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U.S. DEPARTMENT OF TRANSPORTATION

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

LABORATORY TEST PROCEDURE

FOR

FMVSS 111

Rear Visibility

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ENFORCEMENT
Office of Vehicle Safety Compliance
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Washington, DC 20590

OVSC LABORATORY TEST PROCEDURE NO. 111V-01
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REVISION CONTROL LOG
FOR OVSC LABORATORY TEST PROCEDURES
TP111V -- Rearview Mirrors
(other than school bus rearview mirror testing)

Test Procedure		FMVSS 111		Description
Rev. No.	Date	Amendment	Effective Date	
00	10/28/1999	63FR51000	5/27/99	Revised Table 1 – Conversions
01	05/06/2016	79FR19178	06/06/2014	Incorporation of Rearview image Requirements. FMVSS 111 renamed "REAR VISIBILITY"

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PREFACE

On April 7, 2014. the National Highway Traffic Safety Administration (NHTSA) issued a final rule to upgrade Federal Vehicle Motor Safety Standard (FMVSS) No. 111, "Rearview Mirrors". The final rule, renamed "Rear Visibility", sets forth new performance requirements to improve a driver's ability to see areas to the rear of a motor vehicle in order to mitigate fatalities and injuries associated with back-over incidents. The new requirements for a Rearview image are applicable to passenger cars, multipurpose passenger vehicles, low-speed vehicles, trucks, buses and school buses with a gross vehicle weight rating of 4,536 kg or less. This test procedure is organized first with the existing **rearview mirror** testing requirements followed by a new section for **rearview image** testing requirements. The effective dates for the requirements are identified in the applicable procedural sections.

1. PURPOSE AND APPLICATION

This document is a laboratory test procedure provided by the National Highway Traffic Safety Administration (NHTSA), Office of Vehicle Safety Compliance (OVSC) for the purpose of presenting guidelines for a uniform testing data and information recording format, and providing suggestions for the use of specific equipment and procedures for contracted testing laboratories. The data correspond to specific requirements of the Federal Motor Vehicle Safety Standard(s) (FMVSS). The OVSC test procedures include requirements that are general in scope to provide flexibility for contracted laboratories to perform compliance testing and are not intended to limit or restrain a contractor from developing or utilizing any testing techniques or equipment which will assist in procuring the required compliance test data. These test procedures do not constitute an endorsement or recommendation for use of any particular product or testing method.

Prior to conducting compliance testing, contracted laboratories are required to submit a detailed test procedure to the Contracting Officer's Technical Representative (COTR) to demonstrate concurrence with the OVSC laboratory test procedure and the applicable FMVSS. If any contractor views any part of an OVSC laboratory test procedure to be in conflict with a FMVSS or observes deficiencies in a laboratory test procedure, the contractor is required to advise the COTR and resolve the discrepancy prior to the start of compliance testing or as soon as practicable. The contractor's test procedure must include a step-by-step description of the methodology and detailed check-off sheets. Detailed check-off sheets shall also be provided for the testing instrumentation including a complete listing of the test equipment with make and model numbers. The list of test equipment shall include instrument accuracy and calibration dates. All equipment shall be calibrated in accordance with the manufacturer's instructions. There shall be no contradictions between the laboratory test procedure and the contractor's in-house test procedure. Written approval of the in-house test procedures shall be obtained from the COTR before initiating the compliance test program.

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NOTE: The OVSC Laboratory Test Procedures, prepared for the limited purpose of use by independent laboratories under contract to conduct compliance tests for the OVSC, are not rules, regulations or NHTSA interpretations regarding the meaning of a FMVSS. The laboratory test procedures are not intended to limit the requirements of the applicable FMVSS(s). In some cases, the OVSC laboratory test procedures do not include all of the various FMVSS minimum performance requirements. Recognizing applicable test tolerances, the laboratory test procedures may specify test conditions that are less severe than the minimum requirements of the standard.

In addition, the laboratory test procedures may be modified by the OVSC at any time without notice, and the COTR may direct or authorize contractors to deviate from these procedures, as long as the tests are performed in a manner consistent with the standard itself and within the scope of the contract. Laboratory test procedures may not be relied upon to create any right or benefit in any person. Therefore, compliance of a vehicle or item of motor vehicle equipment is not necessarily guaranteed if the manufacturer limits its certification tests to those described in the OVSC laboratory test procedures.

2. GENERAL REQUIREMENTS

Federal Motor Vehicle Safety Standard (FMVSS) No. 111 establishes requirements for rear visibility devices and systems which includes requirements for rearview mirrors and a rearview image. The purpose of the **rearview mirrors** is to reduce the number of deaths and injuries that occur when the driver of a motor vehicle does not have a clear and reasonably unobstructed view to the rear. The purpose of a **rearview image** is to improve a driver's ability to see areas to the rear of a motor vehicle in order to mitigate fatalities and injuries associated with back-over incidents.

A. REARVIEW MIRRORS

FMVSS 111 specifies requirements for the performance and location of rearview mirrors.

REQUIREMENTS FOR PASSENGER CARS

Each passenger car shall have an inside rearview mirror of unit magnification with the required field-of-view and a driver's side outside rearview mirror of unit magnification with the required field-of-view. If the inside rearview mirror does not meet the field-of-view requirements, an outside rearview mirror of unit magnification or a convex mirror (with required markings) is required on the passenger's side. The average radius of curvature of the convex mirror shall be not less than 889 millimeters (mm) and not more than 1,651 mm. All the required mirrors must be adjustable in both the vertical and horizontal directions and have a stable mounting.

REQUIREMENTS FOR MPVs, TRUCKS AND BUSES (OTHER THAN SCHOOL BUSES) WITH A GVWR 4,536 KILOGRAMS

1. Mirrors as described for passenger cars, OR

2. Unit magnification outside mirrors on both sides of the vehicle with stable supports, adjustable in both the vertical and horizontal directions, and with reflective surface of at least 126 square centimeters (cm^2).

REQUIREMENTS FOR MPVs, TRUCKS AND BUSES (OTHER THAN SCHOOL BUSES) WITH A GVWR > 4,536 KILOGRAMS (Kg)

Each vehicle shall have outside mirrors of unit magnification, each with not less than 323 cm^2 of reflective surface, installed with stable supports on both sides of the vehicle. The mirrors shall be located so as to provide the driver a view to the rear along both sides of the vehicle and shall be adjustable both in the horizontal and vertical directions to view the rearward scene.

REQUIREMENTS FOR SCHOOL BUSES

Refer to the latest version of **TP-111SB-00** for testing school bus mirror systems.

REQUIRMENTS FOR MOTORCYCLES

Each motorcycle shall have either a mirror of unit or convex magnification of specified reflective surface area installed with a horizontal and vertically adjustable stable support at least 279mm outward of the longitudinal centerline of the motorcycle.

B. REQUIRMENTS FOR REARVIEW IMAGE

FMVSS 111 specifies requirements for a rearview image detected by a single source, of the area directly behind a vehicle that is provided in a single location to the vehicle operator and by means of indirect vision.

Requirements apply to passenger cars, multi-purpose passenger vehicles, low-speed vehicles, trucks, buses and school buses with a GVWR or 4,536 kg or less.

Each vehicle shall display a rearview image displaying a specified field-of-view and test object image size.. The response time for image display must be within 2 seconds of the vehicle's direction selector being placed in reverse. The image cannot be displayed after the backing event is completed. The image shall remain visible unless the driver modifies the view, or the vehicle direction selector is removed from the reverse position. The Rearview image must default to the image required at the beginning of each backing event regardless of any modifications to the field-of-view the driver previously selected. Lastly, the rear visibility system must meet the field-of-view and test object image size requirements after Corrosion, Humidity, and Temperature exposure.

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METRIC SYSTEM OF MEASUREMENT

Section 5164 of the Omnibus Trade and Competitiveness Act (Pub. L. 100-418) establishes that the metric system of measurement is the preferred system of weights and measures for trade and commerce in the United States. Executive Order 12770 directs Federal agencies to comply with the Act by converting regulatory standards to the metric system after September 30, 1992. In a final rule published on March 15, 1990 (60 FR 13639), NHTSA completed the first phase of metrication, converting English measurements in several regulatory standards to the metric system. Since then, metrication has been applied to other regulatory standards (63 FR 28912).

Accordingly, the OVSC laboratory test procedures include revisions to comply with governmental directives in using the metric system. Regulatory standards converted to metric units are required to use metric measurements in the test procedures, whereas standards using English units are allowed to use English measurements or to use English measurements in combination with metric equivalents in parentheses.

All final compliance test reports are required to include metric measurements for standards using metrication.

NOTE: The methodology for rounding measurement in the test reports shall be made in accordance with ASTM E29-06b, "Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications."
METRIC UNITS

In this Laboratory Test Procedure, metric values maybe followed by English units only for reference purposes (not necessarily equal). If test equipment is not available for direct measurement in metric units, the test laboratory shall calculate the exact metric equivalent by means of a conversion factor carried out to at least 5 significant digits before rounding consistent with the specified metric requirement.

