing the number of dropped packets and whether the system was able to warn even in unfavorable conditions.

Test vehicle follows with 3-6 m headway

The flags placed on test course are meant only for general testing guidance. Official test results will use L1/L2 DPGS ranging information as recorded by DAS.

3.12.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	**Estimated Time**
Initial intersection setup (setup and teardown that is required for all objective tests)	1 hour
Individual Test Runs (5 minutes per run)	40 mins
Total	**1.7 hours**

3.12.6 Test Script

1. The vehicle begins in lane #1 700m from the stop bar
2. The test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state
3. The tractor trailer will begin in lane #2 1000m from the stop bar and will begin accelerating to the test speed
4. Once the tractor trailer passes the vehicle, the vehicle will accelerate and switch to lane #2
5. The driver will begin moderate acceleration to the target test speed
6. The driver will meet the reach the targeted speed range by the time the vehicle reaches the green flag
7. The tractor-trailer will maintain its speed within a range of 5 mph
8. The driver will maintain a distance between 3 m and 6 m from the tractor trailer. See Figure 23.
9. The observer will use a handheld laser range-finder to monitor and verify the distance from the vehicle to the rear of the truck. The test observer will aid the driver in maintaining a valid distance by reporting the measurements.
10. The driver will continue toward the stop bar maintaining the distance to the tractor-trailer and matching its speed.
11. The test observer will note behavior of the DVI, and record state transitions from “off” to “blue” to “red.” The test observer will observe and record if all available warning modalities occur beyond the yellow flag but before the checkered flag.
12. The test observer will note behavior of the DVI, and record state transitions from “off” to “blue” to “red.” The test observer will record any warning modalities that occur beyond the yellow flag but before the checkered flag.

12. Should a valid warning occur, the driver will make a controlled stop prior to the stop bar
13. The Tractor Trailer will continue through the intersection without stopping
14. Should a valid warning fail to occur, the driver will proceed to the checked flag. Once the vehicle passes the checked flag – the driver will make a controlled stop.

Table 22 - SPaT Table for SPaT Reflection and Reception Engineering Test

Approach/Lane	Fixed Value
A3/L1	Fixed Red
A4/L2	Fixed Red
A5/L3	Fixed Red
All Other Approaches	Fixed Red

3.12.7 Tests to be Conducted

Conduct this test eight (8) times at 35 miles per hour (+/-5mph).

Table 23 – Speeds at which to Test Packet Reception Warning Performance

Driver and Tractor-Trailer Maintained Speed (mi/hr)	Required Distance to Warn (m)	Number of Times Test Conducted
35mph (+/-5 mph) Distance between Tractor-Trailer and following vehicle 4.5 m +/-1.5 m	Signal_WA_641-11 table	8

Note additional validation criteria: the number of dropped packets and especially the number of consecutively dropped packets and the following distance to the Tractor Trailer. The test shall be considered valid if the distance maintained between the two vehicles is between 3 m and 6 m. A distance of smaller than 3 m can also be considered valid but is not recommended due to safety concerns. The distance between the vehicles shall be determined by the DAS radar system. In case the DAS radar system has difficulty locking onto rear of the truck for measurement, the hand-held, laser range-finder can be used instead to verify the distance. The variation in speed for this test is greater than for the other tests because the distance between the two vehicles has to be maintained independent of the speed.

3.12.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

4 Test Procedures for Stop Sign-Equipped Intersections

4.1 Test Assumptions

For CICAS-V testing of stop sign-equipped intersections, the following statements are assumed to be true for all tests:

- That the driver will be able to respond within the amount of time given by the warning time selected by VTTI. This assumption was tested as part of Task 3 – Human Factors Studies.
- That GPS performance will meet expected standard performance

In addition to these assumptions, each individual test has assumptions for the given test.

4.2 Various Approach Speeds Test

4.2.1 Background

The operational goal of the CICAS-V as defined in the Concept of Operations is to warn a driver that he/she is about to violate a traffic control device with sufficient time to stop the vehicle. Correspondingly, to pass this objective test, the system must warn the driver the correct distance from the stop bar as determined in Task 3 – Human Factors Studies. The proper distance from the stop bar varies based on the vehicle's speed. An illustration of the acceptable warning distance is shown in.Figure 24. Areas marked in green are acceptable; areas marked in red are not acceptable.

In addition, for this test, modality timing will be evaluated. All three modalities of the driver interface will be recorded by the DAS in a time-synchronized video, audio, and/or scalar signal form and compared to determine whether they activated within 200ms of each other and within 200ms of the specified warning distance.

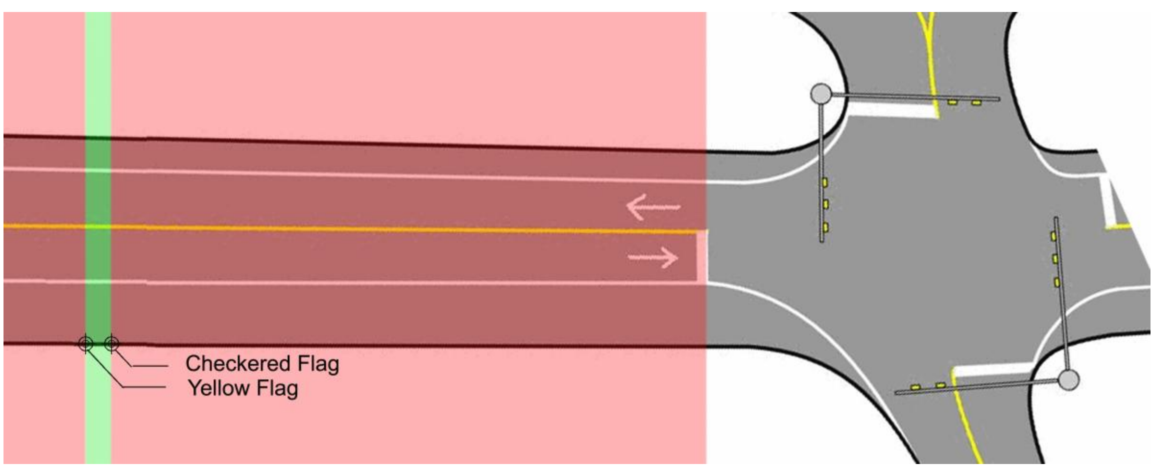

Figure 24 -- Acceptable and Unacceptable Warning Times

4.2.2 Test Assumptions

All the assumptions given in section 3.1 are assumed to be true.

4.2.3 Test Setup

The base test configuration for this test requires the infrastructure and setup defined for stop sign intersections as defined in section 2.1.

In addition the following setup needs to be achieved:

1. The test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state
2. The stop sign GID shall be configured and transmitted from the RSE
3. If the test run to be conducted is at 55mph, the test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state. If the test speed is less than 55mph, the test observer will verify for the first run at each speed that the GID file 005.gid is present in the OBE subdirectory /rwflash/giddb/. The 55mph test should be conducted first to ensure that the GID is present for the first test at 35mph or 25mph.
4. No SPaT server should be transmitting
5. A stop sign will be installed 2m from the edge of the stop bar on the driver's right side
6. Flags will be placed so the driver is aware of the vehicle's location in reference to the stop bar. These flags will be located by their distance from the stop bar. It is assumed that flags will be placed using a L1 GPS handheld receiver. Alternate methods of flag location can be used. Flag locations are:
    a. A red flag 700m from the stop bar
    b. A green flag 300m from the stop bar
    c. A yellow flag placed at the earliest (from the driver's perspective) valid warning point
    d. A checkered flag placed at the last valid (from the driver's perspective) valid warning point

4.2.4 Pass and Fail Definitions

The standard pass-fail criteria as defined in section 1.6 are to be used unmodified. In addition to these criteria, three warning modalities synchronization will be evaluated and required for test passage. Time synchronized video, audio, and scalar information will be used to evaluate if all modalities were activated within a 200mS time span. The DVI icon activation time will be determined from DAS video recordings. The DVI audio activation time will be determined by DAS audio recordings. Finally, the haptic DVI activation time will be determined by the onset of a -0.2G force event in the scalar G-force data recorded by the DAS.

The flags placed on test course are meant only for general testing guidance, official test results will use L1/L2 DPGS ranging information as recorded by DAS.

4.2.5 Estimated Time to Complete

An estimate of the amount of time to complete this test is:

Task	**Estimated Time**
Initial intersection setup (setup and teardown that is required for all objective tests)	1 hour
Various speeds setup	30 minutes
Individual Test Runs (3 minutes per run)	1.2 hours
Total	**2.7 hours**

Initial intersection setup is only required once per day. Therefore, if multiple tests are conducted per day, the total test time will be less than the sum of the times calculated in this section.

