International Association of Chiefs of Police

***RLCS* Performance Standards** **Volume 1 dated November 29, 2007**

PERFORMANCE SPECIFICATIONS:

RED LIGHT CAMERA SYSTEM MODULE

FOREWORD

This document contains the *Red Light Camera System* (*RLCS*) performance specifications developed by the Enforcement Technology Advisory Technical Subcommittee (ETATS), comprised of *RLCS* manufacturers, traffic enforcement agencies using or planning to use *RLCS*s, under agreement with the International Association of the Chiefs of Police (IACP).

By defining minimum performance requirements and verification procedures, this technical document establishes a base line for acceptable *RLCS* measuring device performance. Citizens, courts, and law enforcement officers should be assured that those *RLCS* models, determined by test to comply with these specifications, would provide the high-quality service they require.

Equipment buyers should use these performance specifications as a model to develop purchasing criteria. It is recommended that these specifications be incorporated into procurement documents requiring that devices offered for purchase meet, as a minimum, these specifications.

Manufacturers who want their *RLCS* to be included on the IACP Conforming Product List (CPL) are required to produce an *RLCS* that meets or exceeds these performance specifications.

Because this document is designed as a development and procurement aid, it is necessarily highly technical.

These performance specifications are subjected to continuing review. Technical comments and recommended revisions are welcome. Please send suggestions to:

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National Highway Traffic Safety Administration

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Washington, DC 20590

Before citing these performance specifications, or any part of them, users should verify that the most recent edition of this document is being used.

These performance specifications for *RLCS* will assist law-enforcement administrators in determining the accuracy and reliability of *RLCS* they plan to purchase. These performance specifications and testing protocols are intended to increase the confidence of law-enforcement administrators, the public and the courts in the accuracy and reliability of *RLCS*.

ACKNOWLEDGMENTS

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1 General Information

1.1 Purpose

The purpose of this document is to specify the minimum performance requirements and test procedures for a *Red Light Camera System* (*RLCS*) used by law enforcement agencies for enforcing traffic regulations. Compliance with these specifications conveys to law enforcement agencies and to the public an implied level of *RLCS* reliability and accuracy suitable for traffic law enforcement for *unattended operation*.

1.2 Scope

The scope of this document is limited to *RLCS*s used for enforcing laws governing the safe and orderly flow of traffic at *controlled intersection*s and that use imaging technology to collect appropriate *event* evidence. Generally an *RLCS* comprises one or more imaging device(s), and may include additional sensors to detect vehicle presence, position and motion as well as the traffic *signal phase*. Although required in some capacity, *RLCS* image quality is not quantitatively assessed as a part of this standard.

The word “speed,” as used in this specification, is not intended to convey or imply information on the accuracy of any speed measurements. Consequently, speed law violations alone are not enforceable with equipment tested using this *RLCS* Performance Specification. To the extent that any *RLCS* supports or provides enforceable vehicle speed measurement capability, such capability shall be separately tested in accordance with published standards applicable to the specific speed measuring technology utilized by the specific *RLCS*.

1.3 Application

This document applies to an *RLCS* that senses or measures the position and/or motion of vehicles as they pass through a *controlled intersection* and in the context of the *signal phase*, record images of vehicles violating local traffic regulations.

1.4 Definitions

All defined terms are italicized within this document.

1.4.1 Associated *Event* Data

Alphanumeric data that identifies information specific to an *event*.

1.4.2 Compliant Traffic

Traffic approaching, stopping or proceeding through the *controlled intersection* that is not the subject of a *red phase event*.

1.4.3 Controlled Intersection

An intersection on a public roadway that is equipped with *traffic signal*s that are used to control or meter the flow of traffic through that intersection.

1.4.4 Display

A visual readout device.

1.4.5 Event

An alleged *red phase violation* at a *controlled intersection*.

1.4.6 *Event* ID

A character string that is uniquely associated with an *event* and to which the *associated event data* and *event images* are referenced.

1.4.7 *Event* Images

A series of images for a single *event* taken at the time of the event.

1.4.8 *Event* Information

Both the *event images* and the *associated event data* for a single *event*.

1.4.9 Flashing Red

A red signal that is not constantly illuminated and flashes between 50 cycles per minute and 60 cycles per minute.

1.4.10 Green Phase

The interval during which the green light of the *traffic signal* is continuously illuminating.

1.4.11 Intersection Threshold

A line, real or imaginary, that defines the start of the *controlled intersection*. The *intersection threshold* is perpendicular to traffic flow, located on the lanes facing the *traffic signal*, and its position in those lanes is defined by local law.

1.4.12 Non-*Red Phase*

Any phase of a *traffic signal* that is not a *red phase*. A vehicle is not in violation, for the purposes of this document, during a *non-red phase*.

1.4.13 Phase Duration

The duration, measured in seconds and with an uncertainty of 0.1 s, during which one of the phases of the *traffic signal* is illuminated.

1.4.14 Red Light Camera System (*RLCS*)

All equipment, cabling, and software required to detect, capture, and store *event information* associated with an *event* at an controlled intersection. The *RLCS*, either as a singly-enclosed system or as a distributed system, is located at the *controlled intersection*, and is separate from any hardware or software which is not located at the controlled intersection, for the purpose of collecting, storing, transferring, viewing, or otherwise processing *event* data.

1.4.15 Red Phase

The interval during which the red light of the *traffic signal* is continuously illuminating.

1.4.16 *Red Phase* Violation

An *incident* at a *controlled intersection* whereby any part of a vehicle extends past the *intersection threshold* while the *traffic signal* is displaying a *red phase* to the operator of such vehicle.

1.4.17 *RLCS* Installation

A *controlled intersection* equipped with an *RLCS*.

1.4.18 Signal Phase

The time during which one of the lights (red, yellow, or green) of a *traffic signal* is illuminated.

1.4.19 System Test

A test function (whether manually or automatically initiated) for verifying that the *RLCS* internal signal processing circuitry and software are working. For example, an indicator showing the current *signal phase* as detected by the *RLCS*.

1.4.20 Time Into Red

The duration, measured in seconds and with an uncertainty of 0.1 s, between the instant the *traffic signal* enters the red *signal phase* and the instant an image is captured by the *RLCS*.

1.4.21 Traffic Signal

A collection of lights (usually red lights, yellow lights and green lights) used in various combinations and configurations at *controlled intersection*s.

1.4.22 Yellow Phase

The interval during which the yellow light of the *traffic signal* is continuously illuminating.

1.4.23 Unattended Operation

An operator is not an integral part of the evidence acquisition process.

2 Requirements

The verb "shall" is used to indicate a binding condition of a requirement. Usage of other verbs synonymous with "shall," such as "will" or "must" are allowed to indicate other relationships which might exist, but do not indicate a binding condition. Only one binding condition is associated with each numbered requirement.

Unless otherwise noted, all requirements of this section have an uncertainty of +/- 0.1 seconds, +/- 0.30 m (1.0 feet), or +/- 1 Volt, as applicable.

2.1 Manufacturer Provided Equipment

The following equipment, facilities and information are required to conduct the laboratory and field-testing described in §5 (Test Procedures) for the unit under test (UUT).

2.1.1 *Red Light Camera System* (*RLCS*)

The manufacturer shall provide all equipment, cabling, and software required to automatically detect, capture and store *event information*, as verified in §5.1.1. This does not include mounting pole(s) and associated equipment, or vehicle detector(s) normally associated with an *RLCS* at a *controlled intersection*.

2.1.2 *RLCS* Simulator Interface

The manufacturer shall provide an IACP–approved *RLCS event* simulator interface (Figure 1), as verified in §5.1.2. This simulator interface converts the signals output by the Intersection Simulator (§4.2) to a format which can be input and recognized by the *RLCS* (§2.1.1).

2.1.3 Operational Test Site

2.1.3.1 Test Site Access

The manufacturer shall provide access to an operational *RLCS installation*, as verified in §5.1.3.1.

2.1.3.2 Test Site Components

All components of the operational test site shall be identical to those provided in the *RLCS* specified in §2.1.1, as verified in §5.1.3.2.

2.1.3.3 Test Site Location

The test site shall be at a standard 4-way *controlled intersection*, as verified in §5.1.3.3. A one-way street is allowed for either the through street or the cross street at the intersection.

2.1.3.4 Monitored Lanes

The *RLCS* at the test site shall be configured to monitor at least three adjacent lanes of through traffic for the purpose of the field test, as verified in §5.1.3.4.

2.1.3.5 Lane Width

The lanes monitored by the *RLCS* for the purpose of the field test must be 3.66 m (12 ft) in width, as verified in §5.1.3.5.

2.1.3.6 Yellow *Phase Duration*

The Yellow *Phase Duration* of the monitored lanes shall be a minimum of 3.0 s, as verified in §5.1.3.6.

2.1.3.7 Lane Closure Approval

The manufacturer shall have approval from the contracted jurisdiction for closure of the street and cross streets at the test site as necessary for the time of the Field Operation Test (§5.6), as verified in §5.1.3.7.

2.1.3.8 *RLCS* Mounting

The *RLCS* at the test site shall be mounted such that it is firmly attached to its supporting structure, as verified in §5.1.3.8.

2.1.3.9 *RLCS* Geometry

The positional relationship between *RLCS*, the monitored lanes, *intersection threshold*, and *traffic signal* at the test site shall be within tolerance of any dimensions specified in the *RLCS* Operator's Manual (§2.2.1.1), as verified in §5.1.3.9.

2.2 Manufacturer Provided Documentation

2.2.1 Operator Manuals

2.2.1.1 *RLCS* Operator's Manual

The manufacturer shall provide operator's manuals necessary to install, test and operate an *RLCS*, as verified in §5.2.1.1.

2.2.1.2 *RLCS* Simulator Interface Manual

The manufacturer shall provide operator's manuals necessary to install and use the simulator interface specified in §2.1.2, as verified in §5.2.1.2.

2.2.2 Performance Specifications

2.2.2.1 Power

If multiple power-supply options exist, the manufacturer is allowed to specify information for each option.

2.2.2.1.1 Nominal Voltage Level and Type

The manufacturer shall specify the nominal voltage and voltage type (AC/DC) necessary to power the *RLCS*, as verified in §5.2.2.1.1.

2.2.2.1.2 Voltage Range

The manufacturer shall specify the voltage range over which the *RLCS* will operate, as verified in §5.2.2.1.2.

2.2.2.1.3 Nominal Current Draw

The manufacturer shall specify the nominal current draw of the *RLCS* during normal operation, as verified in §5.2.2.1.3.

2.2.2.1.4 Maximum Current Draw

The manufacturer shall specify the maximum current draw of the *RLCS* during normal operation, as verified in §5.2.2.1.4.

2.2.2.1.5 Maximum Voltage Spike

The manufacturer shall specify the maximum voltage spike for which the *RLCS* will operate without failure, as verified in §5.2.2.1.5.

2.2.2.1.6 System Warm Up Time

The manufacturer shall specify the time required from system turn-on for the *RLCS* to warm up to a fully stable and operational state, as verified in §5.2.2.1.6.

2.2.2.2 Environmental Specifications

If the *RLCS* consists of a distributed system with different subsystems having different environmental requirements, the manufacturer is allowed to specify the listed information for each appropriate subsystem.

2.2.2.2.1 Operational Temperature Range

The manufacturer shall specify the operational temperature range over which the *RLCS* is designed to operate, as verified in §5.2.2.2.1.

2.2.2.2.2 Operational Temperature Certification

The manufacturer shall either submit a statement certifying the *RLCS* has been tested and certified over the operational temperature range specified in §2.2.2.2.1, or authorize the IACP to test and certify the *RLCS* to this temperature range as a part of the IACP certification testing, as verified in §5.2.2.2.2.

2.2.2.2.3 Storage Temperature Range

The manufacturer shall specify the storage temperature range for the *RLCS*, as verified in §5.2.2.2.3.

2.2.2.2.4 Storage Temperature Certification

The manufacturer shall either submit a statement certifying the *RLCS* has been tested and certified over the storage temperature range specified in §2.2.2.2.3, or authorize the IACP to test and certify the *RLCS* to this temperature range as a part of the IACP certification testing, as verified in §5.2.2.2.4.

2.2.2.2.5 Operational Humidity Range

The manufacturer shall specify the humidity range over which the *RLCS* is designed to operate, as verified in §5.2.2.2.5.

2.2.2.2.6 Humidity Certification

The manufacturer shall either submit a statement certifying the *RLCS* has been tested and certified to the humidity range specified in §§2.2.2.2.5, or authorize the IACP to test and certify the *RLCS* to this humidity range as a part of the IACP certification testing, as verified in §5.2.2.2.6.

2.2.2.2.7 Intrusion Resistance Certification

(Reserved)

2.2.2.2.8 Electromagnetic Interference (EMI) Generation Certification

(Reserved)

2.2.2.2.9 Electromagnetic Interference (EMI) Susceptibility Certification

(Reserved)

2.2.3 *Event Information* Samples

The manufacturer shall provide at least ten samples of *event Information* (§2.3) from the operational test site specified in §2.1.3, as verified in §5.2.3.