3. SECURITY

The contractor shall provide appropriate security measures to protect the OVSC test vehicles and Government Furnished Property (GFP) from unauthorized personnel during the entire compliance testing program. The contractor is financially responsible for any acts of theft and/or vandalism which occur during the storage of test vehicles and GFP. Any security problems which arise shall be reported by telephone to the Industrial Property Manager (IPM), Office of Acquisition Management, within two working days after the incident. A letter containing specific details of the security problem shall be sent to the IPM (with copy to the COTR) within 48 hours.

The contractor shall protect and segregate the data that evolves from compliance testing before and after each vehicle test. No information concerning the vehicle safety compliance testing program shall be released to anyone except the COTR, unless specifically authorized by the COTR or the COTR's Division Chief.

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NOTE: No individuals, other than contractor personnel directly involved in the compliance testing program or OVSC personnel, shall be allowed to witness any vehicle or equipment item compliance test or test dummy calibration unless specifically authorized by the COTR.

4. GOOD HOUSEKEEPING

Contractors shall maintain the entire vehicle compliance testing area, fixtures and instrumentation in a neat, clean and painted condition with test instruments arranged in an orderly manner consistent with good test laboratory housekeeping practices.

5. TEST SCHEDULING AND MONITORING

The contractor shall submit a test schedule to the COTR prior to conducting the first compliance test. Tests shall be completed at intervals as required in the contract. If not specified, the first test shall be conducted within 6 weeks after receiving the first delivered unit. Subsequent tests shall be completed in no longer that 1 week intervals unless otherwise specified by the COTR.

Scheduling of tests shall be adjusted to permit vehicles (or equipment, whichever applies) to be tested to other FMVSSs as may be required by the OVSC. All compliance testing shall be coordinated with the COTR in order to allow monitoring by the COTR and/or other OVSC personnel if desired. The contractor shall submit a monthly test status report and a vehicle status report (if applicable) to the COTR. The vehicle status report shall be submitted until all vehicles are disposed of. The status report forms are provided in the forms section.

6. TEST DATA DISPOSITION

The Contractor shall make all preliminary compliance test data available to the COTR if on location within 30 minutes after the test. Final test data, including digital printouts and computer generated plots (if applicable), shall be available to the COTR in accordance with the contract schedule or if not specified within two working days. Additionally, the Contractor shall analyze the preliminary test results as directed by the COTR.

All backup data sheets, strip charts, recordings, plots, technicians' notes, etc., shall be either sent to the COTR or destroyed at the conclusion of each delivery order, purchase order, etc.

The contractor shall protect and segregate the data that evolves from compliance testing before and after each test.

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TEST DATA LOSS

A. INVALID TEST DESCRIPTION

An invalid compliance test is one, which does not conform precisely to all requirements/specifications of the OVSC Laboratory Test Procedure and Statement of Work applicable to the test.

B. INVALID TEST NOTIFICATION

The Contractor shall notify NHTSA of any test not meeting all requirements/specifications of the OVSC Laboratory Test Procedure and Statement of Work applicable to the test, by telephone, within 24 hours of the test and send written notice to the COTR within 48 hours or the test completion.

C. RETEST NOTIFICATION

The Contracting Officer of NHTSA is the only NHTSA official authorized to notify the Contractor that a retest is required. The retest shall be completed within 2 weeks after receipt of notification by the Contracting Officer that a retest is required.

D. WAIVER OF RETEST

NHTSA, in its sole discretion, reserves the right to waive the retest requirement. This provision shall not constitute a basis for dispute over the NHTSA's waiving or not waiving any requirement.

E. TEST VEHICLE

NHTSA shall furnish only one vehicle for each test ordered. The Contractor shall furnish the test vehicle required for the retest. The retest vehicle shall be equipped as the original vehicle. The original vehicle used in the invalid test shall remain the property of NHTSA, and the retest vehicle shall remain the property of the Contractor. The Contractor shall retain the retest vehicle for a period not exceeding 180 days if it fails the test. If the retest vehicle passes the test, the Contractor may dispose of it upon notification from the COTR that the test report has been accepted.

F. TEST REPORT

No test report is required for any test that is determined to be invalid unless NHTSA specifically decides, in writing, to require the Contractor to submit such report. The test data from the invalid test must be safeguarded until the data from the retest has been accepted by the COTR. The report and other required

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deliverables for the retest vehicle are required to be submitted to the COTR within 3 weeks after completion of the retest.

G. DEFAULT

The Contractor is subject to the default and subsequent reprocurement costs for non-delivery of valid or conforming test (pursuant to the Termination For Default clause in the contract).

H. NHTSA'S RIGHTS

None of the requirements herein stated shall diminish or modify the rights of NHTSA to determine that any test submitted by the Contractor does not conform precisely to all requirements/specifications of the OVSC Laboratory Test Procedure and Statement of Work applicable to the test.

7. GOVERNMENT FURNISHED PROPERTY (GFP)

GFP consists of test vehicles. The handling and disposition of GFP is governed by contractual agreement. The Contractor is responsible for the following:

A. ACCEPTANCE OF VEHICLE

The Contractor has the responsibility of accepting the test vehicle from either a dealer or a vehicle transporter. In both instances, the contractor acts in the OVSC's behalf when signing an acceptance of the test vehicle. If the vehicle is delivered by a dealer, the contractor must check to verify the following:

1. Tires and wheel rims are new and the same as listed.
2. There are no dents or other interior or exterior flaws in the vehicle body.
3. The vehicle has been properly prepared and is in running condition.
4. An owner's manual, warranty document, consumer information, and extra set of keys are included with the vehicle.
5. Proper fuel filler cap is supplied on the test vehicle.
6. Spare tire, jack, lug wrench and tool kit (if applicable) is included with the vehicle.

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7. The VIN (vehicle identification number) on the vehicle matches that supplied by the COTR.

8. Seats and, if applicable, restraining barriers are not deformed.

9. The vehicle is equipped as specified by the COTR.

A Vehicle Condition form will be supplied to the Contractor by the COTR when the test vehicle is transferred from a new vehicle dealership or between test contracts. The upper half of the form is used to describe the vehicle as initially accepted. The lower half of the Vehicle Condition form provides space for a detailed description of the post-test condition. The contractor must complete a Vehicle Condition form for each vehicle and deliver it to the COTR with the Final Test Report or the report will NOT be accepted for payment.

If the test vehicle is delivered by a government contracted transporter, the contractor should check for damage which may have occurred during transit. GFP vehicle(s) shall not be driven by the contractor on public roadways unless authorized by the COTR.

B. NOTIFICATION OF COTR

The COTR must be notified within 24 hours after a vehicle (and/or equipment item) has been delivered. In addition, if any discrepancy or damage is found at the time of delivery, a copy of the Vehicle Condition form shall be sent to the COTR immediately.

8. CALIBRATION OF TEST INSTRUMENTS

Before the Contractor initiates the vehicle safety compliance test program, a test instrumentation calibration system must be implemented and maintained in accordance with established calibration practices (See Section 17 - Forms). The calibration system shall include the following as a minimum:

A. Standards for calibrating the measuring and test equipment shall be stored and used under appropriate environmental conditions to assure their accuracy and stability.

B. All measuring instruments and standards shall be calibrated by the Contractor, or a commercial facility, against a higher order standard at periodic intervals not exceeding 12 months for instruments and 12 months for the calibration standards except for static types of measuring devices such as rulers, weights, etc., which shall be calibrated at periodic intervals not to exceed two years. Records, showing the calibration traceability to the National Institute of Standards and Technology (NIST), shall be maintained for all measuring and test equipment.

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Accelerometers shall be calibrated every twelve months or after a test failure or after any indication from calibration checks that there may be a problem with the accelerometer whichever occurs sooner.

C. All measuring and test equipment and measuring standards shall be labeled with the following information:

1. Date of calibration

2. Date of next scheduled calibration

3. Name of the technician who calibrated the equipment

D. A written calibration procedure shall be provided by the Contractor, which includes as a minimum the following information for all measurement and test equipment:

1. Type of equipment, manufacturer, model number, etc.

2. Measurement range

3. Accuracy

4. Calibration interval

5. Type of standard used to calibrate the equipment (calibration traceability of the standard must be evident).

6. The actual procedures and forms used to perform the calibrations.

E. Records of calibration for all test instrumentation shall be kept by the Contractor in a manner that assures the maintenance of established calibration schedules.

F. All such records shall be readily available for inspection when requested by the COTR. The calibration system shall need the acceptance of the COTR before vehicle safety compliance testing commences.

G. Test equipment shall receive a system functional check out using a known test input immediately before and after the test. This check shall be recorded by the test technician(s) and submitted with the final report.