4.2.6 Test Script

The test will be conducted in the following manner:

1. The vehicle will receive the GID prior to moving to the starting point
2. The vehicle will begin at the red flag, in lane #2, 700m from the stop bar
3. If the test run to be conducted is at 55mph, the test observer will use an OBE interface to run a provided script that will erase all existing GIDs from the OBE and reboot the OBE to standard initialized state. If the test speed is less than 55mph, the test observer will verify for the first run at each speed that the GID file 005.gid is present in the OBE subdirectory /rwflash/giddb/.
4. The driver will begin moderate acceleration to the target test speed
5. The driver will reach the targeted speed range by the time the vehicle reaches the green flag
6. If cruise control is supported by the vehicle at the target speed, the driver will set cruise control to the middle of the target range
7. The driver will continue toward the stop bar at the target velocity
8. The test observer will note behavior of the DVI, and record state transitions from "off" to "blue" to "red"
9. Should a valid warning occur, the driver will make a controlled stop of the vehicle. It is acceptable for the driver to stop before or after the stop bar.
10. Should a valid warning fail to occur, the driver will proceed to the checked flag at the test speed
11. If no warning occurs beyond the checkered flag, the driver will continue at the defined test speed until the vehicle passes the stop bar.
12. Once the driver reaches the stop bar, the driver will make a controlled stop. The driver can stop at any point beyond the stop bar.

4.2.7 Tests to be Conducted

Conduct this test a total of twenty-four (24) times.

Table 24 -- Speeds at which to Test Basic Stop Sign Warning Algorithm Performance

Driver Maintained Speed (mi/hr)	Required Distance to Warn (m)	Number of Times Test Conducted
25 (+/-2.5mph)	Depends on warning table used	8
35 (+/-2.5mph)	Depends on warning table used	8
55 (+/-2.5mph)	Depends on warning table used	8

4.2.8 Required Documentation for Each Test

The standard documentation form as illustrated in section 4.2.1 is to be used to document this test.

5 Appendix A – Test Procedure Results Form

Warning Algorithm Test							
Conditions and Data Collected							
Date (GMT)		Time (GMT)			Weather	Wet / Dry	
Driver			Observer				
Location of Test							
Speed of Tests							
Other Conditions for Test Validity							
Collected Data Files			DAS Log				
cicas-v.conf used			WA Log				
Warning Table Used			IIMMLI Log				
Results							
Test Run Number	Observer Speed Recorded	Icon/Audio/haptic Warning Received?			Test Appeared Valid?	Warn at Correct Flag?	Appeared to Pass or Fail
1	_____mph	Y / N	Y / N	Y / N	Y / N	Y / N	Pass /Fail

2	_____mph	Y / N	Y / N	Y / N	Y / N	Y / N	Pass /Fail
3	_____mph	Y / N	Y / N	Y / N	Y / N	Y / N	Pass /Fail
4	_____mph	Y / N	Y / N	Y / N	Y / N	Y / N	Pass /Fail
5	_____mph	Y / N	Y / N	Y / N	Y / N	Y / N	Pass /Fail
6	_____mph	Y / N	Y / N	Y / N	Y / N	Y / N	Pass /Fail
7	_____mph	Y / N	Y / N	Y / N	Y / N	Y / N	Pass /Fail
8	_____mph	Y / N	Y / N	Y / N	Y / N	Y / N	Pass /Fail

6 Appendix B – Testing Results Record Form

Test Name	Speed	Comment	Tests Conducted	Tests Successful	Success Rate	Pass / Fail
Signalized Various Speed Approaches Test	25		8			
	35		8			
	55		8			
Edge of Approach Testing for Warning	35	Right Side	8			
Edge of Approach Testing for Nuisance Warning	35	Left Side	8			
Late Lane Shift Test	35	Right to Left w/Warning	8			
	35	Left to Right w/o Warning	8			
SPaT Reflection and Reception	35		8			
Multiple Intersections within 300m Radius: Warning Case	35		8			
Multiple Intersections within 300m Radius: No Warning Case	35		8			
Dynamic Signal Change to Yellow, Too Late to Warn	35		8			
Dynamic Signal to Red, In Time for Warning	35		8			
Dynamic Signal to Green, No Warning Case	35		8			
Stop Sign Various Approach Speeds Test	25		8			
	35		8			
	55		8			
Overall						

7 Appendix C – Example of Valid Warning Window for Various Speeds

The following table shows an example of calculations that are used to determine the acceptable warning window. This table is an example and may need to be recalculated depending on the warning table used for testing. For a list of possible warning tables that may be used during objective testing, see Section 12.

Vehicle Speed (kmph)	Latest Distance from Stopbar Warning is Acceptable (m)	Optimal warning distance established by VTTI in Task 3 (m)	Earliest Distance from Stop Bar Warning is Acceptable (m)	Acceptable Warning Window (m)
41 km/h	19.42	21.70	23.98	4.56
42 km/h	20.21	22.54	24.87	4.67
43 km/h	21.01	23.40	25.79	4.78
44 km/h	21.83	24.27	26.71	4.89
45 km/h	22.66	25.16	27.66	5.00
46 km/h	23.50	26.06	28.62	5.11
47 km/h	24.36	26.97	29.58	5.22
48 km/h	25.23	27.90	30.57	5.33
49 km/h	26.13	28.85	31.57	5.44
50 km/h	27.03	29.81	32.59	5.56
51 km/h	27.95	30.78	33.61	5.67
52 km/h	28.88	31.77	34.66	5.78
53 km/h	29.84	32.78	35.72	5.89
54 km/h	30.79	33.79	36.79	6.00
55 km/h	31.77	34.83	37.89	6.11
56 km/h	32.77	35.88	38.99	6.22
57 km/h	33.77	36.94	40.11	6.33
58 km/h	34.80	38.02	41.24	6.44
59 km/h	35.83	39.11	42.39	6.56
60 km/h	36.89	40.22	43.55	6.67
61 km/h	37.96	41.35	44.74	6.78
62 km/h	39.04	42.48	45.92	6.89
63 km/h	40.14	43.64	47.14	7.00
64 km/h	41.24	44.80	48.36	7.11
65 km/h	42.38	45.99	49.60	7.22
66 km/h	43.51	47.18	50.85	7.33
67 km/h	44.68	48.40	52.12	7.44
68 km/h	45.84	49.62	53.40	7.56
69 km/h	47.04	50.87	54.70	7.67
70 km/h	48.23	52.12	56.01	7.78
71 km/h	49.45	53.39	57.33	7.89
72 km/h	50.68	54.68	58.68	8.00
73 km/h	51.92	55.98	60.04	8.11
74 km/h	53.19	57.30	61.41	8.22
75 km/h	54.46	58.63	62.80	8.33
76 km/h	55.75	59.97	64.19	8.44
77 km/h	57.05	61.33	65.61	8.56
78 km/h	58.38	62.71	67.04	8.67
79 km/h	59.71	64.10	68.49	8.78
80 km/h	61.07	65.51	69.95	8.89
81 km/h	62.43	66.93	71.43	9.00
82 km/h	63.80	68.36	72.92	9.11
83 km/h	65.20	69.81	74.42	9.22
84 km/h	66.61	71.28	75.95	9.33
85 km/h	68.03	72.75	77.47	9.44
86 km/h	69.47	74.25	79.03	9.56
87 km/h	70.93	75.76	80.59	9.67
88 km/h	72.39	77.28	82.17	9.78
89 km/h	73.88	78.82	83.76	9.89
90 km/h	75.37	80.37	85.37	10.00
91 km/h	76.88	81.94	87.00	10.11
92 km/h	78.42	83.53	88.64	10.22
93 km/h	79.95	85.12	90.29	10.33
94 km/h	81.52	86.74	91.96	10.44
95 km/h	83.09	88.37	93.65	10.56
96 km/h	84.68	90.01	95.34	10.67
97 km/h	86.28	91.67	97.06	10.78
98 km/h	87.90	93.34	98.78	10.89
99 km/h	89.53	95.03	100.53	11.00

Warning Variation = 200

8 Appendix D – Key Test Variables

Key Test Variable	Definition	Unit	Tolerance	Measurement Method
Brake Status	Indicates whether brake is pressed or not; must be off for a warning to be valid	Binary	*	Vehicle CAN network logged by DAS
DVI Status, Audio	Status of the audio modality of the warning: on (warning sounding), or off	Binary	*	CICAS-V output and microphone logged by DAS
DVI Status, Haptic	Status of the haptic modality of the warning: on (brakes pulsing), or off	Binary	*	Vehicle CAN network logged by DAS
DVI Status, Visual	Status of the visual modality of the warning: disabled, equipped, warning	Binary	*	CICAS-V output and camera images logged by DAS
GPS Number of Satellites	Number of GPS satellites reported as “seen” by the GPS receiver	Integer	>5	Reported to OBE and DAS by GPS receiver
HDOP	Maximum GPS horizontal dilution of precision allowed over 3-seconds	Unitless	3	Logged by DAS
Intersection Selected	Intersection identified by CICAS-V as imminent	Integer	*	CICAS-V output logged by DAS
Lane Driven	The identifying number for the lane containing the vehicle	Integer	*	CICAS-V output and camera images logged by DAS
Traffic Signal Status	The state of the traffic signal: off, red, flashing red, yellow, flashing yellow, green, flashing green	Red / Yellow / Green	*	RSE broadcast to OBE, stored on DAS. Camera images recorded by DAS
Vehicle Lateral G-Force	The G-force being measured by the vehicle force sensor.	G	0.2G indicates haptic activation	Vehicle force sensor, reported over serial data bus.
Vehicle Speed	Test vehicle’s ground speed	mph	+/- 2.5	Vehicle CAN network logged by DAS

* Required value varies by test

9 Appendix E – Proposed Schedule

Date		
Begin	**End**	**Task**
06/09/08	06/13/08	Test vehicles for system level performance. Begin preliminary task 11 preparations
07/14/08	07/18/08	Official Task 11 testing.