2.2.4 Methodologies

2.2.4.1 *Event* Activation and Recognition

The manufacturer shall provide a methodology to verify that the *RLCS* has been activated as a result of either a simulated or actual *event*, as verified in §5.2.4.1.

2.2.4.2 Review *Event Information*

The manufacturer shall provide a methodology to review the *event information* captured and stored by the *RLCS*, as verified in §5.2.4.2.

2.2.4.3 *Associated Event Data*

The manufacturer shall provide a methodology to verify the accuracy of the *associated data*, as verified in §5.2.4.3.

2.3 Event Information

2.3.1 Information Consolidation

2.3.1.1 Information Consolidation Storage

The *Red Light Camera System* shall capture the *event information*, and store this information in a consolidated format, minimizing the opportunity for *event information* to be de-synchronized or otherwise misattributed, as verified in §5.3.1.1.

2.3.1.2 Information Consolidation Processes

The processes of combining various elements that constitute the *event information*, in whatever form, shall occur without human intervention at the time of the suspected red-light violation, as verified in §5.3.1.2.

2.3.2 *Event Images*

2.3.2.1 First Image

2.3.2.1.1 The *RLCS* shall acquire an image which shows the suspect vehicle of the *event* behind the *intersection threshold*, as verified in §5.3.2.1.1. This image is referred to as the "First Image."

2.3.2.1.2 The first image shall show the *traffic signal* facing the suspect vehicle in a steady *red phase*, as verified in §5.3.2.1.2.

2.3.2.2 Second Image

2.3.2.2.1 The *RLCS* shall acquire an image which shows the suspect vehicle of the *event* with any portion of the vehicle beyond the *intersection threshold*, as verified in §5.3.2.2.1. This image is referred to as the "Second Image."

2.3.2.2.2 The second image shall show the *traffic signal* facing the suspect vehicle, as verified in §5.3.2.2.2.

2.3.2.3 License Plate

At least one of the images acquired for this *event* shall show the suspect vehicle's license plate, as verified in §5.3.2.3.

2.3.3 *Associated Event Data*

The minimum *associated event data* for each image shall be visually imprinted on each required image identified in Section 2.3.2. This minimum *associated event data* includes the following information:

2.3.3.1 Location Identifier

The location of the intersection shall have a unique identifier, as verified in §5.3.3.1.

2.3.3.2 *Event ID*

The *event* shall be identified with a unique *Event ID*, as verified in §5.3.3.2. This *Event ID* can be used to link the various *event images* and *associated event data*.

2.3.3.3 Date

2.3.3.3.1 Date Identification

The date of the corresponding image shall be identified—i.e., month, day and year, as verified in §5.3.3.3.1.

2.3.3.3.2 Date Format

The date shall be presented in a consistent manner. The format for the date is left up to the manufacturer, as verified in §5.3.3.3.2.

2.3.3.4 Time of Day

2.3.3.4.1 Time of Day Identification

The local-adjusted UTC Time of Day of the corresponding image shall be identified — i.e., hour, minute and second, as verified in §5.3.3.4.1.

2.3.3.4.2 Time of Day Resolution

The Time of Day shall have an uncertainty of +/- one minute, as verified in §5.3.3.4.2.

2.3.3.4.3 Time of Day Format

The Time of Day shall be presented in a consistent manner, as verified in §5.3.3.4.3. The format for the Time of Day is left up to the manufacturer.

2.3.3.5 Time into Red

2.3.3.5.1 *Time Into Red* Identification

The time from the beginning of the *red phase* to when the corresponding image is taken shall be measured and identified, as verified in §5.3.3.5.1.

2.3.3.5.2 *Time Into Red* Format

The *Time Into Red* shall be presented in a consistent manner, as verified in §5.3.3.5.2. The format for providing this timing information is left up to the manufacturer.

2.3.3.6 Duration of *Yellow Phase*

2.3.3.6.1 Duration of *Yellow Phase* Identification

The duration of the *yellow phase* prior to the *event* shall be measured and identified, as verified in §5.3.3.6.1.

2.3.3.6.2 Duration of *Yellow Phase* Format

The duration of the *yellow phase* shall be presented in a consistent manner, as verified in §5.3.3.6.2. The format for providing this timing information is left up to the manufacturer.

2.4 System Operation Performance

The tests of this section will utilize the *RLCS* provided in §2.1.1.

2.4.1 System Power

If the manufacturer provided different power specifications for different power options, then each power option is to be tested to the appropriate specification.

2.4.1.1 Nominal Supply Voltage

The *RLCS* shall operate when supplied with the nominal voltage and voltage type, as specified in §2.2.2.1.1, when tested in accordance with §5.4.1.1.

2.4.1.2 Supply Voltage Range

The *RLCS* shall operate when supplied with voltage over the voltage range, as specified in §2.2.2.1.2, when tested in accordance with §5.4.1.2.

2.4.1.3 Nominal Current Draw

The *RLCS* shall not draw more than 10% above the nominal current draw, as specified in §2.2.2.1.3, when operated at the nominal voltage, as specified in §2.2.2.1.1, when tested in accordance with §5.4.1.3.

2.4.1.4 Maximum Current Draw

The *RLCS* shall not draw more than the maximum current draw, as specified in §2.2.2.1.4 during normal operation at the maximum voltage specified in §2.2.2.1.1, when tested in accordance with §5.4.1.4.

2.4.1.5 Voltage Spike Tolerance

The *RLCS* shall continue to operate as specified when a voltage spike not exceeding that specified in §2.2.2.1.5 is imposed on the voltage supply to the system, when tested in accordance with §5.4.1.5.

2.4.2 Labeling

2.4.2.1 Control and *Display* Identification

All controls and menus shall be identified with the correct functions and settings for all controls and *display*s, when tested in accordance with §5.4.2.1.

2.4.2.2 Unexplained Operations

It shall not be possible to set the controls to a functional mode of operation that is not explained in the operator's manual, when tested in accordance with §5.4.2.2.

2.4.3 *Display* Readability

Any *display* device supplied with an *RLCS* shall be easily readable under normal illumination conditions, including both day and night, when tested in accordance with §5.4.3.

2.4.4 *System Test* Function

The *RLCS* shall activate and create event information consistent with an event, when artificially activated by a *System Test* function, as verified in §5.4.4.

2.5 Laboratory Test Performance

2.5.1 *Event* Acquisition

The requirements presented in this section help ensure that the *RLCS* consistently and accurately detects and saves *event information* with adequate evidentiary basis to support an allegation of a *red phase violation*, when using an intersection simulator (§4.2) to stimulate the *RLCS*. The ability of the *RLCS* to determine *red phase violation*s shall be confirmed as follows:

2.5.1.1 Straight Line Violations

The *RLCS* shall capture *event information* when a single vehicle commits a *red phase violation* in a lane being monitored by the *RLCS*, when tested in accordance with §5.5.1.1.

2.5.1.2 Violation in the Presence of *Compliant Traffic*

The *RLCS* shall capture *event information* when a single vehicle commits a *red phase violation* in a lane being monitored by the *RLCS*, with other vehicles in adjacent lane(s) which are not committing a *red phase event*, when tested in accordance with §5.2.1.2.

2.5.1.3 Multiple Vehicle Events, Single Lane

The *RLCS* shall capture *event information* for at least one of the offending vehicles when multiple vehicles commit *red phase violation*s in a single lane being monitored by the *RLCS*, when tested in accordance with §5.5.1.3. It is allowed for a single image (§5.5.1.3) to be applicable to multiple *event*s provided the criteria of §2.3 are met.

2.5.1.4 Multiple Vehicle Violations, Multiple Lanes

The *RLCS* shall capture *event information* for at least one of the offending vehicles when multiple vehicles commit *red phase violations* in multiple lanes being monitored by the *RLCS*, when tested in accordance with §5.5.1.4. It is allowed for a single image (§2.3.2) to be applicable to multiple *event*s provided the criteria of §2.3 are met.

2.5.2 *Compliant Traffic* (tested using intersection simulator)

Requirements in this section ensure that law *compliant traffic* is not distracted or otherwise disturbed by unnecessary or erroneous operation of the *RLCS* and its illumination. The ability of the *RLCS* to unobtrusively monitor traffic law compliant vehicular flow shall be confirmed as follows:

2.5.2.1 Non-violating Straight Line of Travel Vehicles

The *RLCS* shall not save *event information* or otherwise activate when one or more vehicles traveling in one or more lanes being monitored by the *RLCS* cross the threshold line on a *green phase* or *yellow phase*, when tested in accordance with §5.5.2.1.

2.5.2.2 Non-violating Stop and Turn on *Red Phase*

The *RLCS* shall not save *event information* or otherwise activate when a single vehicle traveling in a lane being monitored by the *RLCS* stops prior to the threshold line on a *red phase*, and then proceeds with a compliant turn, when tested in accordance with §5.5.2.2.

2.5.2.3 Non-violating Complex Traffic Pattern

The *RLCS* shall not save *event information* or otherwise activate when a single vehicle changes lanes upon approaching the threshold line being monitored by the *RLCS*, and stops prior to the threshold line on a *red phase*, when tested in accordance with §5.5.2.3.

2.5.2.4 Wrong Direction of Travel

The *RLCS* shall not save *event information* or otherwise activate when a vehicle travels in the wrong direction in a lane being monitored by an *RLCS*, either during a *red phase* or a *non-red phase*, when tested in accordance with §5.5.2.4.

2.5.2.5 Minimum Yellow *Phase Duration*

The *RLCS* shall not save *event information* or otherwise activate when the yellow *phase duration* is less than 3 seconds, when tested in accordance with §5.5.2.5.

2.5.2.6 *Flashing Red*

The *RLCS* shall not save *event information* or otherwise activate for either *compliant traffic* or non-*compliant traffic* in a lane being monitored by a *RLCS* with a *flashing red* phase, when tested in accordance with §5.5.2.5.

2.6 (Reserved)

2.7 Environmental Performance

If the manufacturer specified different environmental specifications for different subsystems of the *RLCS*, then each subsystem is to be tested to the appropriate specifications.

2.7.1 Operational Temperature Range

The *RLCS* shall function over the operational temperature range specified in §2.2.2.2.1, when tested in accordance with §5.7.1.

2.7.2 Storage Temperature Range

The *RLCS* shall function after having been stored at a temperature within the storage temperature range specified in §2.2.2.2.3, when tested in accordance with §5.7.2.

2.7.3 Operational Humidity Range

The *RLCS* shall function over the operational humidity range specified in §2.2.2.2.5, when tested in accordance with §5.7.3.

2.7.4 (Reserved)

2.8 (Reserved)

2.9 (Reserved)

2.10 (Reserved)

2.11 Field Operation Test Performance

2.11.1 Red Phase Violations

The *RLCS* shall acquire and store *event information* for at least 27 *event*s out of 30 test iterations, including correctly recorded *event information* as specified in §2.3, when tested in accordance with §5.11.1.

2.11.2 Free Flow Traffic

The recorded *event information* shall not detect or indicate any erroneous *events* in a sampling of at least 500 vehicles, when tested in accordance with §5.11.2.

An erroneous *event* includes unexplained absence of traffic (i.e. an empty field of view), unexplained discrepancies between indicated and visually apparent lane designation, and unexplained discrepancies between indicated and visually apparent *signal phase*.

3 Laboratory Test Conditions

3.1 Test System Stability

Allow the *RLCS* UUT (§2.1.1) and all measurement equipment to achieve operating temperature (warm up) per the manufacturers' specifications, and wait until the *RLCS* and all testing instruments have achieved sufficient stability to perform the measurements. Unless otherwise specified, perform all measurements under standard test conditions as follows.

3.2 Standard Temperature

The ambient temperature shall be between 20 °C (68 °F) and 30 °C (86 °F), for tests performed in a laboratory setting.

3.3 Standard Relative Humidity

Standard relative humidity shall be between 10 % and 85 % for tests performed in a laboratory setting.

3.4 Supply Voltage

The laboratory shall provide the supply voltage necessary for all laboratory testing.

4 Test Equipment

4.1 Test Equipment

The test equipment discussed in this section is limited to that equipment which is most critical in making the measurements discussed in this document. All other test equipment shall be of laboratory instrumentation quality. All test equipment shall be provided with instruction manuals, where applicable.

4.2 Intersection Simulator

An intersection simulator comprising a standardized simulator component (provided by the test lab) and a customized simulator interface component (§2.1.2) is required for tests described in §5. The simulator will be utilized to perform precise, repeatable tests.

The output signals of the Intersection Simulator are generic in format, and not specifically applicable to any *RLCS*. An *RLCS* simulator interface (§2.1.2) is to be provided by the manufacturer to convert the output signals of the simulator to a format which can be input to and recognized by the *RLCS*. The injection point for information from the simulator interface will be at the point in the *RLCS* where this information is normally provided to the system, as specified in §2.2.1.1.