H. The Contractor may be directed by NHTSA to evaluate its data acquisition system.

Further guidance is provided in the International Standard ISO 10012-1, “Quality Assurance Requirements for Measuring Equipment” and American National Standard

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ANSI/NCSL Z540-1, “Calibration Laboratories and Measuring and Test Equipment General Requirements.”

NOTE: In the event of a failure to meet the standard's minimum performance requirements additional calibration checks of some critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration will be at the COTR's discretion and shall be performed without additional cost.

9. SUGGESTED TEST EQUIPMENT

The following is an abbreviated list of the minimum suggested test equipment needed to evaluate the performance requirements as outlined in FMVSS 111.
Specific and detailed suggested test equipment is identified in the applicable Compliance Test Execution Sections.

A. General:

1. Various hand measuring devices including tape measure, angle measurement tool, ruler, temperature gauge, timing device/stopwatch, tire pressure gauge, etc.

2. Photographic documentation equipment including 35 mm or larger format still camera, video camera, or digital equivalent.

B. Rearview Mirror Testing Specific:

1. For the Mirror reflectance test-

   An apparatus which consists of a light source, a sample holder, a receiver unit with a photo-detector, an indicating meter, and means for negating the effects of extraneous light. The receiver may incorporate a light integrating sphere to facilitate measuring reflectance of non-flat (convex) mirrors.

2. For the Inside Mirror break-away test the following items -

   - Head Form
   - Loading Ram
   - Displacement Transducer
   - Force Transducer
   - Vernier Protractor
   - Recording Equipment

3. For Unit magnification and convex Mirror Tests -

   - 3-point linear spherometer.

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C. Rearview Image Testing Specific:

1. Three dimensional SAE Standard J826-1995 manikin used for seat and eye-point adjustment.

2. Ruler with precision quality, non-flex, high visibility demarcations, flat finish for use Field-of View and Image size photographs.

3. Luminance meter with an operating range of at least 500 lux to 20,000 lux and an accuracy of at least +/- 5% of the measured value.

4. For vehicle speed measurement and distance traveled - Contact or Optical fifth wheel, GPS, or equivalent.

5. A digital camera (35 mm or larger) with sufficient megapixels, zoom capabilities, and image quality necessary for photographic examination. Location of camera CCD is necessary to properly locate CCD at driver's eye midpoint.

6. Corrosion Test chamber for component testing to ASTM B117-73.

7. Humidity Test Chamber for component testing to specified simultaneous temperature and humidity testing.

8. Temperature Test Chamber for component testing to specified temperature range.

9. Foam, PVC tubing etc. for test objects measuring .8m high, .3 m diameter and marked as specified in applicable test procedure section.

10. Video camera (s) with capability for on-screen timing marks, synchronization capabilities, and multiple inputs for time zero triggers (response and linger time determination).

11. For field- of-view and test object testing, a fixture to hold the camera at the required eye-point position as described in the applicable Compliance Execution section.

12. Mounting bracket to affix camera to the J826 Manikin if used, such that the center of the camera's image plane is located at a defined eye location and the camera lens can be directed at the center of the displays Rearview image.

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10. PHOTOGRAPHIC DOCUMENTATION

DIGITAL PHOTOGRAPHS

The contractor shall take digital photographs of the test execution procedures. Photographs shall be taken in color and contain clear images. A tag, label or placard identifying the test item, NHTSA number (if applicable) and date shall appear in each photograph and must be legible. Each photograph shall be labeled as to the subject matter. The required resolution for digital photographs is a minimum of 1,600 x 1,200 pixels. Digital photographs are required to be created in color and in a JPG format. Glare or light from any illuminated or reflective surface shall be minimized while taking photographs.

The test reports shall include enough photographs to describe the testing in detailed and shall be organized in a logical succession of consecutive pictures. The digital photographs should be included in the test report as 203 mm x 254 mm or 215.9 mm x 279 mm (8 x 10 or 8½ x 11 inch) pictures (or for equipment testing -- 125 mm x 175 mm (5 x 7 inch) pictures). All photographs are required to be included in the test report in the event of a test failure. Any failure must be photographed at various angles to assure complete coverage. Upon request, the photographs shall be sent to the COTR on a CD or DVD and saved in a "read only" format to ensure that the digital photographs are the exact pictures taken during testing and have not been altered from the original condition.

PHOTOGRAPHIC VIEWS -

As a minimum the following photographs shall be included in each final test report, where applicable:

A. 3/4 frontal view from left side of vehicle

B. 3/4 rear view from right side of vehicle

C. Close-up view of vehicle's certification label

D. Close-up view of vehicle's tire information placard or label

<u>REARVIEW MIRROR TESTING SPECIFIC -</u>

A. All rearview mirrors and mirror mountings

B. Field-of-view test setups, including viewing instrument

C. Reflectance test setup

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D. Breakaway test setup

E. Photos required to document test results including those specified in test procedure

F. Photos to document any apparent test failure

REARVIEW IMAGE TESTING SPECIFIC -

A. Field-of-View Test cylinder set-up

B. J826 Manikin positioned in vehicle

C. Viewing instrument in place for field-of-view and test object image size testing.

D. Photograph(s) of the Rearview image display with the ruler included in the frame (Photographic Extraction)

E. Close-up of interior Rearview image visual display.

F. Rearview camera mounted on vehicle.

G. Rearview camera and associated wiring and connectors removed from vehicle.

H. Rearview camera environmental test fixture.

I. Rearview camera and hardware installed in/on environmental test fixture.

J. Rearview camera and hardware pre and post durability testing.

K. Photos required to document test results including those specified in test procedure for field-of-view and test object image size.

L. Photos to document any apparent test failure.

M. Video available (if used) for recording of response time and linger time procedure.

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11. DEFINITIONS (S4)

CONVEX MIRROR
Mirror having a curved reflective surface whose shape is the same as that of the exterior surface of a section of a sphere.

EFFECTIVE MIRROR SURFACE
The portions of a mirror that reflect images, excluding the mirror rim or mounting brackets.

PLAN VIEW REFERENCE LINE
For vehicles with bench type seats, a line parallel to the vehicle longitudinal centerline located outboard of the steering wheel centerline at a distance 0.15 times the difference between one half of the shoulder room dimension and the steering wheel centerline to car centerline dimension.

For vehicles with individual type seats, a line parallel to the vehicle longitudinal centerline which passes through the center of the driver's designated seating position.

PROJECTED EYE POINT
Point on a horizontal plane forward of the mirror at a distance equal to the true distance from the eye to the mirror.

SEATING REFERENCE POINT (SRP)
Vehicle manufacturer's design H-point with the seat in the rearmost driving position, which for purposes of this procedure simulates the position of the pivot center of the human torso and thigh.

STANDARD PRODUCTION ITEMS
Items installed during the assembly of the test vehicle.

UNIT MAGNIFICATION MIRROR
Plane or flat mirror with a reflective surface through which the angular height and width of the image of an object is equal to the angular height and width of the object when viewed directly at the same distance, except for flaws that do not exceed normal manufacturing tolerances. For the purposes of this regulation a prismatic day night adjustment rearview mirror, one of whose positions provides unit magnification, is considered a unit magnification mirror.

95TH PERCENTILE EYELLIPSE CONTOUR
Passenger car driver's eye range in the form of contours developed by analyzing statistical data of eye point locations.

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REARVIEW IMAGE TESTING SPECIFIC DEFINITIONS -

BACKING EVENT
means an amount of time which starts when the vehicle's direction selector is placed in reverse, and ends at the manufacture's choosing, when the vehicle forward motion reaches either;

- a speed of 10 mph,
- a distance of 10 meters traveled, or
- a continuous duration of 10 seconds.

ENVIRONMENTAL TEST FIXTURE
means a device designed to support the external components of the rear visibility system for testing purposes, using any factory seal which would be used during normal vehicle operation, in a manner that simulates the on-vehicle component orientation during normal vehicle operation, and prevents the exposure of any test conditions to portions of the external component which are not exposed to the outside of the motor vehicle.

EXTERNAL COMPONENT
means any part of the rear visibility system which is exposed to the outside of the motor vehicle.

KEY
means a physical device or an electronic code which, when inserted into the starting system (by physical or electronic means), enables the vehicle operator to activate the engine or motor.

LIMITED LINE MANUFACTURER
means a manufacturer that sells three or fewer carlines, as that term is defined in 49 CFR583.4, in the United States during a production year, as that term is defined in S15.

REARVIEW IMAGE
means a visual image, detected by means of a single source, of the area directly behind a vehicle that is provided in a single location to the vehicle operator and by means of indirect vision.

REAR VISIBILITY SYSTEM
means the set of devices or components which together perform the function of producing the Rearview image as required under this standard.

SMALL MANUFACTURER
Small manufacturer means an original vehicle manufacturer that produces or assembles fewer than 5,000 vehicles annually for sale in the United States.