10 Appendix F – Typically Values Stored for Objective Testing

The following list is the list of possible values to be stored for evolution of test validity and success. Not all values contained are supported by all vehicles.

ABS Active	ACC set speed	ACC status
Accelerator Pedal Position %	Algorithm Status	Approach Likelihood
Base Station GPS Status	Battery Voltage	Brake Pedal Position
Brakes Active	CAN Data Valid	Cruise Engaged
Cruise Override	Cruise set speed	Cruise Set Speed
Current Signal Phase	Distance to Lane Center Line	Distance to Stop Bar
Driver Intended Braking Level	DSRC Radio Error	DVI Equipped Keep Low Active
DVI System Error	DVI to OBE Heartbeat Error	DVIN States
DVI-OBE Timeout	Elapsed Days	Elapsed Hours
Elapsed Milliseconds	Elapsed Minutes	Elapsed Months
Elapsed Seconds	Extended Brake Switch	GID Map Version
GID Reception	GID TOM Checksum Failure	GPS Accuracy Requirement Satisfied
GPS Communication Timeout	GPS Data Valid	GPS NMEA Checksum Error
GPS Position Valid	GPS Solution Lost	GPSC Reception
GPSC TOM Checksum Failure	GST error ellipse	Hardware Watchdog Reset Counter
HDOP	HDOP Under Limit during Duration	Headlight status
Heartbeat Error	Heartbeat Error	Horn status
IID Speed Threshold Met	Inaccurate or No GPS Solution (short term)	Interior Dim Status
Interior Dim Status	Intersection Closing	Intersection Id
Intersection In Range	Intersection Type	Lane Likelihood
Lateral Acceleration	Left Turn Phase	Left Turn Signal
Local GPS Differential Age	Local GPS Milliseconds in Week	Local GPS Solution Age
Local GPS Speed	Local GPS Week Number	Longitudinal Acceleration
Message Counter	Negative Elapsed Time	Netway to OBE Heartbeat Error
Netway-OBE Timeout	Number of Approaches	Number of Lanes
Number of Satellites Used	OBE to DVI	Odometer reading
On GID and Approach Identified and Validated	Outside Air Temperature	Overflow Elapsed Time
Panic brake active	PDOP	Pedestrian Phase
Pre charge status	Present Approach	Present Lane

PRNDL	Right Turn Phase	Right Turn Signal
Road / Lane level	Rover GPS Quality / Mode	RSE GPS ms time of the week
Seatbelt status	Seconds Since Pedestrian Phase	SPAT Blackout (intersection error)
SPaT Data Valid	SPAT GPS Age Warning	SPAT Reception
SPAT Timeout	SPAT TOM Checksum Failure	Stability Control Active
Steering Wheel Angle	Time To Intersection	Time to Left Phase
Time to Next Phase	Time to Pedestrian Phase	Time to Right Phase
Tire Pressure LF	Tire Pressure LR	Tire Pressure RF
Tire Pressure RR	Vehicle Altitude	Vehicle CAN Data Timeout
Vehicle Heading	Vehicle is Off GID	Vehicle Lane Position
Vehicle Latitude	Vehicle Length	Vehicle Longitude
Vehicle Speed	Vehicle Width	Vertical Acceleration
Wheel Velocity LF	Wheel Velocity LR	Wheel Velocity RF
Wheel Velocity RR	Wiper Status	WSA Reception
WSU Low Voltage Error	WSU Over Temp Error	Yaw Rate