The simulator shall have two digital time *display*s used to verify the *RLCS*'s timing. At the beginning of each simulation both *display*s shall indicate zero seconds. At the point in the simulation were the *yellow phase* becomes active one of these *display*s, the yellow duration timer, will begin counting forward. When the *yellow phase* ends, the *yellow phase* timer will freeze retaining a numeric value representing the yellow *phase duration*. Similarly when the *red phase* begins, the *red phase* timer will begin counting forward. For the purpose of §5 tests, the *RLCS* camera will be pointed and focused such as to capture images of these two timers. In this way the instantaneous time value present when each image was captured is visually recorded within the image itself for later comparison and validation.

4.3 Intersection Simulator Operator's Manual

The operational characteristics and operation of the intersection simulator is to be included in an Intersection Simulator Operator's Manual.

4.4 Road Barricades

Road barricades are required to shut down the street in the vicinity of the Field Test Site (§2.1.3). The number of road barricades required is to be determined on a case by case basis, as necessary to control the lanes approaching the

intersection for a minimum of one half mile before and after the intersection, the cross lanes at the intersection, and any cross streets within the range of the downlane closure.

4.5 Test Vehicles

A minimum of 3 vehicles is required to perform the tests in §5.6. All vehicles must be capable of safely operating at speeds up to 75 mph and be of subcompact to full-size passenger vehicle variety.

4.6 Video Recorder

An NTSC quality video recorder to record *event information* during field testing. The video recorder must have the ability to add a time/date stamp message to the video.

5 Test Procedures

Unless otherwise noted, all test steps within this section have an uncertainty of +/- 0.1 seconds, +/- 0.30 m (1.0 feet), or +/- 1 Volt, as applicable.

5.1 Manufacturer Provided Equipment Verification

5.1.1 *Red Light Camera System* (*RLCS*)

Verify the manufacturer provided all equipment, cabling, and software required to detect, capture, and store *event information*, as specified in §2.1.1.

5.1.2 *RLCS* Simulator Interface

Verify the manufacturer provided an interface to an IACP approved *RLCS event* simulator, as specified in §2.1.2.

5.1.3 Operational Test Site

5.1.3.1 Verify the manufacturer has provided access to an operational *RLCS installation*, as specified in §2.1.3.1.

5.1.3.2 Verify the components of the *RLCS installation* specified in §2.1.3.1 is identical to that supplied as specified in §2.1.1, as specified in §2.1.3.2.

5.1.3.3 Verify the *RLCS Installation* specified in §2.1.3.1 is at a standard 4-way intersection, as specified in §2.1.3.3.

5.1.3.4 Verify the *RLCS Installation* specified in §2.1.3 is configured to monitor at least 3 adjacent lanes of through traffic, as specified in §2.1.3.4.

5.1.3.5 Verify the lane width of the monitored lanes at the test site are 3.66 m (12 feet), as specified in §2.1.3.5.

5.1.3.6 Verify the yellow *phase duration* of the *traffic signal* at the test site is at least 3.0 seconds, as specified in §2.1.3.6.

5.1.3.7 Verify the manufacturer has received approval from the contracted jurisdiction for closure of the street and cross streets for the time of the Field Operation Tests (§5.6), as specified in §2.1.3.7.

5.1.3.8 Verify the *RLCS* specified in §2.1.3 is firmly attached to its supporting structure, as specified in §2.1.3.8.

5.1.3.9 Verify the positional relationship between the *RLCS*, the monitored lanes, *intersection threshold*, and *traffic signal* at the test site specified in §2.1.3 is within tolerance of the dimensions specified in the *RLCS* Operator's Manual (§2.2.1.1), as specified in §2.1.3.9.

5.2 Manufacturer Provide Documentation Verification

5.2.1 Operator Manuals Verification

5.2.1.1 *RLCS* Operator's Manual

5.2.1.1.1 Verify the manufacturer provided an operator's manual to the *RLCS*, as specified in §2.2.1.1.

5.2.1.1.2 Verify the operator's manual specified in §2.2.1.1 contains all necessary information to install, test, and operate the *RLCS* supplied in §2.1.1.

5.2.1.2 *RLCS* Simulator Interface Operator's Manual

5.2.1.2.1 Verify the manufacturer provided an operator's manual for the simulator interface to the *RLCS* as specified in §2.2.1.2.

5.2.1.2.2 Verify the simulator interface operator's manual provided in §2.2.1.2 contains all necessary information to install and operate the simulator interface supplied in §2.1.2.

5.2.2 Performance Specifications Verification

5.2.2.1 Power

5.2.2.1.1 Nominal Voltage Level and Type

Verify the manufacturer provided the nominal voltage level and voltage type (AC/DC) for the *RLCS*, as specified in §2.2.2.1.1.

5.2.2.1.2 Voltage Range

Verify the manufacturer provided the voltage range tolerance for the *RLCS*, as specified in §2.2.2.1.2.

5.2.2.1.3 Nominal Current Draw

Verify the manufacturer provided the nominal current requirements for the *RLCS*, as specified in §2.2.2.1.3.

5.2.2.1.4 Maximum Current Draw

Verify the manufacturer provided the maximum current requirements for the system, as specified in §2.2.2.1.4.

5.2.2.1.5 Maximum Voltage Spike

Verify the manufacturer provided the maximum voltage spike tolerated by the *RLCS*, as specified in §2.2.2.1.5.

5.2.2.1.6 System Warm Up Time

Verify the manufacturer provided the time required for the system to warm up to a fully stable and operational state, as specified in §2.2.2.1.6

5.2.2.2 Environmental Specifications Verification

5.2.2.2.1 Operational Temperature Range

Verify the Manufacturer provided the operational temperature range for the *RLCS*, as specified in §2.2.2.2.1.

5.2.2.2.2 Operational Temperature Certification

Verify the manufacturer provided certification that the *RLCS* has been tested and certified over the specified operational temperature range, or has provided authorization for the IACP to conduct such testing as part of the IACP certification testing, as specified in §2.2.2.2.2.

5.2.2.2.3 Storage Temperature Range

Verify the manufacturer provided the storage temperature range for the *RLCS*, as specified in §2.2.2.2.3.

5.2.2.2.4 Storage Temperature Certification

Verify the manufacturer provided certification that the *RLCS* has been tested and certified over the specified storage temperature range, or has provided authorization for the IACP to conduct such testing as part of the IACP certification testing, as specified in §2.2.2.2.4.

5.2.2.2.5 Operational Humidity Range

Verify the Manufacturer provided the operational humidity range for the *RLCS*, as specified in §2.2.2.2.5.

5.2.2.2.6 Humidity Certification

Verify the manufacturer provided certification that the *RLCS* has been tested and certified over the specified operational humidity range, or has provided authorization for the IACP to conduct such testing as part of the IACP certification testing, as specified in §2.2.2.2.6.

5.2.2.2.7 Intrusion Resistance Certification

(Reserved)

5.2.2.2.8 Electromagnetic Interference (EMI) Generation Certification

(Reserved)

5.2.2.2.9 Electromagnetic Interference (EMI) Susceptibility Certification

(Reserved)

5.2.3 *Event Information* Sample Verification

Verify the manufacturer provided at least 10 samples of *event information*, as specified in §2.2.3.

5.2.4 Methodologies Verification

5.2.4.1 *Event* Activation and Recognition

Verify the manufacturer provided a methodology to verify that the *RLCS* has been activated as a result of either a simulated or actual *event*, as specified in §2.2.4.1.

5.2.4.2 Review *Event Information*

Verify the manufacturer provided a methodology to review the associated *event information* captured and stored by the *RLCS*, as specified in §2.2.4.2.

5.2.4.3 Associated Data

Verify the manufacturer provided a methodology to verify the accuracy of the required *associated data*, as specified in §2.2.4.3.

5.3 Event Information Verification

Verification of *event information* (§2.3) in this subsection will be performed using the manufacturer provided *event information* samples specified in §2.2.3, and the methodologies specified in §2.2.4.2 and §2.2.4.3. Further verification of *event information* will occur in subsequent test subsections with the *RLCS* simulator (§5.5) and in the field tests (§5.6).

5.3.1 Information Consolidation

5.3.1.1 Information Consolidation Storage

Verify that each *event information* packet provided in §2.2.3 is consolidated, as specified in §2.3.1.1.

5.3.1.2 Information Consolidation Processes

5.3.1.2.1 Set up the *RLCS* provided in §2.1.1 following the instructions provided in §2.2.1.1.

5.3.1.2.2 Set up the *RLCS* simulator specified in §4.2 following the instructions provided in §4.3.

5.3.1.2.3 Set up the *RLCS* simulator interface specified in §2.1.2 following the instructions provided in §2.2.1.2.

5.3.1.2.4 Set up the methodology for detecting that an *event* occurred as specified in §2.2.4.1.

5.3.1.2.5 Set up the methodology for viewing *event information* occurred as specified in §2.2.4.2.

5.3.1.2.6 Apply power to the *RLCS* at the nominal voltage (+/- 2%) specified in §2.2.2.1.1.

5.3.1.2.7 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection, creating a *red phase violation*.

5.3.1.2.8 Start the *RLCS* simulator to run the simulation.

5.3.1.2.9 Verify that an *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.3.1.2.10 Use the methodology specified in §2.2.4.2 to view the *event information*.

5.3.1.2.11 Verify that the *event information* was created at the time of the *event* without human interaction, as specified in §2.3.1.2.

5.3.2 Event Images

5.3.2.1 First Image

5.3.2.1.1 For each *event information* packet provided in §2.2.3, verify that an image exists showing a suspect vehicle in the specified lane behind the threshold line for the intersection, as specified in §2.3.2.1.1.

5.3.2.1.2 For this same image of the same *event information* packet, verify that the *traffic signal* is visible, and that the red light is illuminated, as specified in §2.3.2.1.2.

5.3.2.2 Second Image

5.3.2.2.1 For each *event information* packet provided in §2.2.3, verify that an image exists showing a suspect vehicle in the specified lane beyond the threshold line for the intersection, as specified in §2.3.2.2.1.

5.3.2.2.2 For this same image of the same *event information* packet, verify that the *traffic signal* is visible, as specified in §2.3.2.2.2.

5.3.2.3 License Plate

For each *event information* packet provided in §2.2.3, verify that at least one image exists showing the license plate of the suspect vehicle, as specified in §2.3.2.3.

5.3.3 Associated Event Data

5.3.3.1 Location Identifier

For each *event information* packet provided in §2.2.3, verify that each *event* image has a unique location identifier, as specified in §2.3.3.1.

5.3.3.2 *Event ID*

For each *event information* packet provided in §2.2.3, verify that each *event* image has a unique *Event ID*, as specified in §2.3.3.2.

5.3.3.3 Date

5.3.3.3.1 Date Identification

For each *event information* packet provided in §2.2.3, verify that each *event* image identifies the date, indicating the month, day, and year of the corresponding image, as specified in §2.3.3.3.1.

5.3.3.3.2 Date Format

For each *event information* packet provided in §2.2.3, verify that each *event* image identifies the date of the corresponding image presented in a consistent manner, for all images of all *event* packets, as specified in §2.3.3.3.2.

5.3.3.4 Time of Day

5.3.3.4.1 Time of Day Identification

For each *event information* packet provided in §2.2.3, verify that each *event* image identifies the Time of Day of the corresponding image, as specified in §2.3.3.4.1.

5.3.3.4.2 Time of Day Resolution

For each *event information* packet provided in §2.2.3, verify that each *event* image displays the Time of Day of the corresponding image with an uncertainty of +/- one minute, as specified in §2.3.3.4.2.

5.3.3.4.3 Time of Day Format

For each *event information* packet provided in §2.2.3, verify that each *event* image presents the Time of Day of the corresponding image in a consistent manner, for all images of all *event* packets, as specified in §2.3.3.4.3.

5.3.3.5 Time into Red

5.3.3.5.1 *Time Into Red* Identification

For each *event information* packet provided in §2.2.3, verify that each *event* image identifies the Time into Red of the corresponding image, as specified in §2.3.3.5.1.

5.3.3.5.2 *Time Into Red* Format

For each *event information* packet provided in §2.2.3, verify that each *event* image presents the Time into Red of the corresponding image in a consistent manner, for all images of all *event* packets, as specified in §2.3.3.5.2.

5.3.3.6 Duration of *Yellow Phase*

5.3.3.6.1 Duration Of *Yellow Phase* Identification

For each *event information* packet provided in §2.2.3, verify that each *event* image presents the duration of the *yellow phase* prior to the *event* with a time resolution of 0.1 seconds, as specified in §2.3.3.6.1.

5.3.3.6.2 Duration Of *Yellow Phase* Format

For each *event information* packet provided in §2.2.3, verify that each *event* image presents the duration of the *yellow phase* prior to the *event* in a consistent manner, for all images of all *event* packets, as specified in §.2.3.3.6.2.

5.4 System Operation Testing

All tests in this section are to be performed in the laboratory using the *RLCS* provided in §2.1.1.