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STARTING SYSTEM
means the vehicle system used in conjunctjon with the key to activate the engine or motor.

12. PRETEST REQUIREMENTS

Prior to conducting a compliance test, the contractor shall:

A. Verify COTR approval of contractor's In-house Test Procedure,

B. Verify the training of technicians for performance of this test,

C. Verify the calibration status of test equipment,

D. Review applicable revision of FMVSS 111

VEHICLE PREPARATION

A. Clean all mirrors and both sides of all glazing involved in the compliance test with a non-abrasive cleaner.

B. Clean interior visual display and external rear camera lens with a non-abrasive cleaner.

C. The fuel tank shall be full.

D. All tire pressures shall be set cold according to the vehicle manufacturer's recommendation.

REARVIEW MIRROR TESTING SPECIFIC -

TEST AREA

The compliance test area must be flat, level and approximately 6 to 12 meters wide and 15 to 67 meters long. The test area floor should be marked to aid in locating the test vehicles on axes that are perpendicular to a screen or wall.

To reduce the required length, the test area may include a vertical screen or wall behind the test vehicle that is approximately 2.4 meters high and 4.5 to 6 meters wide, and marked with a square grid of vertical over horizontal intervals every 15 to 30 centimeters (6 inches to 12 inches), or other marker devices that provide for accurate measurement of the field-of-view. Unless specified otherwise, all tests shall be performed within a temperature range of 15.6C to 37.8C (60F to 100F) and a relative humidity of not more than 90 percent.

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REARVIEW IMAGE TESTING SPECIFIC -

TEST AREA

For field-of-view and test object image size testing, the compliance test area must be flat, level and sufficiently sized to position test cylinders at the correct locations as described in Section 13.B of this procedure. The test area floor should be grid-marked with 1-foot squares to aid in locating the test vehicles and cylinders. A solid, light-colored (or white) background beyond the cylinders should be considered to achieve a contrast level with the cylinder markings to ensure measurement accuracy. The vehicle can be driven onto the floor grid and positioned with the rear bumper flush with a 0.0-foot line and the vehicle centerline directly above the longitudinal axis of the floor test grid. The vehicle's position on the test grid can be confirmed using a plumb bob hung from the trunk or rear hatch latching mechanism at the vehicle's centerline as a reference point. For some vehicles, wheeled jacks can be used to lift the vehicle off the surface and pushed accurately into position.

For response time, linger time, deactivation, and default view testing, a sufficiently sized test area is required to allow for unobstructed vehicle movement in both forward and reverse directions.

Unless specified otherwise, all tests shall be performed within an external vehicle ambient temperature range of 15C to 25C (59F to 77F) and a relative humidity of not more than 90 percent.

LIGHTING

The ambient illumination conditions in which testing is conducted consists of light that is evenly distributed from above and at an intensity of between 7,000 lux and 10,000 lux, as measured at the center of the exterior surface of the vehicle's roof and on the top surface of Cylinder B.

PERMANENT RECORDING OF DATA

Where permanent trace recording is not required, data shall be recorded on standard report forms. Changes or corrections shall be made by drawing a line through the original entry, which must remain legible, adding the change above or alongside, and initialed.

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13. COMPLIANCE TEST EXECUTION

13.A REARVIEW MIRROR TESTING

A passenger car shall be subjected to the testing in the order as shown below (1-7).

A (other than school bus) with a GVWR of 4,536 kg or multipurpose passenger vehicle, truck or bus less, shall be subjected to the passenger car tests (1-7), if certified to such by the manufacturer as indicated by the COTR.
These vehicles at the manufacturers option, can instead be tested to the requirements for Multipurpose passenger vehicles, trucks and busses (other than school busses) with a GVWR greater than 4,536 kg

Multipurpose passenger vehicles, trucks and buses (other than school buses) with a GVWR greater than 4,536 kg are subjected to the testing as described in section 8.

1. Inspection

2. Mounting Adequacy Test

3. Field-of-View Test, Inside Rearview Mirror

4. Field-of-View Test, Driver's Side Outside Mirror

5. Reflectance Test /Mirror construction
   NOTE: If the Rearview image is displayed and incorporated into the interior rearview mirror, then this test for the interior mirror is to be performed after completion of the 13.B Rearview image testing below.

6. BreakAway Test
   NOTE: If the Rearview image is displayed and incorporated into the interior rearview mirror, then this test is to be performed after completion of the 13.B Rearview image testing below.

7. Unit Magnification and Convex Mirror Tests

8. Multipurpose passenger vehicles, trucks and buses (other than school busses) with a GVWR greater than 4,536 kg

9. Motorcycles

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1. **INSPECTION -**

Record results on Data Sheet 1.

Inspect the installation of the inside and outside rearview mirrors. Note any evidence of defects or imperfections which could influence the test. Operate the inside and outside rearview mirrors in all modes and directions to verify that the devices meet the manufacturer's specifications in the Vehicle Owner's Manual.

Note: A passenger car is not required to have an outside mirror on the passenger's side unless its inside rearview mirror does NOT meet the field-of-view requirements of S5.1.1

2. **MOUNTING ADEQUACY TEST –**

Record results on Data Sheet 2.

A. INSIDE MIRROR (S5.1.2) Requirement and Procedure:

Verify that the mirror mounting provides a stable support for the mirror, and provides for mirror adjustment by tilting in both the horizontal and vertical directions as shown in **FIGURE 1**.

B. OUTSIDE DRIVER AND PASSENGER SIDE MIRROR(S) (S5.2.2 and S5.3) Requirements and procedure:

Determine that the driver's side mirror can be tilted in both horizontal and vertical directions from the driver's seated position. Determine that the passenger's side mirror, if so equipped, is capable of adjustment by tilting in both the horizontal and vertical directions. Determine the positive and negative angles of adjustment for both horizontal and vertical directions for all outside mirrors. Determine that all outside mirrors are free of sharp points or edges that could contribute to pedestrian injury. Record the results on Data Sheet 2.

Determine that the mirror(s) is(are) securely mounted and that the driver side mirror and mounting do not protrude farther than the widest part of the vehicle body except to the extent necessary to produce a field of view meeting or exceeding the requirements of S5.2.1. The driver side mirror shall not be obscured by the un-wiped portion of the windshield.

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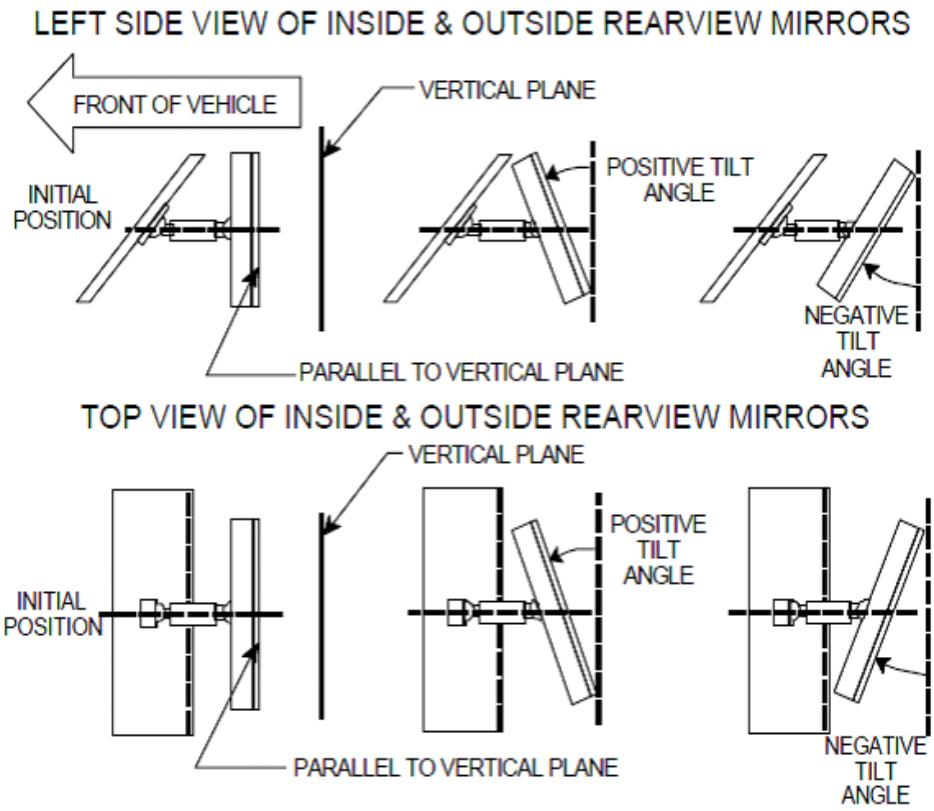

FIGURE 1

3. <u>FIELD-OF-VIEW TEST – INSIDE REARVIEW MIRROR -</u>

Record results on Data Sheet 3.