11 Appendix G – Reference CICAS-V.CONF File (Software Release 1.13)

This appendix lists the reference CICAS-V.conf file that should be used for all objective tests unless otherwise specified in the test procedure.

```
# CICAS-V Warning Application (CWA)
CWADebugFlag                         = 0     # Debug Flag
CWAInfoFlag                          = 0     # Info Flag
CWALogFlag                           = 0     # Log Flag
# Intersection Identification
IntersectionIdentificationMethod     = 2     # Intersection selection method
IntersectionSelectionCriteria        = 0     # Approaching intersection selection
criteria 0-closing most quickly ,1-closest distance
HDOPThreshold                        = 3.0   # Horizontal Dilution of Precision - X.x
HDOPThresholdTimeout                 = 3.0   # HODP debounce time period  - X.x s
GCDThreshold                         = 300   # Great Circle Distance Threshold - XXX m
MovingAverageTime                    = 1.0   # Moving average time - X.x s
IntersectionIDCalculationFilterCutOffFrequency= 2.68 # GPS With Filter cutt-off freq
IntersectionIDCalculationFilterSamplingTime  = 0.10  # GPS filter sampling time - X.x s
LowVehicleSpeedThreshold             = 4.8   # Min Vehicle speed threshold - X.x kmph
EnableLowVehicleSpeedFiltering       = 1     # Flag to enable Low vehicle speed checking
# Map Matching
OffGIDThreshold                      = 4.0   # Off Lane, but on GID Distance Threshold -
XX m
OffGIDMethod                         = 0     # Method to determine Off GID
MapMatchSingleMatchThreshold         = 95    # Threshold for excluding all other lane
matches
MapMatchMaxNumberOfLanes             = 3     # Max number of lanes Map matching will
return for approach correlation
MapMatchAlwaysReturnMatch            = 0     # Map matching will always return a lane
match
BaselineBehaviorFlag                 = 0     # MMLI baseline behvior, which reports
closest
MinApproachLikelihoodLocalCorr       = 1
MinApproachLikelihood                = 1
ApprLikelihoodDiffLocalCorr          = 15
ApprLikelihoodDiff                   = 15
# Lane Identification
MaxLaneConfidenceThreshold            = 1.6 # Maximum Lane Confidence Threshold - X.x
sigma
AntennaOffsetNS                      = -2.5 # Antenna Offset Vehicle Travel Direction -
X.x m
# Warning Algorithm
```

```
WAExecInterval                        = 100   # Warning Algorithm Execution Interval - XXX
ms
SPATTimeout                           = 800   # SPAT Timeout applicable to I-in-R
indication - XXX
DistanceToWarnSignFile                = /rwflash/configs/Dist_Warn_Sign.txt # Distance to
warn Signal array filename
DistanceToWarnStopFile                = /rwflash/configs/Dist_Warn_Stop.txt # Distance to
warn Stop Sign array filename
MinWarnDistMeters                     = 0     # Minimum warning distance meters
MaxWarnDistMeters                     = 500   # Maximum warning distance meters
AddReactTimeinSec                     = 0.0   # Reaction time factor seconds
PreChargeDelay                        = 0.0   # Brake precharge delay seconds
BrakePulseRampup                      = 0.0   # Brake Pulse ramp up time seconds
HysteresisTime                        = 5.0   # Hyteresis time seconds
HysteresisSpeed                       = 5.4   # Hysteresis speed kmph
TimeToPreempt                         = 5.0   # Time to intersection for preempt seconds
PreemptType                           = 2     # default = turn-red, 0 = clear, 1 = green
TSVWGEnable                           = 0     # Enable TSVWG message
RCMDEnable                            = 0     # Enable RCMD message
# AlgChoiceFile                               # to be added later
# CWA Log Enable flags
SPATDataExpdLogFlag                   = 0    # Log Enable Flag for this field
GPSDataExpdLogFlag                    = 0    # Log Enable Flag for this field
CANDataExpdLogFlag                    = 0    # Log Enable Flag for this field
HDOPStatusChngLogFlag                 = 0    # Log Enable Flag for this field
NewApprngIntnLogFlag                  = 0    # Log Enable Flag for this field
MapMatchRsltsSuccLogFlag              = 0    # Log Enable Flag for this field
MapMatchUnsuccLogFlag                 = 0    # Log Enable Flag for this field
VehPosnLogFlag                        = 0    # Log Enable Flag for this field
IntnOrApprChngLogFlag                 = 0    # Log Enable Flag for this field
WarnAlgRsltsIntnInRngLogFlag    = 0           # Log Enable Flag for this field
WarnAlgRsltsNoIntnInRngLogFlag  = 0           # Log Enable Flag for this field
SPATIntn-In-RngTmOutLogFlag     = 0           # Log Enable Flag for this field
WarnStateChngLogFlag            = 0           # Log Enable Flag for this field
# DVI Notifier
DVINDebugFlag                   = 0
DVINInfoFlag                    = 0
DVINLogFlag                     = 0
HeartbeatTimeout                = 500         # milliseconds
DVIOBEHbErrLogFlag      = 0
OBEDVIHbErrLogFlag      = 0
DVISysErrorLogFlag      = 0
DVIOBETimeoutLogFlag    = 0
MaintenanceAudioEnable          = 0
MaintenanceAudioFile            = /rwflash/configs/cicas_maint.wav #
MaintenanceAudioDelay           = 0.0         # seconds
MaintenanceIconEnable           = 1
MaintenanceIconBrightness       = 10          # range from 0 to 10
MaintenanceIconFlashFrequency   = 255         # multiply by 50 = ms - 255 = no flash
MaintenanceIconDelay            = 0.0         # seconds
MalfunctionAudioEnable          = 0
MalfunctionAudioFile            = /rwflash/configs/cicas_malfunc.wav #
MalfunctionAudioDelay           = 0.0         # seconds
MalfunctionIconEnable           = 1
MalfunctionIconBrightness       = 10          # range from 0 to 10
MalfunctionIconFlashFrequency   = 255         # multiply by 50 = ms - 255 = no flash
MalfunctionIconDelay            = 0.0         # seconds
EquippedAudioEnable             = 0
EquippedAudioFile               = /rwflash/configs/cicas_equipped.wav #
EquippedAudioDelay              = 0.0         # seconds
EquippedIconEnable              = 1
EquippedIconBrightness          = 10          # range from 0 to 10
EquippedIconFlashFrequency      = 255         # multiply by 50 = ms - 255 = no flash
EquippedIconDelay               = 0.0         # seconds
EquippedIconKeepHighDuration    = 5.0         # seconds
EquippedIconKeepLowDuration     = 5.0         # seconds
PrewarnDuration                 = 0.0         # seconds
```

```
PrewarnAudioEnable              = 0
PrewarnAudioFile                = /rwflash/configs/cicas_prewarn.wav #
PrewarnAudioDelay               = 0.0        # seconds
PrewarnIconEnable               = 1
PrewarnIconBrightness           = 10         # range from 0 to 10
PrewarnIconFlashFrequency       = 255        # multiply by 50 = ms - 255 = no flash
PrewarnIconDelay                = 0.0        # seconds
WarningAudio_enable             = 0
WarningSignalizedAudioFile      = /rwflash/configs/stoplight.wav #
WarningStopsignAudioFile        = /rwflash/configs/stopsign.wav #
WarningAudioDelay               = 0.0        # seconds
WarningIconEnable               = 1
WarningIconBrightness           = 10         # range from 0 to 10
WarningIconFlashFrequency       = 10         # multiply by 50 = ms - 255 = no flash
WarningIconDelay                = 0.0        # seconds
WarningIconKeepHighDuration     = 5.0        # seconds
WarningIconKeepLowDuration      = 30.0       # seconds
FlexWarnTrig1Enable             = 0
FlexWarnTrig1Offset             = 0.0        # seconds
FlexWarnTrig1Duration           = 0.0        # seconds
FlexWarnTrig2Enable             = 0
FlexWarnTrig2Offset             = 0.0        # seconds
FlexWarnTrig2Duration           = 0.0        # seconds
FlexWarnTrig3Enable             = 0
FlexWarnTrig3Offset             = 0.0        # seconds
FlexWarnTrig3Duration           = 0.0        # seconds
FlexWarnTrig4Enable             = 0
FlexWarnTrig4Offset             = 0.0        # seconds
FlexWarnTrig4Duration           = 0.0        # seconds
FlexWarnTrig5Enable             = 0
FlexWarnTrig5Offset             = 0.0        # seconds
FlexWarnTrig5Duration           = 0.0        # seconds
FlexWarnTrig6Enable             = 0
FlexWarnTrig6Offset             = 0.0        # seconds
FlexWarnTrig6Duration         = 0.0          # seconds
FlexWarnTrig7Enable           = 0
FlexWarnTrig7Offset           = 0.0          # seconds
FlexWarnTrig7Duration         = 0.0          # seconds
# CICAS-V DSRC Information (CDI)
CDIDebugFlag                  = 0            # Debug Flag