5.4.1 System Power Testing

5.4.1.1 Nominal Supply Voltage Test

5.4.1.1.1 Set up the *RLCS* following the instructions provided in §2.2.1.1.

5.4.1.1.2 Set up the *RLCS* simulator specified in §4.2 following the instructions provided in §4.3.

5.4.1.1.3 Set up the *RLCS* simulator interface specified in §2.1.2 following the instructions provided in §2.2.1.2.

5.4.1.1.4 Set up the methodology for detecting that an *event* occurred as specified in §2.2.4.1.

5.4.1.1.5 Apply power to the *RLCS* at the nominal voltage (+/- 2%) specified in §2.2.2.1.1.

5.4.1.1.6 Allow the *RLCS* to warm up for the time specified in §2.2.2.1.6.

5.4.1.1.7 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection, creating a *red phase violation*.

5.4.1.1.8 Start the *RLCS* simulator to run the simulation.

5.4.1.1.9 Verify that an *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.4.1.1.10 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection on a *green phase*, such that the vehicle is not in violation.

5.4.1.1.11 Start the *RLCS* simulator to run the simulation.

5.4.1.1.12 Verify that an *event* was not created by the *RLCS* using the methodology specified in §2.2.4.1.

5.4.1.2 Supply Voltage Range Test

5.4.1.2.1 Leave or set up the *RLCS*, simulator, simulator interface as configured in §5.4.1.1.1 through §5.4.1.1.4.

5.4.1.2.2 Apply power to the *RLCS* at the maximum voltage specified in §2.2.2.1.2.

5.4.1.2.3 Repeat the test steps §5.4.1.1.6 through §5.4.1.4.5.

5.4.1.2.4 Apply power to the *RLCS* at minimum voltage specified in §2.2.2.1.2.

5.4.1.2.5 Repeat the test steps §5.4.1.1.6 through §5.4.1.4.5.

5.4.1.3 <u>Nominal Current Draw Test</u>

5.4.1.3.1 Leave or set up the *RLCS*, simulator, simulator interface as configured in §5.4.1.1.1 through §5.4.1.1.4.

5.4.1.3.2 Connect an ammeter to monitor *RLCS* current draw.

5.4.1.3.3 Apply power to the *RLCS* at the nominal voltage (+/- 2%) specified in §2.2.2.1.1.

5.4.1.3.4 Allow the *RLCS* to warm up for the time specified in §2.2.2.1.6.

5.4.1.3.5 Verify the current draw is within 10% of the nominal current draw specified in §2.2.2.1.3.

5.4.1.4 Maximum Current Draw Test

5.4.1.4.1 Leave or set up the *RLCS*, simulator, simulator interface as configured in §5.4.1.1.1 through §5.4.1.1.4.

5.4.1.4.2 Connect an ammeter to monitor *RLCS* current draw.

5.4.1.4.3 Apply power to the *RLCS* at the maximum voltage specified in §2.2.2.1.2.

5.4.1.4.4 Repeat the test steps §5.4.1.1.6 through §5.4.1.4.5.

5.4.1.4.5 Verify that at no time during the simulation did the ammeter detect a current draw exceeding the maximum current specified in §2.2.2.1.4.

5.4.1.5 Voltage Spike Test

5.4.1.5.1 Leave or set up the *RLCS*, simulator, simulator interface as configured in §5.4.1.1.1 through §5.4.1.1.4.

5.4.1.5.2 Apply power to the *RLCS* at the nominal voltage (+/- 2%) specified in §2.2.2.1.1.

5.4.1.5.3 Allow the *RLCS* to warm up for the time specified in §2.2.2.1.6.

5.4.1.5.4 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection, creating a *red phase violation*.

5.4.1.5.5 Start the *RLCS* simulator to run the simulation.

5.4.1.5.6 During the simulation, apply a voltage spike with a duration of no more than 0.1 seconds, and energy of from 95% to 100% of the maximum voltage spike specified in §2.2.2.1.5.

5.4.1.5.7 Verify that an *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.4.1.5.8 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection on a *green phase*, such that the vehicle is not in violation.

5.4.1.5.9 Start the *RLCS* simulator to run the simulation.

5.4.1.5.10 During the simulation, apply a voltage spike with a duration of no more than 0.1 seconds, and energy of from 95% to 100% of the maximum voltage spike specified in §2.2.2.1.5.

5.4.1.5.11 Verify that an *event* was not created by the *RLCS* using the methodology specified in §2.2.4.1.

5.4.2 System Labeling Testing

5.4.2.1 Control and *Display* Identification Test

5.4.2.1.1 Set up the *RLCS* following the instructions provided in §2.2.1.1.

5.4.2.1.2 Set up the *RLCS* simulator specified in §4.2 following the instructions provided in §4.3.

5.4.2.1.3 Set up the *RLCS* simulator interface specified in §2.1.2 following the instructions provided in §2.2.1.2.

5.4.2.1.4 Apply power to the *RLCS* at the nominal voltage (+/- 2%) specified in §2.2.2.1.1.

5.4.2.1.5 Verify that all controls on the *RLCS* are identified and labeled correctly, as specified in §2.4.2.1.

5.4.2.1.6 Verify that no control on the *RLCS* has a function which is not documented or explained in the operator's manual specified in §2.2.1.1, as specified in §2.4.2.2.

5.4.2.2 Unexplained Operations Testing

5.4.2.2.1 Leave or setup the *RLCS*, simulator, and simulator interface as configured in §5.4.2.1.1 through §5.4.2.1.4.

5.4.2.2.2 Verify that all *display* menus on the *RLCS* are identified and labeled correctly, as specified in §2.4.2.1.

5.4.2.2.3 Verify that no control on a *display* menu of the *RLCS* has a function which is not documented or explained in the operator's manual specified in §2.2.1.1, as specified in §2.4.2.2.

5.4.3 *Display* Readability

5.4.3.1 Set up the *RLCS* following the instructions provided in §2.2.1.1.

5.4.3.2 Apply power to the *RLCS* at the nominal voltage (+/- 2%) specified in §2.2.2.1.1.

5.4.3.3 Shine white light of intensity in the range of 100 lux to 200 lux on any *display*s of the *RLCS*.

5.4.3.4 Verify that any *display*s of the *RLCS* are easily readable, as specified in §2.4.3.

5.4.3.5 Shine white light of intensity in the range of 90,000 lux to 110,000 lux on any *display*s of the *RLCS*.

5.4.3.6 Verify that any *display*s on the *RLCS* are easily readable, as specified in §2.4.3.

5.4.4 *System Test* Function Test

This section verifies the *System Test* Function specified in §2.4.4.

5.4.4.1 Set up the *RLCS* as specified in §2.2.1.1.

5.4.4.2 Place a clock with the current local time accurate to within 1.0 seconds of the locally-adjusted UTC such that it is visible within the images produced by all of the *RLCS* cameras.

5.4.4.3 Initiate the *System Test* Function of the *RLCS*.

5.4.4.4 Verify an event was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.4.4.5 Review the event information using the methodologies specified in §2.2.4.2 and §2.2.4.3.

5.4.4.6 Verify the *event information* is consolidated for the *event*, as specified in §2.3.1.1.

5.4.4.7 Verify the *event information* was created at the time of the *event* with no human intervention, as specified in §2.3.1.2.

5.4.4.8 Verify all *event* images display all associated *event* data correctly, as is able to be determined, as specified in §2.3.

5.5 Laboratory Testing

The following tests are to be carried out in the laboratory using the *RLCS* specified in §2.1.1, the intersection simulator specified in §4.2, and the simulator interface specified in §2.1.2.

5.5.1 *Event* Acquisition Tests

The following tests verify operation of the *RLCS* to *events*.

5.5.1.1 Straight Line Violations Test

This test verifies the requirements of §2.5.1.1.

5.5.1.1.1 Apply power to the *RLCS* at the nominal voltage specified in §2.2.2.1.1.

5.5.1.1.2 Apply power to the *RLCS* simulator.

5.5.1.1.3 Apply power to the *RLCS* simulator interface, if required, as specified in §2.2.1.2.

5.5.1.1.4 Set up the *RLCS* simulator specified in §4.2 following the instructions provided in §4.3.

5.5.1.1.5 Set up the *RLCS* simulator interface specified in §2.1.2 following the instructions provided in §2.2.1.2.

5.5.1.1.6 Set up the *RLCS* following the instructions provided in §2.2.1.1 to monitor the first three through lanes of the approach of the simulator.

5.5.1.1.7 Place a clock with the current local time accurate to within 1.0 seconds of the locally-adjusted UTC next to the simulator.

5.5.1.1.8 Aim the cameras and flash units of the *RLCS* at the simulator, such that both the simulator and clock are visible within the images produced by all of the *RLCS* cameras.

5.5.1.1.9 Set up the simulator as depicted in Figure 2, with:

- A single vehicle moving in lane 1 through the intersection.
- A speed of 20 MPH for the vehicle.
- A red *phase duration* of 2.0 seconds when the vehicle crosses the threshold line.
- A yellow *phase duration* of 3.5 seconds.

5.5.1.1.10 Start the *RLCS* simulator to run the simulation.

5.5.1.1.11 Verify that an *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.5.1.1.12 Review the *event information* using the methodologies specified in §2.2.4.2 and §2.2.4.3.

5.5.1.1.13 Verify that the *event information* is consolidated as specified in §2.3.1.1.

5.5.1.1.14 Verify that the *event information* was created at the time of the *event* with no human intervention, as specified in §2.3.1.2.

5.5.1.1.15 Verify the first *event* image shows the vehicle behind the threshold line, as specified in §2.3.2.1.1.

5.5.1.1.16 Verify the second *event* image shows the vehicle beyond the threshold line, as specified in §2.3.2.2.1.

5.5.1.1.17 Verify every *event* image displays the *Time Into Red* field of the image equal to that of the *Time Into Red* timer of the simulator, as specified in §2.3.3.5.1.

5.5.1.1.18 Verify every *event* image displays the Duration of Yellow field of the image equal to that of the Duration of Yellow timer of the simulator, as specified in §2.3.3.6.1.

5.5.1.1.19 Verify every image of the *event* shows the Time field equal to the time on the clock in the image, within 1.0 minutes, as specified in §2.3.3.4.1.

5.5.1.1.20 Verify every *event* image displays all other *associated event data* correctly, as specified in §2.3.3.

5.5.1.1.21 Repeat §5.5.1.1.9 through §5.5.1.1.20 for all monitored lanes of the approach.

5.5.1.1.22 Repeat §5.5.1.1.9 through §5.5.1.1.21 with a vehicle speed of 40 MPH.

5.5.1.1.23 Repeat §5.5.1.1.9 through §5.5.1.1.21 with a vehicle speed of 80 MPH.

5.5.1.2 <u>Violations in the Presence of *Compliant Traffic* Test</u>

This test verifies the requirements of §2.5.1.2.

5.5.1.2.1 Leave or set up the *RLCS*, simulator, simulator interface, and clock as configured in §5.5.1.1.1 through §5.5.1.1.8.

5.5.1.2.2 Set up the simulator as depicted in Figure 3, with:

- A compliant vehicle stopped behind the threshold in lane 1.
- A single vehicle moving in lane 2 through the intersection.
- A speed of 20 MPH for the moving vehicle.
- A red *phase duration* of 3.0 seconds when the vehicle crosses the threshold line.
- A yellow *phase duration* of 4.5 seconds.

5.5.1.2.3 Start the *RLCS* simulator to run the simulation.

5.5.1.2.4 Verify that an *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.5.1.2.5 Review the *event information* using the methodologies specified in §2.2.4.2 and §2.2.4.3.

5.5.1.2.6 Verify that the *event information* is consolidated as specified in §2.3.1.1.

5.5.1.2.7 Verify that the *event information* was created at the time of the *event* with no human intervention, as specified in §2.3.1.2.

5.5.1.2.8 Verify the first *event* image shows the vehicle behind the threshold line, as specified in §2.3.2.1.1.

5.5.1.2.9 Verify the second *event* image shows the vehicle beyond the threshold line, as specified in §2.3.2.2.1.

5.5.1.2.10 Verify every *event* image displays the *Time Into Red* field of the image equal to that of the *Time Into Red* timer of the simulator, as specified in §2.3.3.5.1.

5.5.1.2.11 Verify every *event* image displays the Duration of Yellow field of the image equal to that of the Duration of Yellow timer of the simulator, as specified in §2.3.3.6.1.

5.5.1.2.12 Verify every image of the *event* shows the Time field equal to the time on the clock in the image, within 1.0 minutes, as specified in §2.3.3.4.1.

5.5.1.2.13 Verify every *event* image displays all other *associated event data* correctly, as specified in §2.3.3.

5.5.1.2.14 Repeat §5.5.1.2.2 through §5.5.1.2.13 with the moving vehicle in all lanes of the approach unoccupied by a compliant vehicle.

5.5.1.2.15 Repeat §5.5.1.2.2 through §5.5.1.2.14 with the compliant vehicle in all lanes of the approach and the moving vehicle in lanes unoccupied by the compliant vehicle.

5.5.1.2.16 Repeat §5.5.1.2.2 through §5.5.1.2.15 with a vehicle speed of 40 MPH.

5.5.1.2.17 Repeat §5.5.1.2.2 through §5.5.1.2.15 with a vehicle speed of 80 MPH.

5.5.1.3 Multiple Vehicle Violations, Single Lane Test

This test verifies the requirements of §2.5.1.3.