A. REQUIREMENTS (S5.1.1)

Mirror shall provide a field of view with an included horizontal angle measured from the projected eye point of at least 20 degrees, and sufficient vertical angle to provide a view of a level road surface extending to the horizon beginning at a point not greater than 61m (200 feet) to the rear of the vehicle when the vehicle is occupied by the driver and four passengers or the designated occupant capacity, if less. The line of sight may be partially obscured by seated occupants or by head restraints.

Each passenger car whose inside mirror does not meet the field of view requirements of S5.1.1 shall have an outside mirror of unit magnification or a convex mirror installed on the passenger's side. (S5.3). The mirror mounting shall provide a stable support and be free of sharp points or edges that could contribute to pedestrian injury. The mirror need not be

adjustable from the driver's seat but shall be capable of adjustment by tilting in both horizontal and vertical directions.

PROCEDURE

The general procedure is to position the viewing instrument using an appropriate fixture at the left and right eye point locations respectively and to view the field-of-view grid and markers placed at a specified distance behind the vehicle. The required field-of-view measurements are then made and calculations performed as required to evaluate compliance with the standard. Refer to **FIGURE 2**.

(1) Maneuver the vehicle onto a predetermined location on the level floor of the test laboratory. This location will also be used for the driver side and passenger side outside mirror testing.

(2) Establish a vertical longitudinal plane tangent to the widest point of the test vehicle on the driver's side (parallel to the

centerline of the vehicle) and locate its intersection with the floor.

(3) Measure 10.7 meters (35 feet) to rear of the driver's eye location provided by the COTR and set up a field-of-view test screen perpendicular to the tangent plane. Screen should be grid format with lines equally spaced and delineated with letters and numbers for reference purposes.

(4) Load the vehicle to simulate the driver and four passengers (unless capacity is less) with ballast of 68 kilograms (150 pounds) per occupant.

(5) Block and secure the vehicle in place to eliminate vertical or horizontal motion during the test and to maintain vehicle position when the load is removed. Measure and record in the general test log the vehicle orientation for future reference.

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INSIDE REARVIEW MIRROR FIELD OF VIEW
TEST GRID AND MARKER SETUP

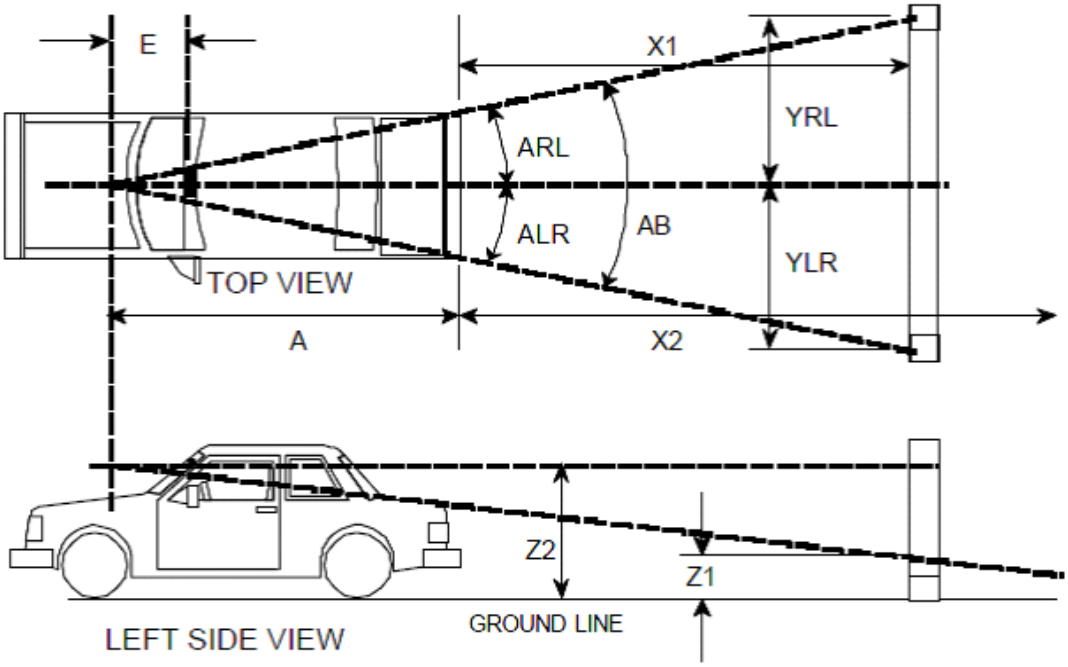

FIGURE 2

WHERE –

E = Distance from center of the mirror to the projected eye point. The distance to this imaginary point is equal to the distance from the mid-point between the driver eye locations to the center of the mirror surface.

X1= Distance to field-of-view grid from rear of vehicle.

X2= CALCULATED distance where a 95th percentile male driver would first see a level road surface behind vehicle (calculated as shown on Data Sheet 3). Must be 61 meters (200 feet) or less.

AB= Included horizontal am-binocular angle. Must be at least 20 degrees.

Z1= Vertical distance to lowest target on field-of-view grid.

Z2= Height of center of mirror.

(6) Remove the front seat(s) and install the viewing instrument positioning fixture. The viewing instrument shall be located using the fixture such that the focal point of the instrument is in the

position of the driver eye point location provided by the COTR. These locations are obtained from the manufacturer based on the nominal location appropriate for any **95th** percentile male driver. The location is provided using an x,y,z coordinate system measured from a fixed body point. The viewing instrument and fixture shall be designed such that the viewing instrument can be rotated about the vertical axis.

(7) Measure the vertical height of the center of the mirror Z2. Place a target on the field-of view grid at this height at the centerline of the vehicle.

(8) While observing through the viewing instrument, adjust the inside mirror both horizontally and vertically such that the Z2 target is visible on the TOP EDGE of the mirror on the mirror centerline. Once the mirror is adjusted it should not be altered until the end of the inside mirror test.

(9) While observing through the viewing instrument, have an assistant place a target on the vehicle centerline on the field-of-view screen at a vertical height Z1 at a location where the target appears at the LOWER edge of the mirror. This point will be used to calculate the distance at which the level road surface would be first visible.

(10) While observing through the instrument in the driver's left eye location, have an assistant place markers on the field-of-view screen at the extreme left and right sides of the mirror view. Repeat while observing from the driver's right eye location. Take photographs of the left and right eye views through the viewing instrument. In addition, photograph the field-of-view grid with all markers shown.

Record the following on Data Sheet 3.

YRR The maximum lateral distance to the driver's right of the center line that is viewed on the grid with the instrument in the right eye location.**13.**

YLL The maximum lateral distance to the driver's left of the center line that is viewed on the grid with the instrument in the left eye location.

YRL The maximum lateral distance to the driver's right of the center line that is viewed on the grid with the instrument in the left eye location.

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YLR The maximum lateral distance to the driver's left that is viewed with the instrument in the right eye location.

NOTE: The YRL and YLR lateral distances provide the widest field-of-view.

(11) With the positioning fixture still in position, measure the distance from the midpoint between the driver eye point locations to the center of the mirror surface. Establish the location of the imaginary projected eye point on a horizontal plane forward of the mirror surface at a distance E equal to the measured distance.

(12) Calculate distance X2 using the formula on Data Sheet 3. Measure and record other variables.

(13) Inspect outside mirror on passenger's side of car, if installed either by requirement S5.3 or by manufacturer's option. Record the results on Data Sheet 3.

4. FIELD-OF-VIEW TEST: DRIVER'S SIDE OUTSIDE REARVIEW MIRROR

Record results on Data Sheet 3.

(a) REQUIREMENTS (S5.2)

Each passenger car shall have an outside mirror of unit magnification. The mirror shall provide the driver a view of a level road surface extending to the horizon from a line, perpendicular to a longitudinal plane tangent to the driver's side of the vehicle at the widest point, extending 2.4 meters (8 feet) out from the tangent plane 10.7 meters (35 feet) behind the driver's eyes, with the seat in the rearmost position. The line of sight may be partially obscured by rear body or fender contours. (S5.2.1)

Neither the mirror nor the mounting shall protrude farther than the widest part of the vehicle body except to the extent necessary to produce a field of view meeting or exceeding the requirements of S5.2.1. The mirror shall not be obscured by the un-wiped portion of the windshield. (S5.2.2)

(b) PROCEDURE (Refer to **FIGURES 3A, 3B, 3C, and 3D**)

(1) Maintain the vehicle, field-of-view grid and test equipment positions as established for the inside rearview mirror test.

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(2) Place a small target disc, approximately 6 millimeters (0.25 inches) in diameter, on upper inboard quadrant of mirror reflecting surface.

(3) Measure distance X between the tangent plane at widest point on vehicle and the center of the target on the mirror reflecting surface. Note whether distance is inboard or outboard of tangent plane. Enter result on Data Sheet 3.