CDIInfoFlag                   = 0            # Info Flag
CDILogFlag                    = 0            # Log Flag
# Radio Handler / Data Demux
VIICRSEFlag                   = 0            # VIIC RSE Flag
GIDPSID                       = 0x01E00002   # PSID for GID WSMs (Hex)
SPATPSID                      = 0x01E00001   # PSID for SPAT WSMs (Hex)
GPSCPSID                      = 0x01E00003   # PSID for GPSC WSMs (Hex)
TSVWGPSID                     = 0x03E00001   # PSID for TSVWG WSMs
TSVWGPower                    = 20           # In db
TSVWGDataRate                 = 12           # In Mbps (value = desired datarate * 2 .
Supported values are 6, 9, 12, 18, 24, 36, 48, 54)
TSVWGPriority                 = 1
TSVWGRepeatCount              = 1
TSVWGRepeatInterval           = 10           # In milliseconds
RCMDPSID                      = 0x07E00001   # PSID for RCMD WSMs
RCMDPower                     = 20           # In db
RCMDDataRate                  = 12           # In Mbps (value = desired datarate * 2 .
Supported values are 6, 9, 12, 18, 24, 36, 48, 54)
RCMDPriority                  = 7
RCMDRepeatCount               = 1
RCMDRepeatInterval            = 10           # In milliseconds
RadioStatisticsPollInterval   = 1000         # Polling Interval for Radio Statistics -
XXXX ms
# GID DB Handler
GIDExpirationTime             = 30           # GID expiration time - XX days
GIDStorageAllocation          = 1024         # GID storage allocation - XXXX KB (1 MB =
1024 KB)
```

```
# SPAT DB handler
SPATExpirationTime            = 800          # SPAT expiration time - XXX ms
SPATAgeWarnThreshold = 400                   # SPAT Age warn - millisec
# CDI Log Enable Flags
CDISuppTomFmtsLogFlag         = 0            # Log Enable Flag for this field
CDIRadioStatsLogFlag          = 0            # Log Enable Flag for this field
CDIWsaRxLogFlag               = 0            # Log Enable Flag for this field
CDINewModWSARxLogFlag         = 0            # Log Enable Flag for this field
CDIWbssJoinedLogFlag          = 0            # Log Enable Flag for this field
CDIWbssLeftLogFlag            = 0            # Log Enable Flag for this field
CDITomHdrChkFailedLogFlag     = 0            # Log Enable Flag for this field
CDIWSATomHdrChkFailedLogFlag  = 0            # Log Enable Flag for this field
CDIWSAGPSCStatusFailedLogFlag = 0            # Log Enable Flag for this field
CDISuppGIDFmtsLogFlag         = 0            # Log Enable Flag for this field
CDIExpGIDRecDelLogFlag        = 0            # Log Enable Flag for this field
CDIExpGIDRecDelOptDataLogFlag = 0            # Log Enable Flag for this field
CDIStartupGIDDBContsLogFlag   = 0            # Log Enable Flag for this field
CDIStartupGIDDBContsOptDataLogFlag    = 0    # Log Enable Flag for this field
CDIGidRxLogFlag               = 0            # Log Enable Flag for this field
CDIGidRxOptDataLogFlag        = 0            # Log Enable Flag for this field
CDINewGidRxLogFlag            = 0            # Log Enable Flag for this field
CDIUpdGidRxLogFlag            = 0            # Log Enable Flag for this field
CDIUpdGidRxOptDataLogFlag     = 0            # Log Enable Flag for this field
CDIUnexpGidDelLogFlag         = 0            # Log Enable Flag for this field
CDIUnexpGidDelOptDataLogFlag  = 0            # Log Enable Flag for this field
CDISuppSpatFmtsLogFlag        = 0            # Log Enable Flag for this field
CDISpatRxLogFlag              = 0            # Log Enable Flag for this field
CDISpatRxOptDataLogFlag       = 0            # Log Enable Flag for this field
CDISpatRxApprngLogFlag        = 0            # Log Enable Flag for this field
CDINonDupSpatRxApprngLogFlag  = 0            # Log Enable Flag for this field
CDIFirstSpatRxApprngLogFlag   = 0            # Log Enable Flag for this field
CDISpatValExpLogFlag          = 0            # Log Enable Flag for this field
CDIMetricLogFlag              = 0
# CICAS-V Vehicle Location (CVL)
CVLDebugFlag                  = 0            # Debug Flag
CVLInfoFlag                   = 0            # Info Flag
CVLLogFlag                    = 0            # Log Flag
# GPS Handler
GPSExpirationTime             = 400          # GPS expiration time - XXX ms
# Log Enable Flags
CVLSupGpscFmtsLogFlag         = 0            # Log Enable Flag for this field
CVLGpsDataRxLogFlag           = 0            # Log Enable Flag for this field

CVLGpsDataTmoutLogFlag        = 0            # Log Enable Flag for this field
CVLGpsDataTmoutNoDataLogFlag  = 0            # Log Enable Flag for this field
CVLGpscRxLogFlag              = 0            # Log Enable Flag for this field
CVLGpscRxDataLogFlag          = 0            # Log Enable Flag for this field
CVLGpsStatusChLogFlag         = 0            # Log Enable Flag for this field
CVLGpscRtcmCksmFailLogFlag    = 0            # Log Enable Flag for this field
CVLGpscRtcmCksmFailDataLogFlag= 0            # Log Enable Flag for this field
CVLVehCanDataTmoLogFlag = 0
# CICAS-V Vehicle Information (CVI)
CVIDebugFlag                  = 0            # Debug Flag
CVIInfoFlag                   = 0            # Info Flag
CVILogFlag                    = 0            # Log Flag
# Vehicle message handler
CANExpirationTime             = 400          # CAN expiration time - XXX ms
CAN704TxInterval              = 100
# Log Enable Flags
CANDataRxLogFlag              = 0            # Log Enable Flag for this field
IncompCANDataRxLogFlag        = 0            # Log Enable Flag for this field
CANExpdLogFlag                = 0            # Log Enable Flag for this field
CAN606ExpdLogFlag             = 0
CAN606HBErrLogFlag            = 0
CAN606SeqErrLogFlag           = 0
CANErrLogFlag                 = 0
# CICAS-V Logger (CLOG)
```

```
CLOGDebugFlag                = 0              # Debug Flag
CLOGInfoFlag                 = 0              # Info Flag
CLOGLogFlag                  = 0              # Log Flag
# DAS Handler, logger
GlobalLogFlag                = 0              # Global Log Enable or Disable Flag
DASLogInterval               = 1              # Controls the logging rate
CLOGDasMsgsLogFlag           = 0              # Log Enable Flag for this field
# Error Handler
EnableHWWatchdog             = 1              # Allows turning off HW watchdog while
debugging
EnableHBLogging              = 0              # HB would be too numerous to log at runtime
HWWatchdogTimeout            = 10000          # timeout in msec
SWWatchdogTimeout            = 1000           # timeout in msec
# Error Types                                 # 0=none, 1=maintenance, 2=malfunction
InitErrType27                = 0              #2 GPS Tmout (No Data)
InitErrType35                = 0              #2 Netway-OBE HB Error
InitErrType37                = 0              #2 Vehicle CAN Data Timeout
InitErrType56                = 0              #1   DAS System Error
InitErrType57                = 0              #1   DAS Boot Up Error
InitErrType58                = 0              #1   DAS Shutdown Error
InitErrType59                = 0              #1   OBE to DAS Heartbeat Error
InitErrType62                = 0              #1   DAS Video Health Status
InitErrType63                = 0              #1   DAS Radar Health Status
InitErrType64                = 0              #1   DAS Hard-drive Space Low
InitErrType65                = 0              #1   DAS Battery Voltage Low
InitErrType66                = 0              #1   DAS Heartbeat Sequence Mismatch
InitErrType68                = 0              #2   DVI to OBE HB Error
InitErrType69                = 0              #2   OBE to DVI HB Error
InitErrType70                = 0              #2   OBE to Netway HB Error
InitErrType71                = 0              #2   DVI Sys Error
InitErrType72                = 0              #2   Netway OBE Timeout
InitErrType73                = 0              #2   DVI OBE Timeout
# Thresholds
MalfPersThresh               = 1000           #in msec
MaintPersThresh              = 1000           #in msec
LowHDThresh                  = 10             # in GB
LowVoltThresh                = 9.5            # in Volts
# DAS $701 Error Flags
DASSysErrLogFlag             = 0
DASBootupErrLogFlag          = 0
DASShutdownErrLogFlag        = 0
DASOBEDASHbErrLogFlag        = 0
DASRunModeLogFlag            = 0
DASShutdownModeLogFlag       = 0
DASVideoHSLogFlag            = 0
DASRadarHSLogFlag             = 0
DASHDSpaceLogFlag             = 0
DASBatVoltLogFlag             = 0
DASHbMismatchLogFlag          = 0
```