5.5.1.3.1 Leave or set up the *RLCS*, simulator, simulator interface, and clock as configured in §5.5.1.1.1 through §5.5.1.1.8.

5.5.1.3.2 Set up the simulator as depicted in Figure 4, with:

- Four vehicles moving in lane 1 in sequence through the intersection.
- A separation of between 1.0 and 2.0 seconds between vehicles.
- A speed of 20 MPH for all moving vehicles.
- A red *phase duration* of 4.0 seconds when the first vehicle crosses the threshold line.
- A yellow *phase duration* of 4.5 seconds.

5.5.1.3.3 Start the *RLCS* simulator to run the simulation.

5.5.1.3.4 Verify that at least one *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

It is not necessary for the *RLCS* to generate an *event* for all violating vehicles. It is allowable for a single image to be used for multiple *event*s, if appropriate.

5.5.1.3.5 Review the *event information* using the methodologies specified in §2.2.4.2 and §2.2.4.3.

5.5.1.3.6 Verify that the *event information* for all detected *event*s is consolidated as specified in §2.3.1.1.

5.5.1.3.7 Verify that the *event information* for all detected *events* was created at the time of the *event* with no human intervention, as specified in §§2.3.1.2.

5.5.1.3.8 Verify the first *event* image for all detected *events* shows the vehicle behind the threshold line, as specified in §2.3.2.1.1.

5.5.1.3.9 Verify the second *event* image for all detected *events* shows the vehicle beyond the threshold line, as specified in §2.3.2.2.1.

5.5.1.3.10 Verify every *event* image for all detected *events* displays the *Time Into Red* field of the image equal to that of the *Time Into Red* timer of the simulator, as specified in §2.3.3.5.1.

5.5.1.3.11 Verify every *event* image for all detected *events* displays the Duration of Yellow field of the image equal to that of the Duration of Yellow timer of the simulator, as specified in §2.3.3.6.1.

5.5.1.3.12 Verify every image of the *event* for all detected *events* shows the Time field equal to the time on the clock in the image, within 1.0 minutes, as specified in §2.3.3.4.1.

5.5.1.3.13 Verify every *event* image for all detected *events* displays all other *associated event data* correctly, as specified in §2.3.3.

5.5.1.3.14 Repeat §5.5.1.3.2 through §5.5.1.3.13 for all lanes of the approach, all vehicles in one lane for each repetition.

5.5.1.3.15 Repeat §5.5.1.3.2 through §5.5.1.3.14 with a vehicle speed of 40 MPH.

5.5.1.3.16 Repeat §5.5.1.3.2 through §5.5.1.3.14 with a vehicle speed of 80 MPH.

5.5.1.4 Multiple Vehicle Violations, Multiple Lanes Test

This test verifies the requirements of §2.5.1.4.

5.5.1.4.1 Leave or set up the *RLCS*, simulator, simulator interface, and clock as configured in §5.5.1.1.1 through §5.5.1.1.8.

5.5.1.4.2 Set up the simulator as depicted in Figure 5, with:

- A single vehicle in each lane for all lanes of the approach, moving through the intersection.
- A separation of 0.0 seconds between vehicles as they cross the *threshold line*.
- A speed of 20 MPH for all moving vehicles.
- A red *phase duration* of 5.0 seconds when all vehicles cross the threshold line.
- A yellow *phase duration* of 3.1 seconds.

5.5.1.4.3 Start the *RLCS* simulator to run the simulation.

5.5.1.4.4 Verify that at least one *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

It is not necessary for the *RLCS* to generate an *event* for all violating vehicles. It is allowable for a single image to be used for multiple *event*s, if appropriate.

5.5.1.4.5 Review the *event information* using the methodologies specified in §2.2.4.2 and §2.2.4.3.

5.5.1.4.6 Verify that the *event information* for all detected *event*s is consolidated as specified in §2.3.1.1.

5.5.1.4.7 Verify that the *event information* for all detected *events* was created at the time of the *event* with no human intervention, as specified in §§2.3.1.2.

5.5.1.4.8 Verify the first *event* image for all detected *events* shows the vehicle behind the threshold line, as specified in §2.3.2.1.1.

5.5.1.4.9 Verify the second *event* image for all detected *events* shows the vehicle beyond the threshold line, as specified in §2.3.2.2.1.

5.5.1.4.10 Verify every *event* image for all detected *events* displays the *Time Into Red* field of the image equal to that of the *Time Into Red* timer of the simulator, as specified in §2.3.3.5.1.

5.5.1.4.11 Verify every *event* image for all detected *events* displays the Duration of Yellow field of the image equal to that of the Duration of Yellow timer of the simulator, as specified in §2.3.3.6.1.

5.5.1.4.12 Verify every image of the *event* for all detected *events* shows the Time field equal to the time on the clock in the image, within 1.0 minutes, as specified in §2.3.3.4.1.

5.5.1.4.13 Verify every *event* image for all detected *events* displays all other *associated event data* correctly, as specified in §2.3.3.

5.5.1.4.14 Repeat §5.5.1.4.2 through §5.5.1.4.13 with a vehicle speed of 40 MPH.

5.5.1.4.15 Repeat §5.5.1.4.2 through §5.5.1.4.13 with a vehicle speed of 80 MPH.

5.5.2 *Compliant Traffic* Tests

The following tests verify *RLCS* response to non-*event*s as generated by the *RLCS* simulator.

5.5.2.1 Non-violating Straight Line of Travel Vehicles Test

This test verifies the requirements of §2.5.2.

5.5.2.1.1 Leave or set up the *RLCS*, simulator, simulator interface, and clock as configured in §5.5.1.1.1 through §5.5.1.1.8.

5.5.2.1.2 Set up the simulator as depicted in Figure 2, with:

- a single vehicle in lane 1 moving through the intersection, entering the intersection on a *green phase.*
- A speed of 20 MPH for the vehicle.
- A yellow *phase duration* of 3.1 seconds.

5.5.2.1.3 Start the *RLCS* simulator to run the simulation.

5.5.2.1.4 Verify that no *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.5.2.1.5 Repeat §5.5.2.1.2 through §5.5.2.1.4, adding a second vehicle to lane 2 traveling abreast of the vehicle in lane 1 with a downlane separation of 0.0 m (0.0 feet) between vehicles.

5.5.2.1.6 Repeat §5.5.2.1.2 through §5.5.2.1.4, adding a third vehicle to lane 3 traveling abreast of the vehicles in lanes 1 and 2 with a downlane separation of 0.0 m (0.0 feet) between vehicles.

5.5.2.1.7 Repeat §5.5.2.1.2 through §5.5.2.1.6, with a speed of 35 MPH for vehicles.

5.5.2.1.8 Repeat §5.5.2.1.2 through §5.5.2.1.6, with a speed of 50 MPH for vehicles.

5.5.2.1.9 Repeat §5.5.2.1.2 through §5.5.2.1.8, with the vehicles entering the intersection at a time of 1.0 seconds into the *yellow phase*.

5.5.2.1.10 Repeat §5.5.2.1.2 through §5.5.2.1.9 with a vehicle speed of 40 MPH.

5.5.2.1.11 Repeat §5.5.2.1.2 through §5.5.2.1.9 with a vehicle speed of 80 MPH.

5.5.2.2 Non-violating Stop and Turn on *Red Phase* Test

This test verifies the requirements of §2.5.2.2.

5.5.2.2.1 Leave or set up the *RLCS*, simulator, simulator interface, and clock as configured in §5.5.1.1.1 through §5.5.1.1.8.

5.5.2.2.2 Set up the simulator as depicted in Figure 6, with:

- A single vehicle in lane 1 approaching the intersection and stopping behind the threshold line for a period of 2.0 seconds.
- The instance of the stop corresponding to a red *phase duration* of 5.0 seconds.
- A yellow *phase duration* of 3.1 seconds.
- The vehicle proceeding after the stop into the intersection and making a right hand turn onto the cross street.
- Start the *RLCS* simulator to run the simulation.

5.5.2.2.3 Verify that no *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.5.2.3 Non-violating Complex Traffic Pattern Test

This test verifies the requirements of §2.5.2.3.

5.5.2.3.1 Leave or set up the *RLCS*, simulator, simulator interface, and clock as configured in §5.5.1.1.1 through §5.5.1.1.8.

5.5.2.3.2 Set up the simulator as depicted in Figure 7, with:

- A single vehicle in lane 2 moving through the intersection, entering the intersection on a *green phase*.
- A speed of 20 MPH for the vehicle.
- As the vehicle approaches the intersection in lane 2, it changes lanes to lane 1, such that it is detected by the *RLCS* in both lanes 2 and 1, according to the position of detection as stated in the simulator interface operator's manual (§2.1.2).
- A yellow *phase duration* of 3.1 seconds.

5.5.2.3.3 Start the *RLCS* simulator to run the simulation.

5.5.2.3.4 Verify that no *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.5.2.4 Wrong Direction of Travel Test

This test verifies the requirements of §2.5.2.4.

5.5.2.4.1 Leave or set up the *RLCS*, simulator, simulator interface, and clock as configured in §5.5.1.1.1 through §5.5.1.1.8.

5.5.2.4.2 Set up the simulator as depicted in Figure 8, with:

- A single vehicle in lane 1 proceeding through the intersection in the wrong direction, and continuing in lane 1 to the extent of the simulator.
- A speed of 25 MPH for the vehicle.
- The *traffic signal* in a *red phase.*

5.5.2.4.3 Start the *RLCS* simulator to run the simulation.

5.5.2.4.4 Verify that no *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.5.2.5 Minimum Yellow *Phase Duration* Test

This test verifies the requirements of §2.5.2.5.

5.5.2.5.1 Leave or set up the *RLCS*, simulator, simulator interface, and clock as configured in §5.5.1.1.1 through §5.5.1.1.8.

5.5.2.5.2 Set up the simulator as depicted in Figure 2, with:

- A single vehicle moving in lane 1 through the intersection.
- A speed of 25 MPH for the vehicle.
- A red *phase duration* of 2.0 seconds when vehicles cross the threshold line.
- A yellow *phase duration* of 1.0 second.

5.5.2.5.3 Start the *RLCS* simulator to run the simulation.

5.5.2.5.4 Verify that no *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.5.2.5.5 Repeat §5.5.2.5.1 with a yellow *phase duration* of 2.0 seconds.

5.5.2.5.6 Repeat §5.5.2.5.1 with a yellow *phase duration* of 2.9 seconds.

5.5.2.5.7 Repeat §5.5.2.5.1 with a yellow *phase duration* of 3.3 seconds.

5.5.2.6 *Flashing Red* Test

This test verifies the requirements of §2.5.2.5.

5.5.2.6.1 Leave or set up the *RLCS*, simulator, simulator interface, and clock as configured in §5.5.1.1.1 through §5.5.1.1.8.

5.5.2.6.2 Set up the simulator as depicted in Figure 2, with:

- A single vehicle in lane 1 approaching the intersection and stopping behind the threshold line for a period of 2.0 seconds.
- A speed of 25 MPH for the vehicle prior to coming to a stop.
- The *traffic signal* in a *flashing red* phase.

  Note: The *red phase* should be set to flash at the correct timing sequence according to NEMA standards.

- The vehicle proceeding after the stop through the intersection.

5.5.2.6.3 Start the *RLCS* simulator to run the simulation.

5.5.2.6.4 Verify that no *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.6 (Reserved)

5.7 Environmental Testing

All tests in this section are to be performed with the *RLCS* specified in §2.1.1. Testing within this section can be subcontracted by the IACP test laboratory to an external certified testing laboratory.

If an environmental chamber is to be used, only the *RLCS* components needs to be placed in the environmental chamber. All other equipment can be external to the chamber. If size restrictions necessitate, distributed components of the system can be tested individually in the chamber, with other components external, provided all components of the *RLCS* are tested within the chamber.

The intersection simulator (§4.2), simulator interface (§2.1.2), and any hardware relevant to the methodologies for viewing *event information* (§2.2.4) are not required to be placed in the chamber as a part of this test. However, placement of some items within the chamber might be necessary to verify proper performance of the *RLCS*.

All measurements within this subsection are with an uncertainty of +/- 0.1 Celsius or +/- 1.0% Humidity, as applicable, unless otherwise noted.

5.7.1 Operational Temperature Range

This test is to be performed only if the manufacturer did not provide certification that the *RLCS* has been tested and certified over the operational temperature range, as specified in §2.2.2.2.2. This test verifies the requirement of §2.7.1.

5.7.1.1 Install the *RLCS* in an environmental chamber.

5.7.1.2 Set up the *RLCS* following the instructions provided in §2.2.1.1.

5.7.1.3 Set up the *RLCS* simulator specified in §4.2 following the instructions provided in §4.3.

5.7.1.4 Set up the *RLCS* simulator interface specified in §2.1.2 following the instructions provided in §2.2.1.2.

5.7.1.5 Set up the methodology for detecting an *event* occurred as specified in §2.2.4.1.

5.7.1.6 Allow the *RLCS* to warm up for the time specified in §2.2.2.1.6.

5.7.1.7 Lower the temperature in the environmental chamber to the minimum temperature specified in §2.2.2.2.1.

5.7.1.8 Set the humidity to a maximum of 50%.

5.7.1.9 After the temperature and humidity have stabilized, allow one hour to pass.

5.7.1.10 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection, creating a *red phase violation*.