(4) Measure the height H above ground of the center of the target on the mirror surface.

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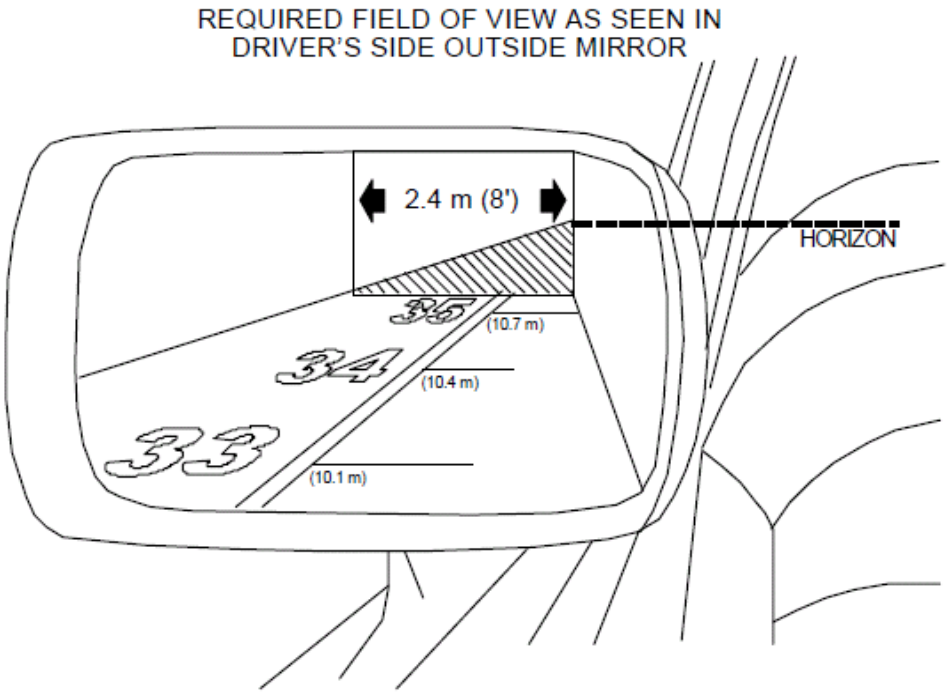