12 Appendix H – Distance to Stopbar Warning Distances

12.1 Signal_WA_641-11.table

```
#
# Algorithm Components: 6.4.1
#   Algorithm: 641-11.v1
#   Speed Threshold:   32.19 kph (20 mph)
#   Braking Threshold:  None
#
# Relevant Assumed Parameters:
#   Parameter_1:  0.163
#   Parameter_2:  2.012
#   Parameter_3:  -0.491
#
# Notes:
#   Compromise between max True Positives and early warnings
#   False Positive Rate < 0.05
#   Equation:  Parameter_1*Velocity^Parameter_2_+Parameter_3
#
# Revision History:
#   1.0   04/02/2008  S. VanSickle      Initial Table from VTTI
#   1.1   04/15/2008  S. VanSickle      Adding Brake Intent Value
#   1.2   04/27/2008  S. VanSickle      Name change to less than 32 chars
#                                       Fixed duplicate DistanceToWarn104 issue


# Minimum Threshold Speed for signal intersections - XX km/h
MinSignalSpeedThreshold       32.19

# Minimum Braking Intent Threshold for signal intersections
MinSignalBrakeIntent   10

# Distance to warn, in meters, based on speed in kph values
DistanceToWarn001      0.00    #   1 km/h - X.xx m
DistanceToWarn002      0.00    #   2 km/h - X.xx m
DistanceToWarn003      0.00    #   3 km/h - X.xx m
DistanceToWarn004      0.00    #   4 km/h - X.xx m
DistanceToWarn005      0.00    #   5 km/h - X.xx m
DistanceToWarn006      0.00    #   6 km/h - X.xx m
DistanceToWarn007      0.00    #   7 km/h - X.xx m
DistanceToWarn008      0.00    #   8 km/h - X.xx m
DistanceToWarn009      0.00    #   9 km/h - X.xx m
DistanceToWarn010      0.00    #  10 km/h - X.xx m
DistanceToWarn011      0.00    #  11 km/h - X.xx m
DistanceToWarn012      0.00    #  12 km/h - X.xx m
DistanceToWarn013      0.00    #  13 km/h - X.xx m
DistanceToWarn014      0.00    #  14 km/h - X.xx m
DistanceToWarn015      0.00    #  15 km/h - X.xx m
DistanceToWarn016      0.00    #  16 km/h - X.xx m
DistanceToWarn017      0.00    #  17 km/h - X.xx m
DistanceToWarn018      0.00    #  18 km/h - X.xx m
DistanceToWarn019      0.00    #  19 km/h - X.xx m
DistanceToWarn020      0.00    #  20 km/h - X.xx m
DistanceToWarn021      0.00    #  21 km/h - X.xx m
DistanceToWarn022      0.00    #  22 km/h - X.xx m
DistanceToWarn023      0.00    #  23 km/h - X.xx m
DistanceToWarn024      0.00    #  24 km/h - X.xx m
DistanceToWarn025      0.00    #  25 km/h - X.xx m
DistanceToWarn026      0.00    #  26 km/h - X.xx m
DistanceToWarn027      0.00    #  27 km/h - X.xx m
DistanceToWarn028      0.00    #  28 km/h - X.xx m
```

```
DistanceToWarn029      0.00    #  29 km/h - X.xx m
DistanceToWarn030      0.00    #  30 km/h - X.xx m
DistanceToWarn031      0.00    #  31 km/h - X.xx m
DistanceToWarn032      12.71   #  32 km/h - X.xx m
DistanceToWarn033      13.55   #  33 km/h - X.xx m
DistanceToWarn034      14.42   #  34 km/h - X.xx m
DistanceToWarn035      15.32   #  35 km/h - X.xx m
DistanceToWarn036      16.24   #  36 km/h - X.xx m
DistanceToWarn037      17.19   #  37 km/h - X.xx m
DistanceToWarn038      18.16   #  38 km/h - X.xx m
DistanceToWarn039      19.16   #  39 km/h - X.xx m
DistanceToWarn040      20.19   #  40 km/h - X.xx m
DistanceToWarn041      21.24   #  41 km/h - X.xx m
DistanceToWarn042      22.32   #  42 km/h - X.xx m
DistanceToWarn043      23.43   #  43 km/h - X.xx m
DistanceToWarn044      24.56   #  44 km/h - X.xx m
DistanceToWarn045      25.72   #  45 km/h - X.xx m
DistanceToWarn046      26.91   #  46 km/h - X.xx m
DistanceToWarn047      28.12   #  47 km/h - X.xx m
DistanceToWarn048      29.35   #  48 km/h - X.xx m
DistanceToWarn049      30.62   #  49 km/h - X.xx m
DistanceToWarn050      31.91   #  50 km/h - X.xx m
DistanceToWarn051      33.23   #  51 km/h - X.xx m
DistanceToWarn052      34.57   #  52 km/h - X.xx m
DistanceToWarn053      35.94   #  53 km/h - X.xx m
DistanceToWarn054      37.34   #  54 km/h - X.xx m
DistanceToWarn055      38.76   #  55 km/h - X.xx m
DistanceToWarn056      40.21   #  56 km/h - X.xx m
DistanceToWarn057      41.68   #  57 km/h - X.xx m
DistanceToWarn058      43.19   #  58 km/h - X.xx m
DistanceToWarn059      44.71   #  59 km/h - X.xx m
DistanceToWarn060      46.27   #  60 km/h - X.xx m
DistanceToWarn061      47.85   #  61 km/h - X.xx m
DistanceToWarn062      49.46   #  62 km/h - X.xx m
DistanceToWarn063      51.09   #  63 km/h - X.xx m
DistanceToWarn064      52.75   #  64 km/h - X.xx m
DistanceToWarn065      54.44   #  65 km/h - X.xx m
DistanceToWarn066      56.15   #  66 km/h - X.xx m
DistanceToWarn067      57.89   #  67 km/h - X.xx m
DistanceToWarn068      59.66   #  68 km/h - X.xx m
DistanceToWarn069      61.45   #  69 km/h - X.xx m
DistanceToWarn070      63.27   #  70 km/h - X.xx m
DistanceToWarn071      65.12   #  71 km/h - X.xx m
DistanceToWarn072      66.99   #  72 km/h - X.xx m
DistanceToWarn073      68.89   #  73 km/h - X.xx m
DistanceToWarn074      70.82   #  74 km/h - X.xx m
DistanceToWarn075      72.77   #  75 km/h - X.xx m
DistanceToWarn076      74.75   #  76 km/h - X.xx m
DistanceToWarn077      76.75   #  77 km/h - X.xx m
DistanceToWarn078      78.78   #  78 km/h - X.xx m
DistanceToWarn079      80.84   #  79 km/h - X.xx m
DistanceToWarn080      82.93   #  80 km/h - X.xx m
DistanceToWarn081      85.04   #  81 km/h - X.xx m
DistanceToWarn082      87.18   #  82 km/h - X.xx m
DistanceToWarn083      89.34   #  83 km/h - X.xx m
DistanceToWarn084      91.53   #  84 km/h - X.xx m
DistanceToWarn085      93.75   #  85 km/h - X.xx m
DistanceToWarn086      95.99   #  86 km/h - X.xx m
DistanceToWarn087      98.26   #  87 km/h - X.xx m
DistanceToWarn088      100.56  #  88 km/h - X.xx m
DistanceToWarn089      102.88  #  89 km/h - X.xx m
DistanceToWarn090      105.24  #  90 km/h - X.xx m