5.7.1.11 Start the *RLCS* simulator to run the simulation.

5.7.1.12 Verify that an *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.7.1.13 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection on a *green phase*, such that the vehicle is not in violation.

5.7.1.14 Start the *RLCS* simulator to run the simulation.

5.7.1.15 Verify that an *event* was not created by the *RLCS* using the methodology specified in §2.2.4.1.

5.7.1.16 Raise the temperature in the environmental chamber to the maximum temperature specified in §2.2.2.2.1.

5.7.1.17 After the temperature and humidity have stabilized, allow one hour to pass.

5.7.1.18 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection, creating a *red phase violation*.

5.7.1.19 Start the *RLCS* simulator to run the simulation.

5.7.1.20 Verify that an *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.7.1.21 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection on a *green phase*, such that the vehicle is not in violation.

5.7.1.22 Start the *RLCS* simulator to run the simulation.

5.7.1.23 Verify that an *event* was not created by the *RLCS* using the methodology specified in §2.2.4.1.

5.7.2 Storage Temperature Range

This test is to be performed only if the manufacturer did not provide certification that the *RLCS* has been tested and certified over the storage temperature range, as specified in §§2.2.2.2.4. This test verifies the requirement of §2.7.2.

5.7.2.1 Leave or set up the *RLCS*, simulator, and simulator interface as configured in §5.7.1.1 through §5.7.1.5.

5.7.2.2 Ensure the *RLCS* is powered down.

5.7.2.3 Lower the temperature in the environmental chamber to the minimum temperature specified in §2.2.2.2.3.

5.7.2.4 Set the humidity to a maximum of 50%.

5.7.2.5 After the temperature and humidity have stabilized, allow 24 hours to pass.

5.7.2.6 After the temperature has stabilized, allow 24 hours to pass.

5.7.2.7 Lower the temperature in the environmental chamber to 30 Celsius.

5.7.2.8 Set up the *RLCS* following the instructions provided in §2.2.1.1.

5.7.2.9 Set up the *RLCS* simulator specified in §4.2 following the instructions provided in §4.3.

5.7.2.10 Set up the *RLCS* simulator interface specified in §2.1.2 following the instructions provided in §2.2.1.2.

5.7.2.11 Set up the methodology for detecting an *event* occurred as specified in §2.2.4.1.

5.7.2.12 Allow the *RLCS* to warm up for the time specified in §2.2.2.1.6.

5.7.2.13 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection, creating a *red phase violation*.

5.7.2.14 Start the *RLCS* simulator to run the simulation.

5.7.2.15 Verify that an *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.7.2.16 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection on a *green phase*, such that the vehicle is not in violation.

5.7.2.17 Start the *RLCS* simulator to run the simulation.

5.7.2.18 Verify that an *event* was not created by the *RLCS* using the methodology specified in §2.2.4.1.

5.7.3 Operational Humidity Range

This test is to be performed only if the manufacturer did not provide certification that the *RLCS* has been tested and certified over the operational humidity range, as specified in §2.2.2.2.6. This test verifies the requirement of §2.7.3.

5.7.3.1 Leave or set up the *RLCS*, simulator, and simulator interface as configured in §5.7.1.1 through §5.7.1.5.

5.7.3.2 Set the humidity to the maximum specified in §2.2.2.2.5.

5.7.3.3 Raise the temperature in the environmental chamber to the maximum temperature specified in §2.2.2.2.1.

5.7.3.4 After the temperature and humidity have stabilized, allow one hour to pass.

5.7.3.5 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection, creating a *red phase violation*.

5.7.3.6 Start the *RLCS* simulator to run the simulation.

5.7.3.7 Verify that an *event* was created by the *RLCS* using the methodology specified in §2.2.4.1.

5.7.3.8 Set the *RLCS* simulator to create an incidence of one vehicle traveling through the intersection on a *green phase*, such that the vehicle is not in violation.

5.7.3.9 Start the *RLCS* simulator to run the simulation.

5.7.3.10 Verify that an *event* was not created by the *RLCS* using the methodology specified in §2.2.4.1.

5.7.4 (Reserved)

5.8 (Reserved)

5.9 (Reserved)

5.10 (Reserved)

5.11 Field Operation Testing

Tests performed under this section are to be conducted using the *RLCS* specified in §2.1.3 at the installed location.

5.11.1 *Red Phase* Violations Test

This test verifies the requirements of §2.11.1.

5.11.1.1 Ensure the *RLCS* is set up for normal operation as specified in §2.2.1.1.

5.11.1.2 Set up the methodology necessary to review *event information* as specified in §2.2.4.2.

5.11.1.3 Set up the methodology necessary to review associated *event* data as specified in §2.2.4.3.

5.11.1.4 Set up the test video camera to monitor the approach such that the video image includes:

- The vehicles for all monitored lanes immediately behind the threshold line such that the position of the vehicle relative to the threshold line is visible.
- All monitored lanes completely through the intersection.
- At least one *traffic signal* for the monitored lanes.

5.11.1.5 Access the traffic controller for the intersection. Ensure the *traffic signal* for the monitored lanes has a *yellow phase* of at least 3.0 seconds.

5.11.1.6 Use as many barricades as necessary to close off the portion of the street for the lanes to be tested for a minimum of one half mile before and after the intersection monitored by the *RLCS*.

5.11.1.7 Use as many barricades as necessary to close off the cross street at the intersection monitored by the *RLCS*.

5.11.1.8 Start the 3 test vehicles from a point approximately one half mile behind the intersection and within the barricades. Have the vehicles approach the intersection with:

- All vehicles in a single lane.
- A spacing of 5.0 to 10.0 seconds between vehicles as they cross the *intersection threshold*.
- A speed of 15 MPH for all vehicles.
- The first vehicle crosses the threshold at a time between 3 seconds and 10 seconds into red.
- All vehicles pass through the intersection on a *red phase*.

5.11.1.9 Repeat §5.11.1.6 nine additional times, changing the lane of travel and increasing the speed of the vehicles by 5 MPH for each iteration, such that all monitored lanes are used and the speed for the final iteration is 60 MPH. This results in a total of 30 incidents of vehicles passing through the intersection on a *red phase*.

5.11.1.10 Remove all barricades from §5.11.1.2 and §5.11.1.7, allowing traffic to flow freely through the intersection.

5.11.1.11 Review the *event information* using the methodologies specified in §2.2.4.2 and §2.2.4.3.

5.11.1.12 Verify at least 27 out of the 30 incidents resulted in *event*s created by the *RLCS*, as specified in §2.11.1.

5.11.1.13 Verify the *event information* is consolidated for each *event*, as specified in §2.3.1.1.

5.11.1.14 Verify the *event information* was created at the time of each *event* with no human intervention, as specified in §2.3.1.2.

5.11.1.15 Verify the first *event* image for each *event* shows the moving vehicle behind the threshold line, as specified in §2.3.2.1.1.

5.11.1.16 Verify the first *event* image for each *event* shows the *traffic signal* showing a *red phase,* as specified in §2.3.2.1.2.

5.11.1.17 Verify the second *event* image shows the moving vehicle beyond the threshold line, as specified in §2.3.2.2.1.

5.11.1.18 Verify the second *event* image shows the *traffic signal,* as specified in §2.3.2.2.2.

5.11.1.19 Verify at least one image shows the license plate of the moving vehicle*,* as specified in §2.3.2.3.

5.11.1.20 Verify all *event* images display all associated *event* data correctly as is able to be determined*,* as specified in §2.3.3.

Compare the *event images* to that recorded by the test video camera, if necessary.

5.11.2 Free Flow Traffic Test

This test verifies the requirements of §2.11.2.

5.11.2.1 Set up or leave the *RLCS* and associated test equipment as specified in §5.11.1.1 through §5.11.1.5.

5.11.2.2 Allow a sample of at least 500 vehicles to pass through the intersection in the monitored lanes.

5.11.2.3 Review all *event*s captured by the *RLCS* within this sample using the methodologies specified in §2.2.4.2 and §2.2.4.3.

5.11.2.4 Verify that there are no erroneous *events* within this sample, as specified in §2.11.2.

Compare the *event images* to that recorded by the test video camera, if necessary.

Table 1 – Minimum Performance Specifications for *Red Light Camera Systems*

Performance Characteristic	Minimum Requirement	Section
Event information	Captures and stores the required images and *associated data*	§2.3.1.1
Event images	A minimum of two images with the same unique *Event ID*; license plate visible	§2.3.2
Required *associated data*	Location identifier, *event ID*, date, time, time into red and duration of *yellow phase*	§2.3.3
Electrical Tolerance	Operates within specified electrical tolerances	§2.4.1
Labeling	Proper labeling of all controls and *displays*	2.4.2
Display readability	Easily readable under normal illumination conditions	§2.4.3
System Test function	*System Test* capability to verify functionality and performance	§2.4.4
Response to *red phase* violations	*RLCS* registers a *red phase* violation and records all required *event information*	§2.5.1
Response to *compliant traffic*	*RLCS* shall not save images or otherwise activate for *compliant traffic*	§2.5.2
Response to yellow *phase duration* less than 3 seconds	*RLCS* shall not save images or otherwise activate under any traffic conditions	§2.5.2.5
Statistical Repeatability	Capture and store a minimum of 90% of *events*.	§2.11.1
Live Traffic Conditions	No erroneous data for a sampling of 500 *events* at a live intersection	§2.11.2
Environmental	Operates within the specified environmental tolerances	§2.7

Appendix

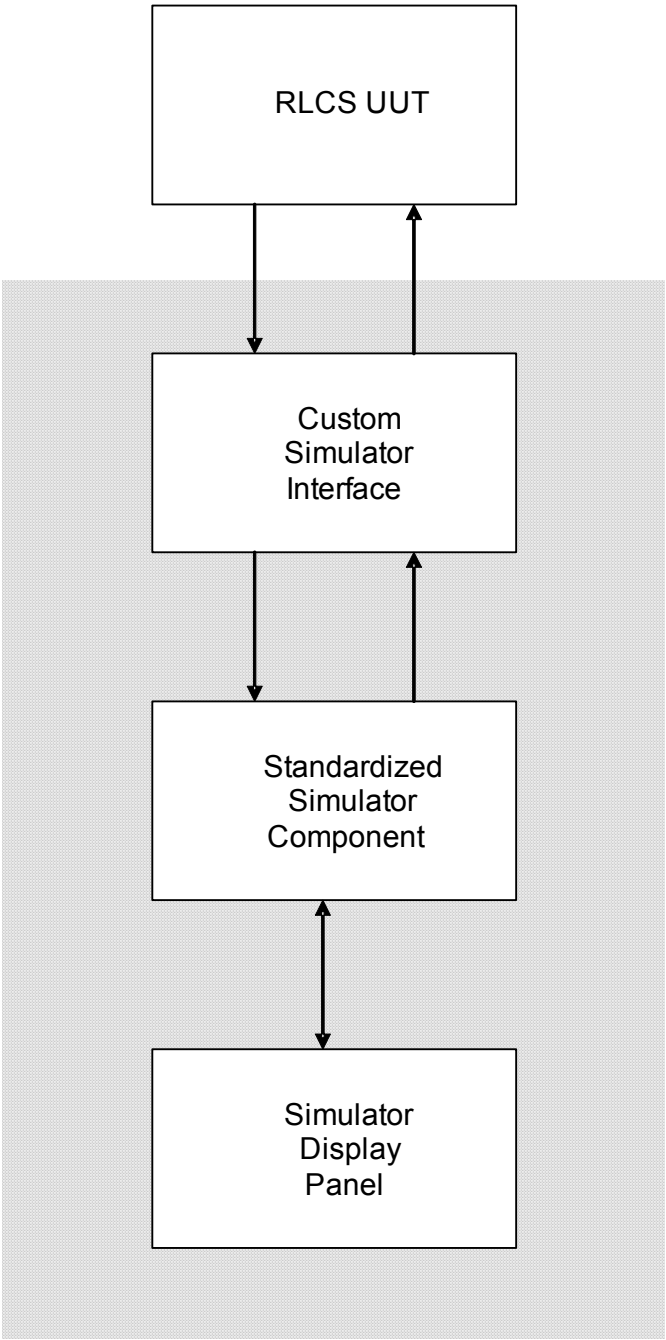

Figure 1. - Block diagram illustrating the *RLCS* Unit Under Test (*RLCS* UUT) connected to the *RLCS* Intersection Simulator (*RLCS*-IS).