FIGURE 3A

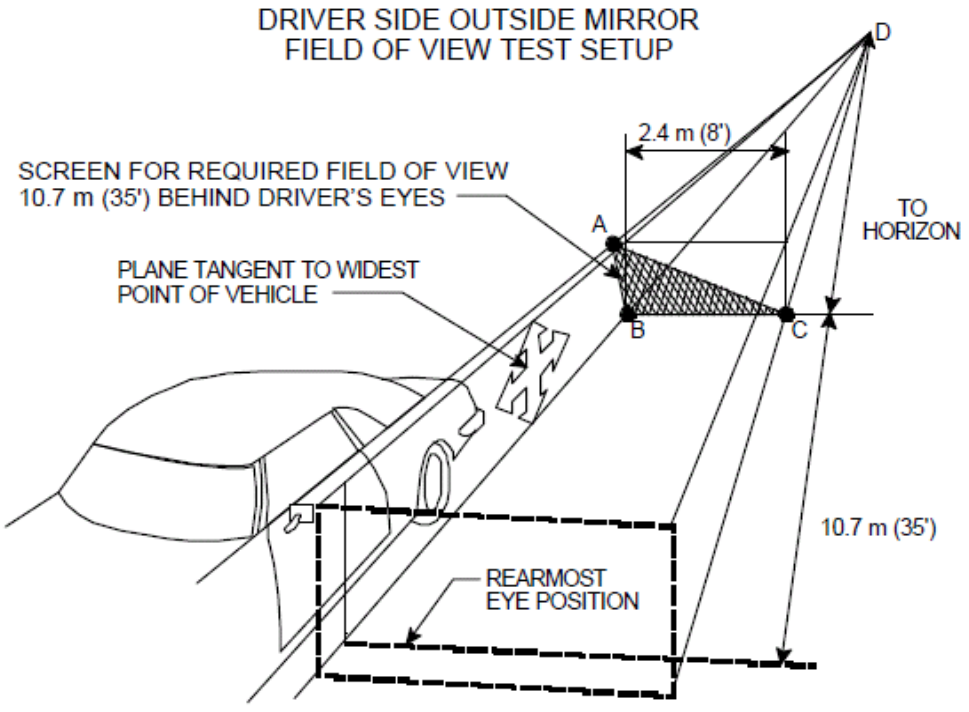

FIGURE 3B

DRIVER SIDE OUTSIDE MIRROR TARGET DISC
LOCATION WITH X AND H DIMENSIONS

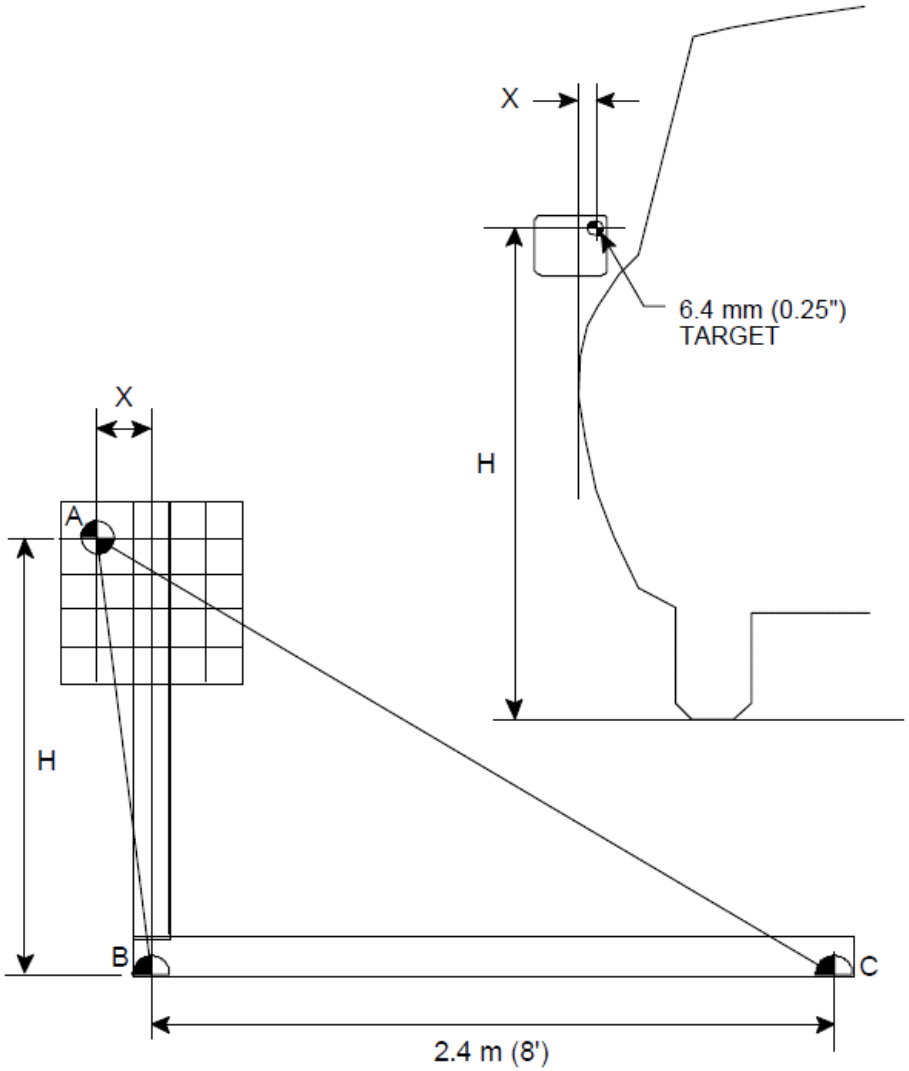

FIGURE 3C

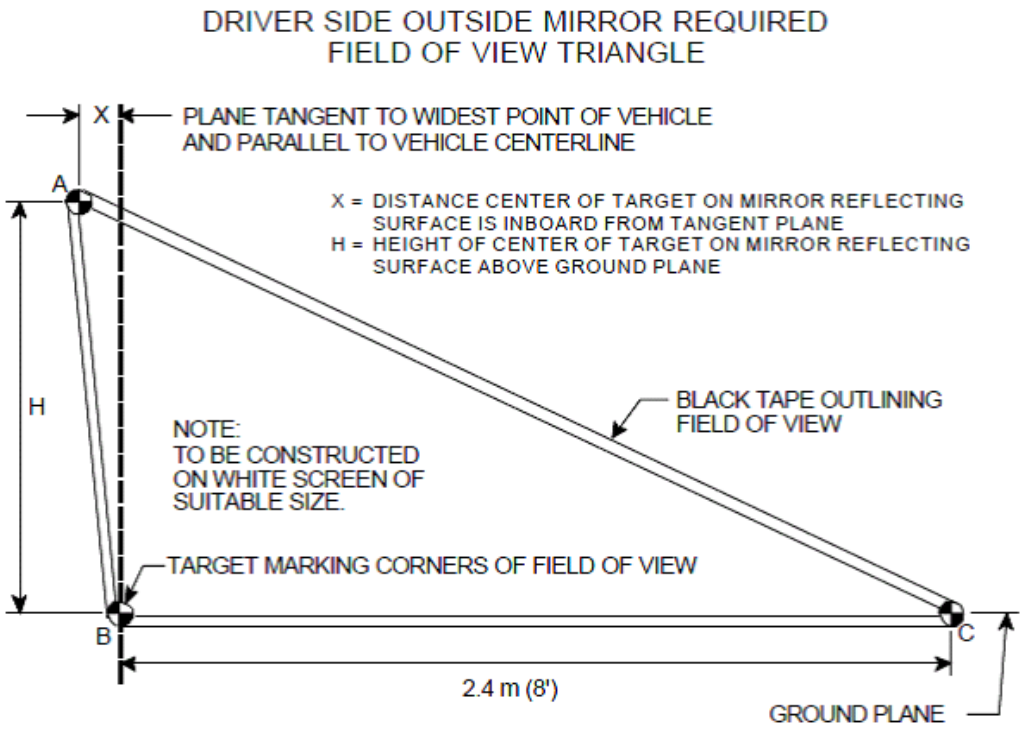

FIGURE 3D

(5) Construct a triangular-shaped driver's side view mirror test target area on the field-of-view screen using 3 points (A, B, and C) according to the following:

Point A: At a vertical height from ground equal to the vertical height of the center of the target on the mirror (dimension H) and a distance (Dimension X) equal to the distance from the center of the target on the mirror to the plane tangent to the widest part of the vehicle on the driver's side,

Point B: At ground level, on the plane tangent to the driver's side of the vehicle at the widest point, and

Point C: At ground level, 2.4 m (8 ft) outboard on a plane parallel to the plane tangent to the driver's side of the vehicle at the widest point.

(6) Adjust the mirror such that the entire triangle area defined by points A, B, and C is visible with the combined view taken from the left and right eyelipse locations. Initially adjust mirror such that the roadway extending from point B to point C is visible at the

mirror base. The field-of-view requirement is met if the triangle is visible in its entirety with the combined left and right eyelipse views.

NOTE: The right eye sees the widest outboard distance. The left sees the most inboard distance.

(7) Photograph the left and right eyelipse views. Record measurements in Data Sheet 3 for height of view and lateral distance visible from widest point of the vehicle body.

(8) Observe and record if mirror is obscured by unwiped area of windshield.

(9) Observe and record any protrusion of the side view mirror or its support beyond a plane tangent to widest part of the vehicle. Record whether the protrusion, if any, is required to meet the field-of-view requirements.

(10) Enter results on Data Sheet 3.

5. REFLECTANCE TEST – ALL MIRRORS, ALL VEHICLES -

Record results on Data Sheet 4.

NOTE: If the Rearview image is displayed and incorporated into the interior rearview mirror, then this test for the interior mirror is to be performed after completion of the 13.B Rearview image testing as described below.

(a) REQUIREMENT (S11)

All single reflectance mirrors shall have an average reflectance of at least 35 percent. If a mirror is capable of multiple reflectance levels, the minimum reflectance level in the day mode shall be at least 35 percent and the minimum reflectance level in the night mode shall be at least 4 percent. The average reflectance of any

mirror required by this standard shall be determined in accordance with SAE Recommended Practice J964, OCT 84.
A multiple reflectance mirror shall either be equipped with a means for the driver to adjust the mirror to a reflectance level of at least 35 percent in the event of electrical failure, or achieve such reflectance level automatically in the event of electrical failure.

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(b) APPARATUS DESCRIPTION, SETUP, AND PREPARATION

The apparatus shall consist of a light source, a sample holder, a receiver unit with a photo-detector and an indicating meter as shown in **FIGURE 4**, and means for negating the effects of extraneous light. The receiver may incorporate a light integrating sphere to facilitate measuring reflectance of non-flat (convex) mirrors as shown in **FIGURE 5.**

(1) Characteristic of Light Source and Photoreceptor

The light source shall consist of an incandescent tungsten filament lamp operating at a nominal color temperature of 2,856 K (CIE Illuminant A) and associated optics to provide a near collimated light beam. A voltage stabilizer is recommended for maintaining a fixed lamp voltage during instrument operation. The photoelectric receptor shall have a spectral response proportional to the photopic luminosity function of the standard CIE observer. Any other combination of illuminant-filters-receptor which gives the overall equivalent of illuminant A and average visual response may be used.

When an integrating sphere is used in the receiver, the interior surface of the sphere shall be coated with a matt (diffusive) spectrally nonselective white coating.

(2) Geometric Conditions

The angle of the incident beam (A1) shall preferably be 25 ± 5 (0.44 ± 0.09 radian) and shall not exceed 30 (0.53 radians) from the perpendicular to the test surface, and the axis of the receptor shall make an angle (A2) with this perpendicular equal to that of the incident beam. The incident beam upon arrival to the test surface, shall have a diameter of 19 mm (0.75 inch) or larger and shall not exceed the sample test area. The reflected beam upon arrival at the photoreceptor, shall not be larger than the photosensitive area and shall not cover less than 50 percent of such area. The reflected beam should strike that area of the photoreceptor used for calibration.

When an integrating sphere is used in the receiver section, the sphere shall have a minimum diameter of 127 millimeters (5 inches). The sample and incident beam apertures in the sphere wall shall be of such a size as to admit the entire incident and reflected light beams. The photodetector shall be so located as not

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to receive direct light from either the incident or the reflected beams.

(3) Receptor Indicator Unit

The photoreceptor output as read on the indicating meter shall be a linear function of the light intensity on the photosensitive area of the receptor. Further, means (electrical and/or optical) shall be provided for calibration and zeroing adjustments. Such means shall not affect the linearity or the spectral characteristics of the instrument. The accuracy of the receptor indicator unit shall be within ± 2 percent of full scale, or ± 10 percent of the magnitude of the reading, whichever is smaller.

(4) Sample Holder

The mechanism shall be capable of locating the test sample such that the axes of the source arm and receptor arm intersect at the reflecting surface. The reflecting surface may lie within or at either face of the mirror sample depending on whether it is a first surface, second surface, or prismatic "flip" type mirror.

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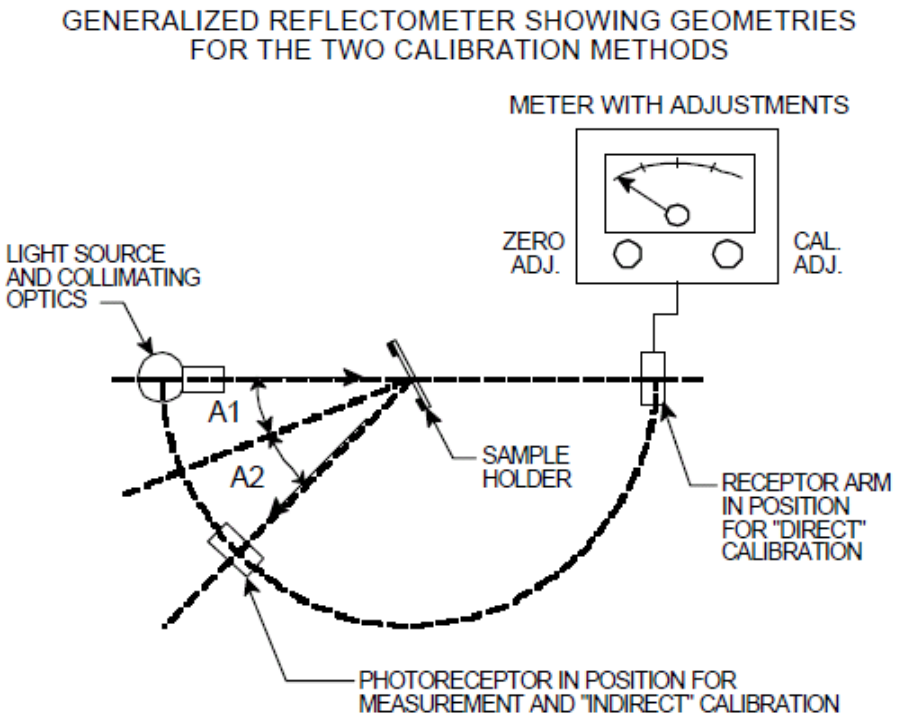