DistanceToWarn091      107.61  #  91 km/h - X.xx m
DistanceToWarn092      110.02  #  92 km/h - X.xx m
DistanceToWarn093      112.45  #  93 km/h - X.xx m
DistanceToWarn094      114.90  #  94 km/h - X.xx m
DistanceToWarn095      117.39  #  95 km/h - X.xx m
```

```
DistanceToWarn096      119.90  #  96 km/h - X.xx m
DistanceToWarn097      122.43  #  97 km/h - X.xx m
DistanceToWarn098      125.00  #  98 km/h - X.xx m
DistanceToWarn099      127.59  #  99 km/h - X.xx m
DistanceToWarn100      130.20  # 100 km/h - X.xx m
DistanceToWarn101      132.84  # 101 km/h - X.xx m
DistanceToWarn102      135.51  # 102 km/h - X.xx m
DistanceToWarn103      138.21  # 103 km/h - X.xx m
DistanceToWarn104      140.93  # 104 km/h - X.xx m
DistanceToWarn105      143.68  # 105 km/h - X.xx m
DistanceToWarn106      146.46  # 106 km/h - X.xx m
DistanceToWarn107      149.26  # 107 km/h - X.xx m
DistanceToWarn108      152.09  # 108 km/h - X.xx m
DistanceToWarn109      154.95  # 109 km/h - X.xx m
DistanceToWarn110      157.83  # 110 km/h - X.xx m
DistanceToWarn111      160.74  # 111 km/h - X.xx m
DistanceToWarn112      163.68  # 112 km/h - X.xx m
DistanceToWarn113      166.64  # 113 km/h - X.xx m
DistanceToWarn114      169.63  # 114 km/h - X.xx m
DistanceToWarn115      172.64  # 115 km/h - X.xx m
DistanceToWarn116      175.69  # 116 km/h - X.xx m
DistanceToWarn117      178.75  # 117 km/h - X.xx m
DistanceToWarn118      181.85  # 118 km/h - X.xx m
DistanceToWarn119      184.97  # 119 km/h - X.xx m
DistanceToWarn120      188.12  # 120 km/h - X.xx m
DistanceToWarn121      191.30  # 121 km/h - X.xx m
DistanceToWarn122      194.50  # 122 km/h - X.xx m
DistanceToWarn123      197.73  # 123 km/h - X.xx m
DistanceToWarn124      200.99  # 124 km/h - X.xx m
DistanceToWarn125      204.27  # 125 km/h - X.xx m
DistanceToWarn126      207.58  # 126 km/h - X.xx m
DistanceToWarn127      210.91  # 127 km/h - X.xx m
DistanceToWarn128      214.28  # 128 km/h - X.xx m
DistanceToWarn129      217.67  # 129 km/h - X.xx m
DistanceToWarn130      221.08  # 130 km/h - X.xx m
DistanceToWarn131      224.53  # 131 km/h - X.xx m
DistanceToWarn132      227.99  # 132 km/h - X.xx m
DistanceToWarn133      231.49  # 133 km/h - X.xx m
DistanceToWarn134      235.01  # 134 km/h - X.xx m
DistanceToWarn135      238.56  # 135 km/h - X.xx m
DistanceToWarn136      242.14  # 136 km/h - X.xx m
DistanceToWarn137      245.74  # 137 km/h - X.xx m
DistanceToWarn138      249.37  # 138 km/h - X.xx m
DistanceToWarn139      253.03  # 139 km/h - X.xx m
DistanceToWarn140      256.71  # 140 km/h - X.xx m
DistanceToWarn141      260.42  # 141 km/h - X.xx m
DistanceToWarn142      264.16  # 142 km/h - X.xx m
DistanceToWarn143      267.92  # 143 km/h - X.xx m
DistanceToWarn144      271.71  # 144 km/h - X.xx m
DistanceToWarn145      275.53  # 145 km/h - X.xx m
DistanceToWarn146      279.37  # 146 km/h - X.xx m
DistanceToWarn147      283.24  # 147 km/h - X.xx m
DistanceToWarn148      287.14  # 148 km/h - X.xx m
DistanceToWarn149      291.06  # 149 km/h - X.xx m
DistanceToWarn150      295.01  # 150 km/h - X.xx m
DistanceToWarn151      298.99  # 151 km/h - X.xx m
DistanceToWarn152      303.00  # 152 km/h - X.xx m
DistanceToWarn153      307.03  # 153 km/h - X.xx m
DistanceToWarn154      311.08  # 154 km/h - X.xx m
DistanceToWarn155      315.17  # 155 km/h - X.xx m
DistanceToWarn156      319.28  # 156 km/h - X.xx m
DistanceToWarn157      323.42  # 157 km/h - X.xx m
DistanceToWarn158      327.58  # 158 km/h - X.xx m
DistanceToWarn159      331.77  # 159 km/h - X.xx m
DistanceToWarn160      335.99  # 160 km/h - X.xx m
DistanceToWarn161      340.24  # 161 km/h - X.xx m
DistanceToWarn162      344.51  # 162 km/h - X.xx m
```

```
DistanceToWarn163      348.81  # 163 km/h - X.xx m
DistanceToWarn164      353.13  # 164 km/h - X.xx m
DistanceToWarn165      357.48  # 165 km/h - X.xx m
DistanceToWarn166      361.86  # 166 km/h - X.xx m
DistanceToWarn167      366.27  # 167 km/h - X.xx m
DistanceToWarn168      370.70  # 168 km/h - X.xx m
DistanceToWarn169      375.16  # 169 km/h - X.xx m
DistanceToWarn170      379.64  # 170 km/h - X.xx m
DistanceToWarn171      384.16  # 171 km/h - X.xx m
DistanceToWarn172      388.70  # 172 km/h - X.xx m
DistanceToWarn173      393.26  # 173 km/h - X.xx m
DistanceToWarn174      397.86  # 174 km/h - X.xx m
DistanceToWarn175      402.48  # 175 km/h - X.xx m
DistanceToWarn176      407.12  # 176 km/h - X.xx m
DistanceToWarn177      411.80  # 177 km/h - X.xx m
DistanceToWarn178      416.50  # 178 km/h - X.xx m
DistanceToWarn179      421.22  # 179 km/h - X.xx m
DistanceToWarn180      425.98  # 180 km/h - X.xx m
DistanceToWarn181      430.76  # 181 km/h - X.xx m
DistanceToWarn182      435.56  # 182 km/h - X.xx m
DistanceToWarn183      440.40  # 183 km/h - X.xx m
DistanceToWarn184      445.26  # 184 km/h - X.xx m
DistanceToWarn185      450.15  # 185 km/h - X.xx m
DistanceToWarn186      455.06  # 186 km/h - X.xx m
DistanceToWarn187      460.00  # 187 km/h - X.xx m
DistanceToWarn188      464.97  # 188 km/h - X.xx m
DistanceToWarn189      469.97  # 189 km/h - X.xx m
DistanceToWarn190      474.99  # 190 km/h - X.xx m
DistanceToWarn191      480.04  # 191 km/h - X.xx m
DistanceToWarn192      485.11  # 192 km/h - X.xx m
DistanceToWarn193      490.22  # 193 km/h - X.xx m
DistanceToWarn194      495.34  # 194 km/h - X.xx m
DistanceToWarn195      500.50  # 195 km/h - X.xx m
DistanceToWarn196      505.68  # 196 km/h - X.xx m
DistanceToWarn197      510.89  # 197 km/h - X.xx m
DistanceToWarn198      516.13  # 198 km/h - X.xx m
DistanceToWarn199      521.39  # 199 km/h - X.xx m
DistanceToWarn200      526.68  # 200 km/h - X.xx m
```