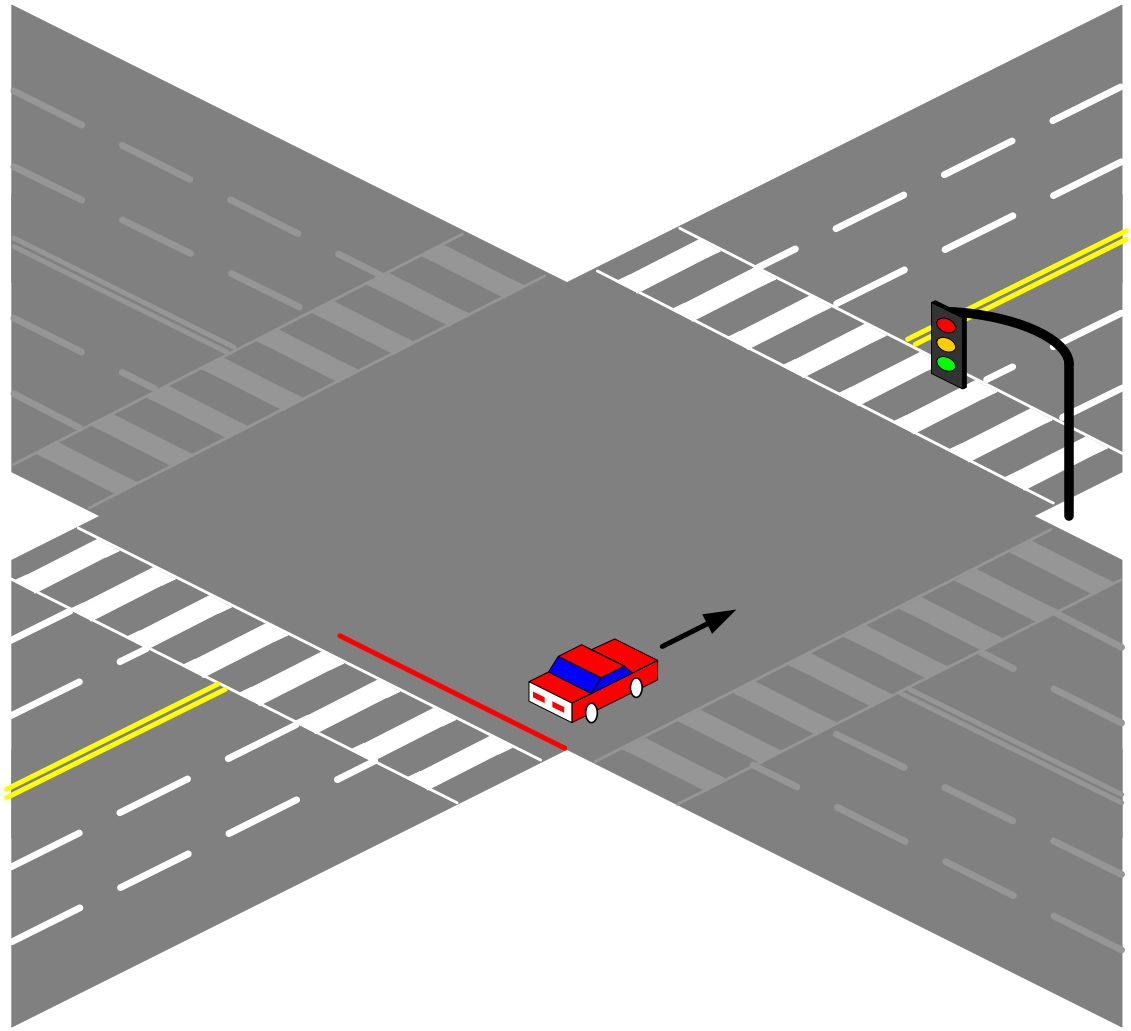

Figure 2. – A single vehicle traveling through a *controlled intersection*.

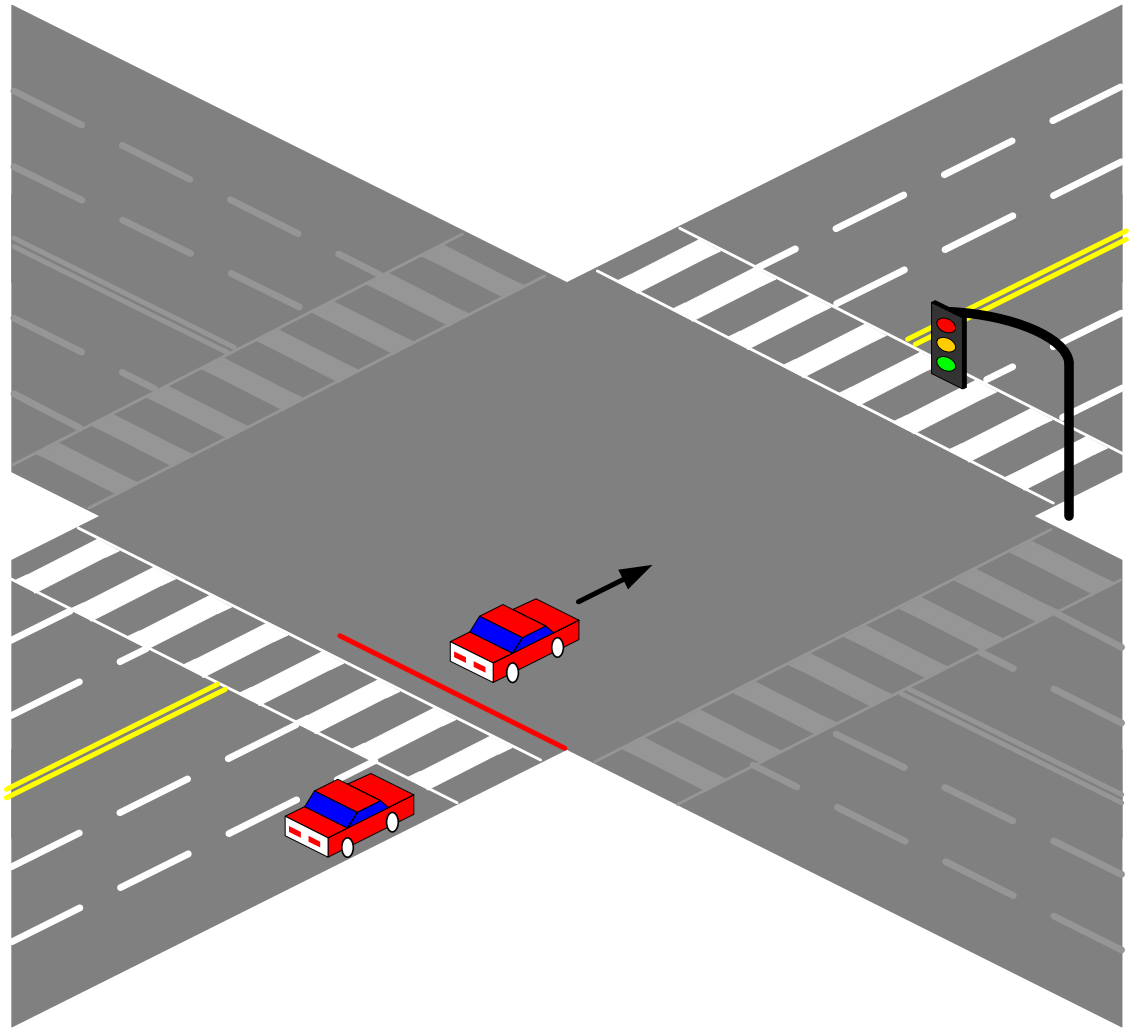

Figure 3. – A red-light violation in the presence of *compliant traffic*.

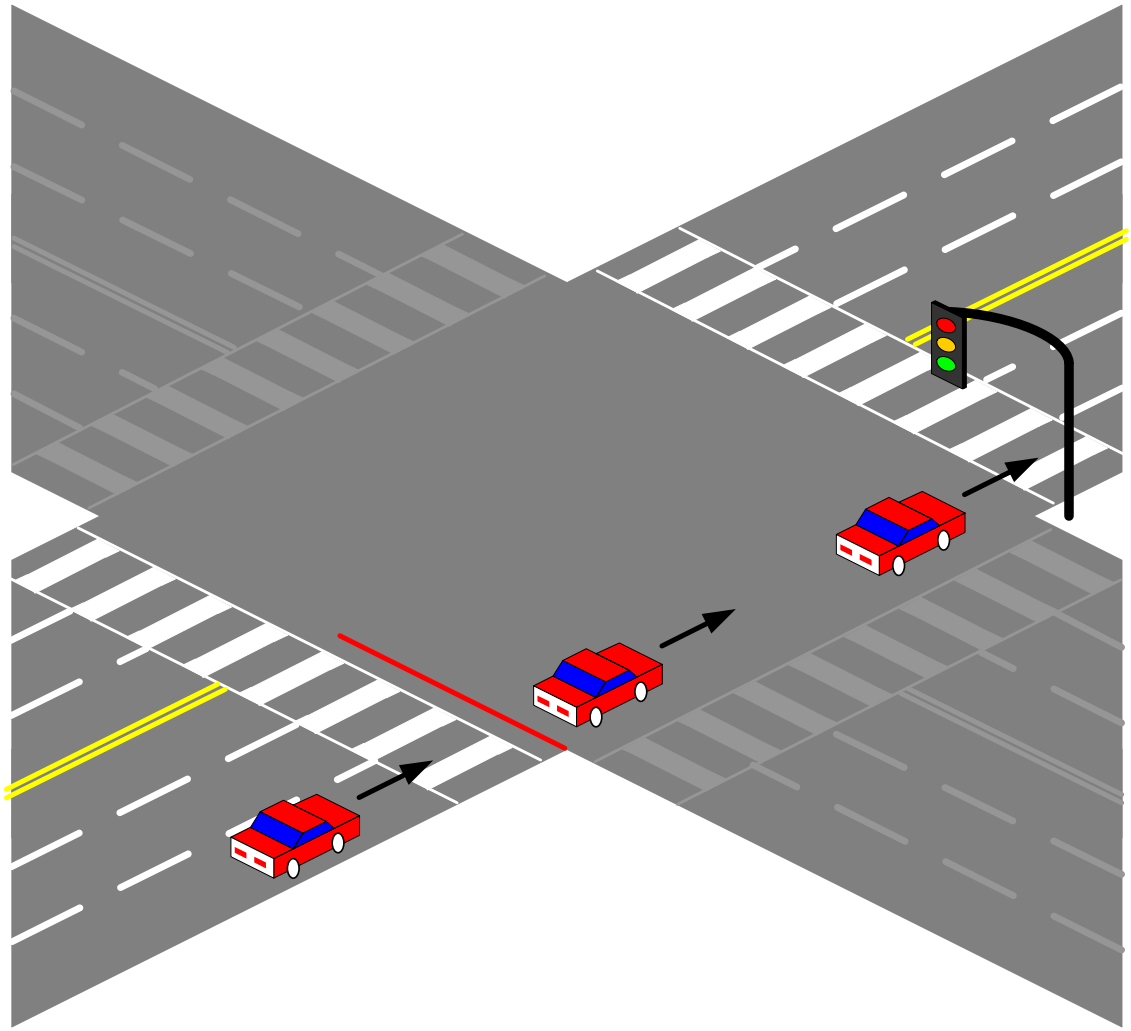

Figure 4. – Multiple vehicles traveling in line through a *controlled intersection*.

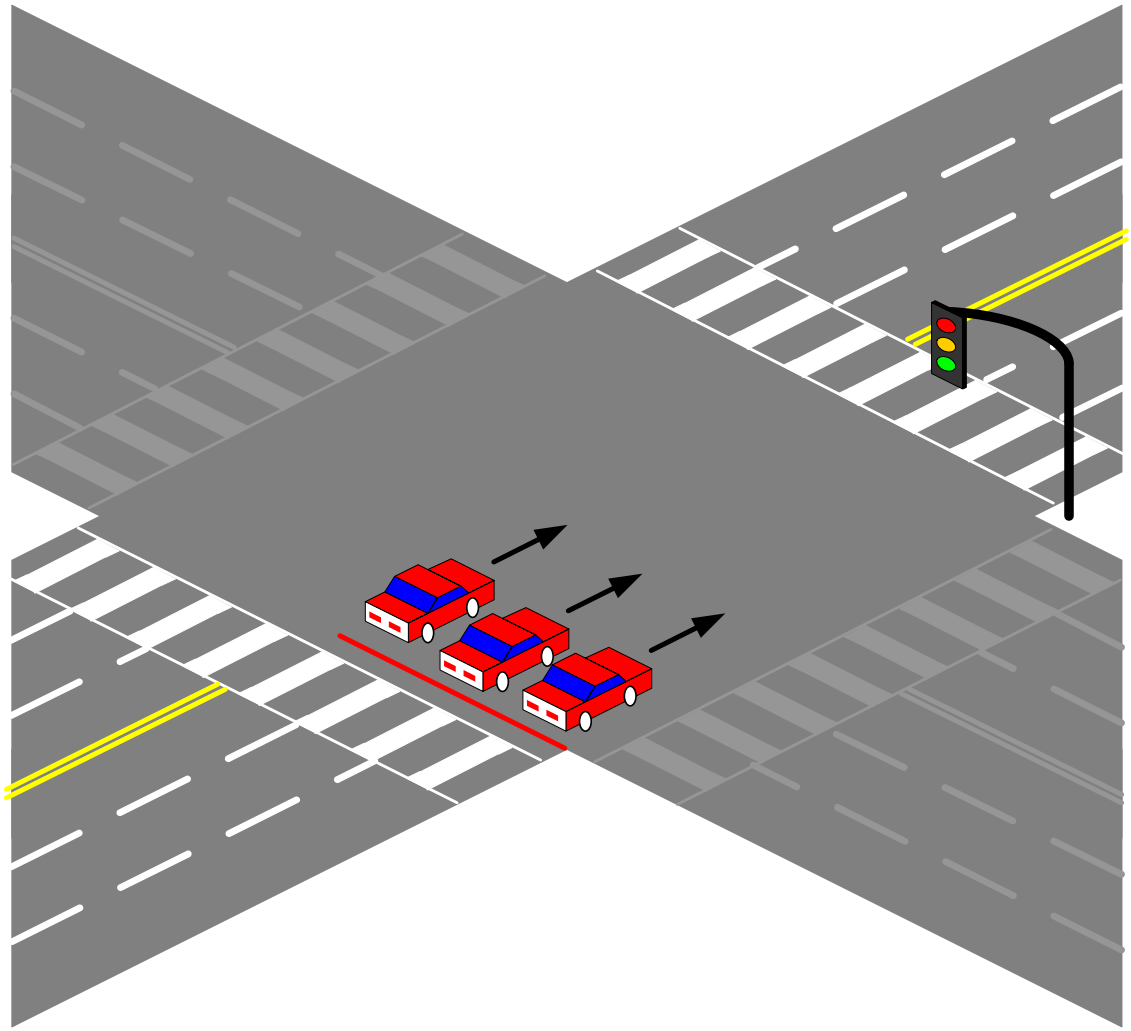

Figure 5. – Multiple vehicles traveling abreast through a *controlled intersection*.

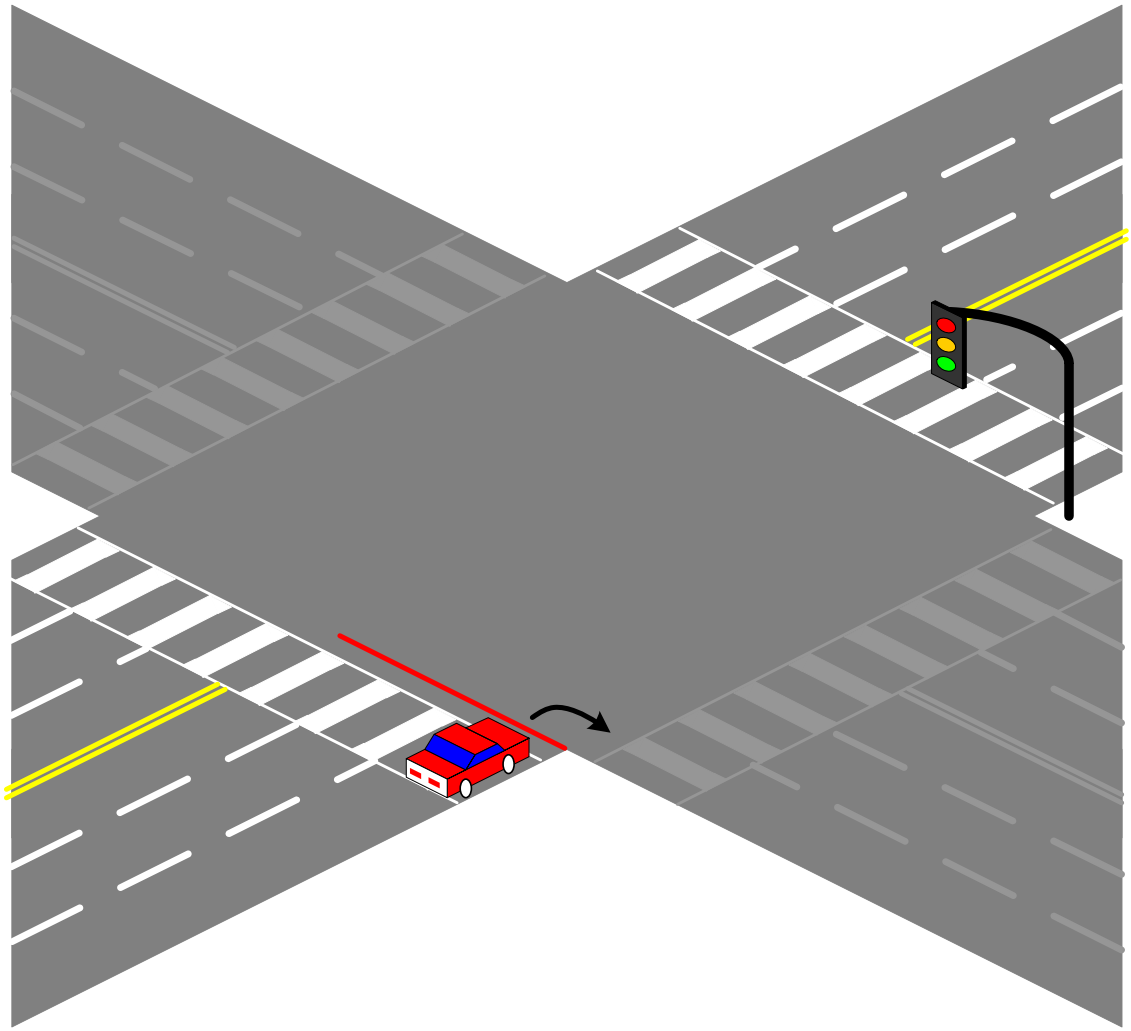

Figure 6. – A vehicle turning right on red after coming to a stop.

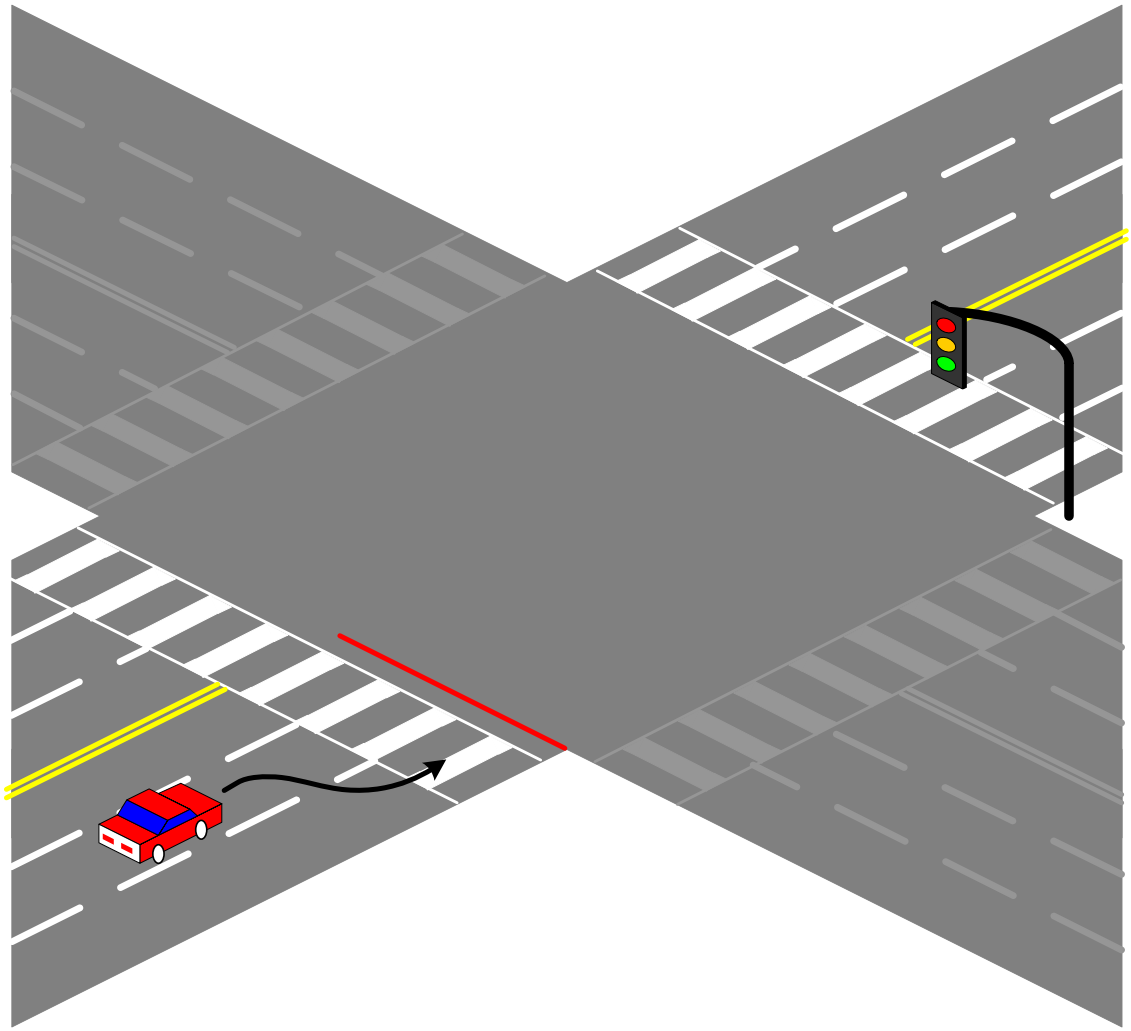

Figure 7. – A vehicle changing lanes prior to entering a *controlled intersection*.

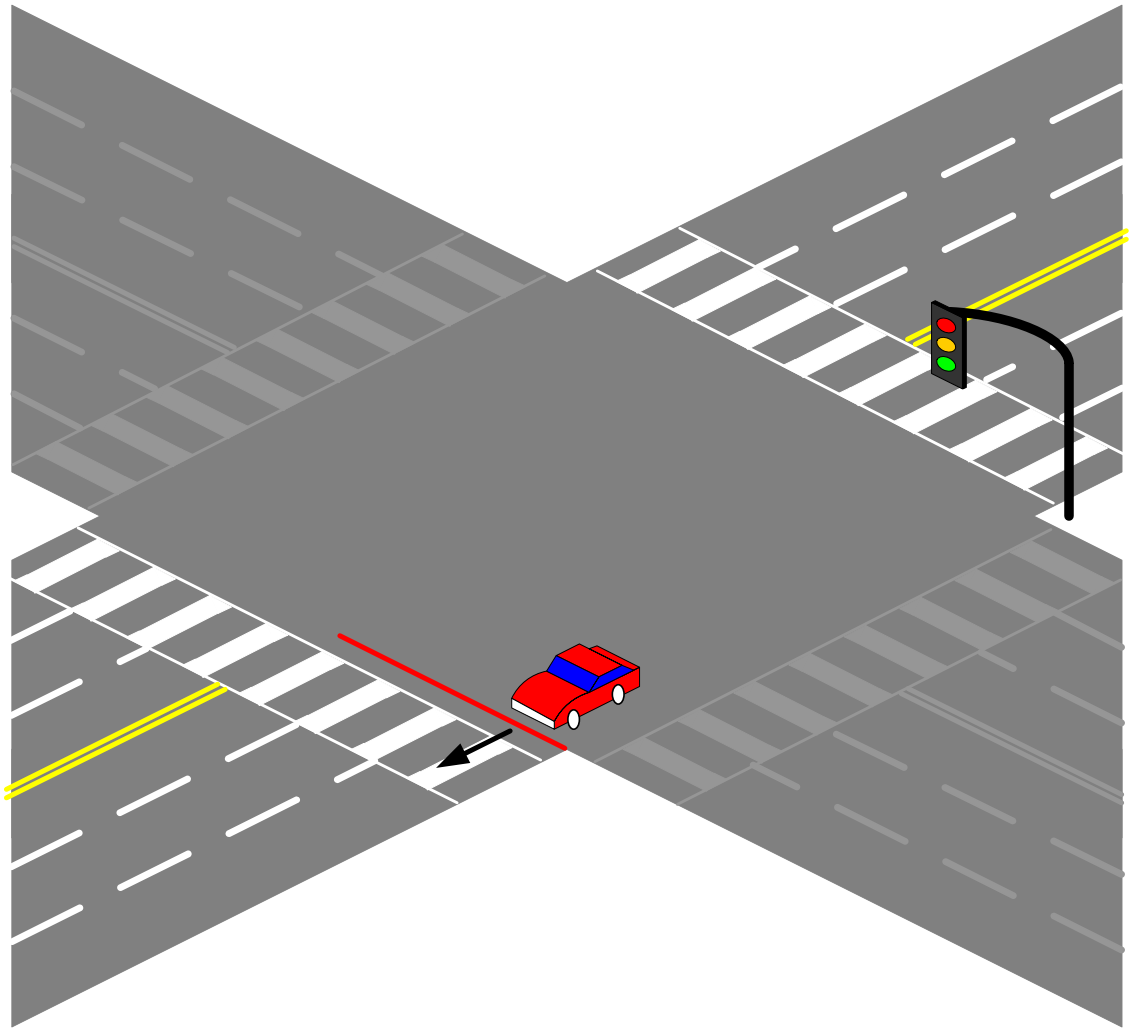

Figure 8 – A vehicle traveling the wrong way through a *controlled intersection*.