12.2 StopSign_WA_741-09.table

```
Algorithm Components: 7.4.1
#   Algorithm:         741-09
#   Speed Threshold:   32.19 kph (20 mph)
#   Braking Threshold:  none
#
# Relevant Assumed Parameters:
#   Parameter_1:  0.019
#   Parameter_2:  2.726
#   Parameter_3:  1.320
#
# Notes:
#   Compromise between max True Positives and early warnings
#   False Positive Rate < 0.05
#   Equation:  Parameter_1*Velocity^Parameter_2_+Parameter_3
#
# Revision History:
#   1.0   06/04/2008  z.Doerzaph      Initial Table from VTTI



# Minimum Threshold Speed for stop sign intersections - XX km/h
MinStopSignSpeedThreshold            32.19

# Minimum Braking Intent Threshold for stop sign intersections
MinStopSignBrakeIntent               10
```

```
"# Distance to warn, in meters, based on speed in kph values"
DistanceToWarn001      0.00    # 1 km/h - X.xx m
DistanceToWarn002      0.00    # 2 km/h - X.xx m
DistanceToWarn003      0.00    # 3 km/h - X.xx m
DistanceToWarn004      0.00    # 4 km/h - X.xx m
DistanceToWarn005      0.00    # 5 km/h - X.xx m
DistanceToWarn006      0.00    # 6 km/h - X.xx m
DistanceToWarn007      0.00    # 7 km/h - X.xx m
DistanceToWarn008      0.00    # 8 km/h - X.xx m
DistanceToWarn009      0.00    # 9 km/h - X.xx m
DistanceToWarn010      0.00    # 10 km/h - X.xx m
DistanceToWarn011      0.00    # 11 km/h - X.xx m
DistanceToWarn012      0.00    # 12 km/h - X.xx m
DistanceToWarn013      0.00    # 13 km/h - X.xx m
DistanceToWarn014      0.00    # 14 km/h - X.xx m
DistanceToWarn015      0.00    # 15 km/h - X.xx m
DistanceToWarn016      0.00    # 16 km/h - X.xx m
DistanceToWarn017      0.00    # 17 km/h - X.xx m
DistanceToWarn018      0.00    # 18 km/h - X.xx m
DistanceToWarn019      0.00    # 19 km/h - X.xx m
DistanceToWarn020      0.00    # 20 km/h - X.xx m
DistanceToWarn021      0.00    # 21 km/h - X.xx m
DistanceToWarn022      0.00    # 22 km/h - X.xx m
DistanceToWarn023      0.00    # 23 km/h - X.xx m
DistanceToWarn024      0.00    # 24 km/h - X.xx m
DistanceToWarn025      0.00    # 25 km/h - X.xx m
DistanceToWarn026      0.00    # 26 km/h - X.xx m
DistanceToWarn027      0.00    # 27 km/h - X.xx m
DistanceToWarn028      0.00    # 28 km/h - X.xx m
DistanceToWarn029      0.00    # 29 km/h - X.xx m
DistanceToWarn030      0.00    # 30 km/h - X.xx m
DistanceToWarn031      0.00    # 31 km/h - X.xx m
DistanceToWarn032      8.67    # 32 km/h - X.xx m
DistanceToWarn033      9.31    # 33 km/h - X.xx m
DistanceToWarn034      9.99    # 34 km/h - X.xx m
DistanceToWarn035      10.70   # 35 km/h - X.xx m
DistanceToWarn036      11.45   # 36 km/h - X.xx m
DistanceToWarn037      12.23   # 37 km/h - X.xx m
DistanceToWarn038      13.06   # 38 km/h - X.xx m
DistanceToWarn039      13.92   # 39 km/h - X.xx m
DistanceToWarn040      14.82   # 40 km/h - X.xx m
DistanceToWarn041      15.76   # 41 km/h - X.xx m
DistanceToWarn042      16.74   # 42 km/h - X.xx m
DistanceToWarn043      17.76   # 43 km/h - X.xx m
DistanceToWarn044      18.82   # 44 km/h - X.xx m
DistanceToWarn045      19.93   # 45 km/h - X.xx m
DistanceToWarn046      21.08   # 46 km/h - X.xx m
DistanceToWarn047      22.27   # 47 km/h - X.xx m
DistanceToWarn048      23.51   # 48 km/h - X.xx m
DistanceToWarn049      24.79   # 49 km/h - X.xx m
DistanceToWarn050      26.12   # 50 km/h - X.xx m
DistanceToWarn051      27.50   # 51 km/h - X.xx m
DistanceToWarn052      28.92   # 52 km/h - X.xx m
DistanceToWarn053      30.39   # 53 km/h - X.xx m
DistanceToWarn054      31.91   # 54 km/h - X.xx m
DistanceToWarn055      33.48   # 55 km/h - X.xx m
DistanceToWarn056      35.10   # 56 km/h - X.xx m
DistanceToWarn057      36.77   # 57 km/h - X.xx m
DistanceToWarn058      38.49   # 58 km/h - X.xx m
DistanceToWarn059      40.26   # 59 km/h - X.xx m
DistanceToWarn060      42.08   # 60 km/h - X.xx m
DistanceToWarn061      43.96   # 61 km/h - X.xx m
DistanceToWarn062      45.90   # 62 km/h - X.xx m
DistanceToWarn063      47.88   # 63 km/h - X.xx m
DistanceToWarn064      49.93   # 64 km/h - X.xx m
DistanceToWarn065      52.02   # 65 km/h - X.xx m
DistanceToWarn066      54.18   # 66 km/h - X.xx m
```

```
DistanceToWarn067      56.39   # 67 km/h - X.xx m
DistanceToWarn068      58.66   # 68 km/h - X.xx m
DistanceToWarn069      60.99   # 69 km/h - X.xx m
DistanceToWarn070      63.37   # 70 km/h - X.xx m
DistanceToWarn071      65.82   # 71 km/h - X.xx m
DistanceToWarn072      68.33   # 72 km/h - X.xx m
DistanceToWarn073      70.89   # 73 km/h - X.xx m
DistanceToWarn074      73.52   # 74 km/h - X.xx m
DistanceToWarn075      76.21   # 75 km/h - X.xx m
DistanceToWarn076      78.97   # 76 km/h - X.xx m
DistanceToWarn077      81.78   # 77 km/h - X.xx m
DistanceToWarn078      84.66   # 78 km/h - X.xx m
DistanceToWarn079      87.61   # 79 km/h - X.xx m
DistanceToWarn080      90.62   # 80 km/h - X.xx m
DistanceToWarn081      93.69   # 81 km/h - X.xx m
DistanceToWarn082      96.83   # 82 km/h - X.xx m
DistanceToWarn083      100.04  # 83 km/h - X.xx m
DistanceToWarn084      103.32  # 84 km/h - X.xx m
DistanceToWarn085      106.66  # 85 km/h - X.xx m
DistanceToWarn086      110.07  # 86 km/h - X.xx m
DistanceToWarn087      113.56  # 87 km/h - X.xx m
DistanceToWarn088      117.11  # 88 km/h - X.xx m
DistanceToWarn089      120.73  # 89 km/h - X.xx m
DistanceToWarn090      124.42  # 90 km/h - X.xx m
DistanceToWarn091      128.19  # 91 km/h - X.xx m
DistanceToWarn092      132.02  # 92 km/h - X.xx m
DistanceToWarn093      135.93  # 93 km/h - X.xx m
DistanceToWarn094      139.91  # 94 km/h - X.xx m
DistanceToWarn095      143.97  # 95 km/h - X.xx m
DistanceToWarn096      148.10  # 96 km/h - X.xx m
DistanceToWarn097      152.30  # 97 km/h - X.xx m
DistanceToWarn098      156.59  # 98 km/h - X.xx m
DistanceToWarn099      160.94  # 99 km/h - X.xx m
DistanceToWarn100      165.38  # 100 km/h - X.xx m
DistanceToWarn101      169.89  # 101 km/h - X.xx m
DistanceToWarn102      174.47  # 102 km/h - X.xx m
DistanceToWarn103      179.14  # 103 km/h - X.xx m
DistanceToWarn104      183.89  # 104 km/h - X.xx m
DistanceToWarn105      188.71  # 105 km/h - X.xx m
DistanceToWarn106      193.62  # 106 km/h - X.xx m
DistanceToWarn107      198.60  # 107 km/h - X.xx m
DistanceToWarn108      203.67  # 108 km/h - X.xx m
DistanceToWarn109      208.81  # 109 km/h - X.xx m
DistanceToWarn110      214.04  # 110 km/h - X.xx m
DistanceToWarn111      219.36  # 111 km/h - X.xx m
DistanceToWarn112      224.75  # 112 km/h - X.xx m
DistanceToWarn113      230.23  # 113 km/h - X.xx m
DistanceToWarn114      235.80  # 114 km/h - X.xx m
DistanceToWarn115      241.45  # 115 km/h - X.xx m
DistanceToWarn116      247.18  # 116 km/h - X.xx m
DistanceToWarn117      253.00  # 117 km/h - X.xx m
DistanceToWarn118      258.91  # 118 km/h - X.xx m
DistanceToWarn119      264.90  # 119 km/h - X.xx m
DistanceToWarn120      270.98  # 120 km/h - X.xx m
DistanceToWarn121      277.15  # 121 km/h - X.xx m
DistanceToWarn122      283.41  # 122 km/h - X.xx m
DistanceToWarn123      289.76  # 123 km/h - X.xx m
DistanceToWarn124      296.20  # 124 km/h - X.xx m
DistanceToWarn125      302.72  # 125 km/h - X.xx m
DistanceToWarn126      309.34  # 126 km/h - X.xx m
DistanceToWarn127      316.05  # 127 km/h - X.xx m
DistanceToWarn128      322.85  # 128 km/h - X.xx m
DistanceToWarn129      329.74  # 129 km/h - X.xx m
DistanceToWarn130      336.73  # 130 km/h - X.xx m
DistanceToWarn131      343.81  # 131 km/h - X.xx m
DistanceToWarn132      350.98  # 132 km/h - X.xx m
DistanceToWarn133      358.25  # 133 km/h - X.xx m
```

```
DistanceToWarn134      365.61  # 134 km/h - X.xx m
DistanceToWarn135      373.07  # 135 km/h - X.xx m
DistanceToWarn136      380.63  # 136 km/h - X.xx m
DistanceToWarn137      388.28  # 137 km/h - X.xx m
DistanceToWarn138      396.02  # 138 km/h - X.xx m
DistanceToWarn139      403.87  # 139 km/h - X.xx m
DistanceToWarn140      411.81  # 140 km/h - X.xx m
DistanceToWarn141      419.85  # 141 km/h - X.xx m
DistanceToWarn142      428.00  # 142 km/h - X.xx m
DistanceToWarn143      436.24  # 143 km/h - X.xx m
DistanceToWarn144      444.58  # 144 km/h - X.xx m
DistanceToWarn145      453.02  # 145 km/h - X.xx m
DistanceToWarn146      461.56  # 146 km/h - X.xx m
DistanceToWarn147      470.20  # 147 km/h - X.xx m
DistanceToWarn148      478.95  # 148 km/h - X.xx m
DistanceToWarn149      487.80  # 149 km/h - X.xx m
DistanceToWarn150      496.75  # 150 km/h - X.xx m
DistanceToWarn151      505.80  # 151 km/h - X.xx m
DistanceToWarn152      514.96  # 152 km/h - X.xx m
DistanceToWarn153      524.22  # 153 km/h - X.xx m
DistanceToWarn154      533.59  # 154 km/h - X.xx m
DistanceToWarn155      543.07  # 155 km/h - X.xx m
DistanceToWarn156      552.65  # 156 km/h - X.xx m
DistanceToWarn157      562.33  # 157 km/h - X.xx m
DistanceToWarn158      572.13  # 158 km/h - X.xx m
DistanceToWarn159      582.03  # 159 km/h - X.xx m
DistanceToWarn160      592.04  # 160 km/h - X.xx m
DistanceToWarn161      602.16  # 161 km/h - X.xx m
DistanceToWarn162      612.38  # 162 km/h - X.xx m
DistanceToWarn163      622.72  # 163 km/h - X.xx m
DistanceToWarn164      633.17  # 164 km/h - X.xx m
DistanceToWarn165      643.72  # 165 km/h - X.xx m
DistanceToWarn166      654.39  # 166 km/h - X.xx m
DistanceToWarn167      665.17  # 167 km/h - X.xx m
DistanceToWarn168      676.06  # 168 km/h - X.xx m
DistanceToWarn169      687.07  # 169 km/h - X.xx m
DistanceToWarn170      698.18  # 170 km/h - X.xx m
DistanceToWarn171      709.41  # 171 km/h - X.xx m
DistanceToWarn172      720.76  # 172 km/h - X.xx m
DistanceToWarn173      732.22  # 173 km/h - X.xx m
DistanceToWarn174      743.79  # 174 km/h - X.xx m
DistanceToWarn175      755.48  # 175 km/h - X.xx m
DistanceToWarn176      767.28  # 176 km/h - X.xx m
DistanceToWarn177      779.21  # 177 km/h - X.xx m
DistanceToWarn178      791.24  # 178 km/h - X.xx m
DistanceToWarn179      803.40  # 179 km/h - X.xx m
DistanceToWarn180      815.67  # 180 km/h - X.xx m
DistanceToWarn181      828.06  # 181 km/h - X.xx m
DistanceToWarn182      840.57  # 182 km/h - X.xx m
DistanceToWarn183      853.20  # 183 km/h - X.xx m
DistanceToWarn184      865.95  # 184 km/h - X.xx m
DistanceToWarn185      878.82  # 185 km/h - X.xx m
DistanceToWarn186      891.81  # 186 km/h - X.xx m
DistanceToWarn187      904.92  # 187 km/h - X.xx m
DistanceToWarn188      918.15  # 188 km/h - X.xx m
DistanceToWarn189      931.51  # 189 km/h - X.xx m
DistanceToWarn190      944.98  # 190 km/h - X.xx m
DistanceToWarn191      958.58  # 191 km/h - X.xx m
DistanceToWarn192      972.30  # 192 km/h - X.xx m
DistanceToWarn193      986.15  # 193 km/h - X.xx m
DistanceToWarn194      1000.10 # 194 km/h - X.xx m
DistanceToWarn195      1014.20 # 195 km/h - X.xx m
DistanceToWarn196      1028.40 # 196 km/h - X.xx m
DistanceToWarn197      1042.80 # 197 km/h - X.xx m
DistanceToWarn198      1057.30 # 198 km/h - X.xx m
DistanceToWarn199      1071.90 # 199 km/h - X.xx m
DistanceToWarn200      1086.60 # 200 km/h - X.xx
```

1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free "Help Line" 866-367-7487
www.its.dot.gov

FHWA-JPO-10-068

U.S. Department of Transportation

Research and Innovative Technology Administration