FIGURE 4

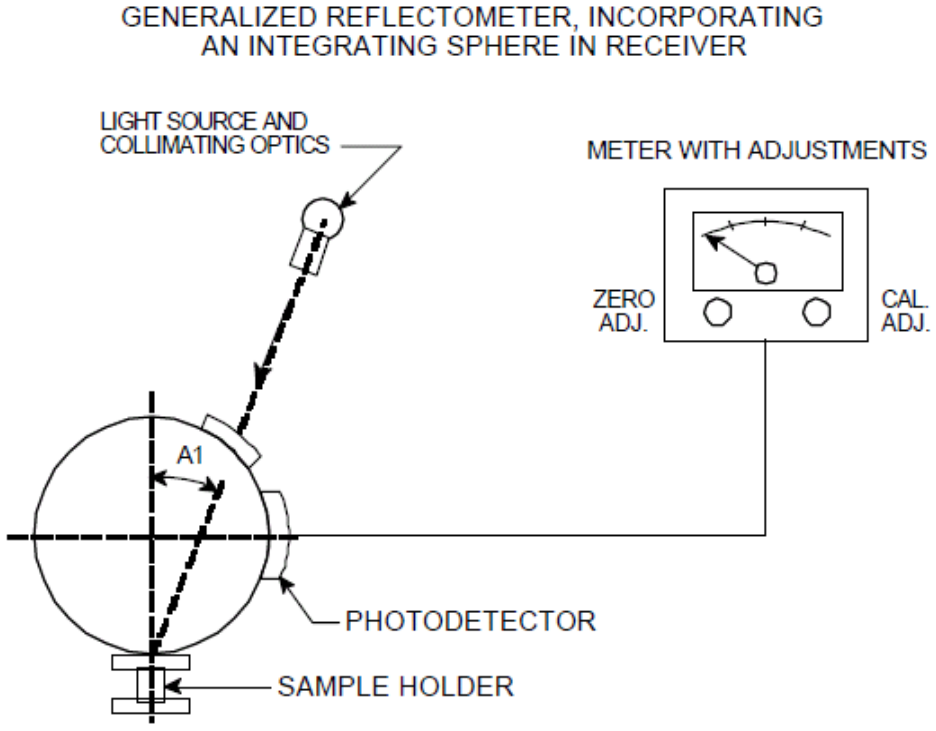

FIGURE 5

(5) Direct Calibration Method

The direct calibration method is for those instruments which are so constructed as to permit calibration at the 100% point by swinging the photoreceptor arm to a position directly on the axis of the light source.

It may be desired in some cases (such as, when measuring low reflective surfaces) to use an intermediate calibration point neutral density filter of known transmission value inserted in the optical path. The calibrate control will then be adjusted until the meter reads the percent transmission of the neutral density filter. This filter must be removed before making any reflectivity measurement.

(6) Indirect Calibration Method

The indirect calibration method is for those instruments with a fixed photoreceptor arm and thus requires a properly calibrated and maintained reference mirror standard.

(7) Flat Mirror Measurement

Reflectance of flat mirror samples is measured on instruments which employ either the direct or indirect calibration method. The reflectance value is read directly from the instrument indicator meter.

(8) Non-flat (Convex) Mirror Measurement

Reflectance of non-flat (convex) mirror measurement requires the use of instruments which incorporate an integrating sphere in the receiver unit. The reflectance value is read directly from the instrument indicating meter.

(C) REFLECTANCE TEST PROCEDURE

(1) Conduct test with mirror in the day mode.

(2) The mirror is mounted in a special holder.

(3) The photoreceptor is mounted such that light from the light source is directly received as shown in **FIGURE 6.**

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(4) Five measurements are made. After each measurement, the photoreceptor is moved and then realigned such that the meter reading is a maximum.

(5) The mirror in the sample holder is placed to receive the light beam as shown in **FIGURE 4**.

(6) The photoreceptor is located such that only light reflected from the mirror is received, normal to the photoreceptor surface.

(7) Five measurements are made, each time adjusting the photoreceptor to maximize the reading.

(8) The direct light readings are averaged.

(9) The reflected light readings are averaged.

(10) The percentage of light reflected is computed and the reflectance determined.

(11) Repeat test with the mirror in the night mode, if so equipped.

(12) If a multiple reflectance mirror remove all electrical power and adjust manually to day mode position, if so equipped. Repeat test for the day mode requirement. (For multiple reflectance mirrors obtain instructions from the COTR concerning the manufacturer's recommended procedure for obtaining "day mode" and "night mode" position settings.)

(13) All measurements shall be recorded and calculations performed as called for on Data Sheet 4. An average reflectance value is calculated for each single reflectance mirror and for the daytime and nighttime modes of the inside rearview mirror.

6. BREAKAWAY TEST – INSIDE REARVIEW MIRROR

Record results on Data Sheet 5.

NOTE: If the Rearview image for backing maneuvers is displayed in the inside rearview mirror, this test should be conducted after completion of the Rearview image Testing as described in 13.B below.

(a) REQUIREMENTS (S5.1.2)
If the mirror is in the head impact area, the mounting shall deflect, collapse, or break away without leaving sharp edges when the reflective surface of the mirror is subjected to a force of 400 N (90 lb) in any

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forward direction that is not more than 45 degrees from the longitudinal direction.

(b) SUGGESTED TEST EQUIPMENT

(1) Head Form

The head form used shall conform to the specifications shown in Figure 6.

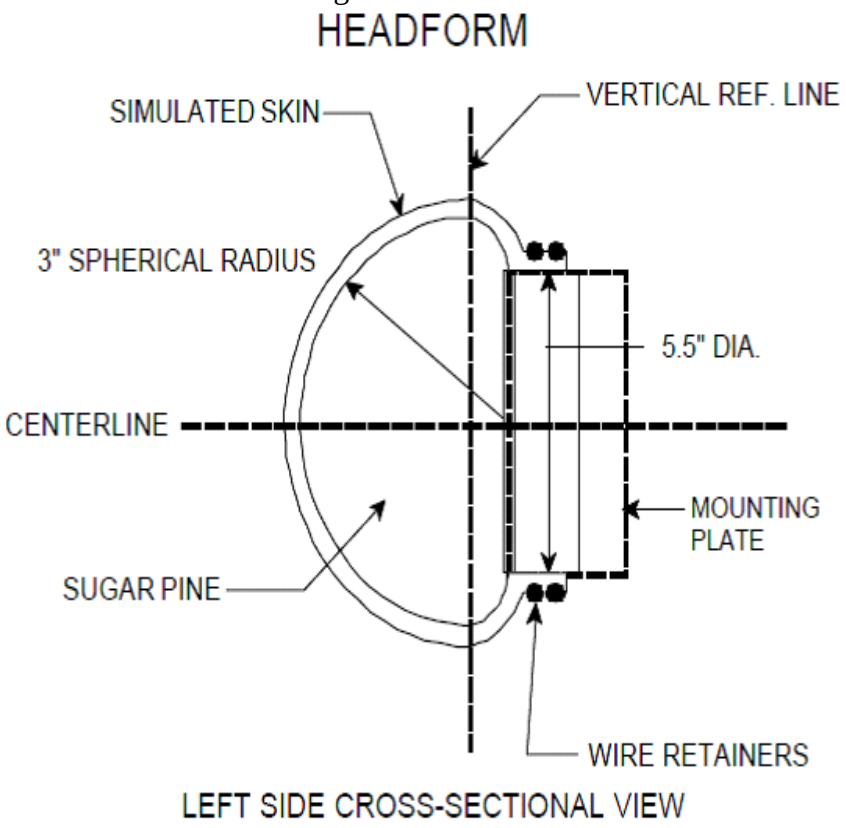

FIGURE 6

NOTE: Skin and Underlayer Characteristics — Animal skin such as Napa goat skin or wet chamois may be used. When this type of skin is used the skin thickness requirement does not apply. Headform specifications:

Simulated Skin —
Thickness = 0.030 inches, ± 0.003 inches
Tensile Strength = 1,000 psi ± 5 percent

Elongation = 100 percent, ± 5 percent
Penetremeter = 16 to 18

Synthetic Underlayer —
Thickness = 0.250 inches, ± 0.025 inches
Tensile Strength = 250 psi, ± 10 percent
Elongation = 50 percent, ± 10 percent
Penetremeter = Not Applicable

Sugar Pine shall have grain direction perpendicular to base, 4,000 to 5,000 lb on 1 in^2 parallel to grain to appreciable crush.

(2) Loading Ram
The loading ram shall produce a load of up to 534 N (120 pounds) over a stroke length of a minimum of 25.4 cm (10 inches), and provide a displacement rate of 5.08 cm (2 inches) per minute, plus or minus 5.08 mm (0.2 inch) per minute.

(3) Displacement Transducer
Capable of measuring displacement over a range from 0 to at least 30.5 cm (12 inches) of continuous stroke.

(4) Force Transducer
Capable of measuring force over a range from 0 to at least 534 N (120 pounds) with the load continuously applied.

(5) Vernier Protractor

(6) Recorder
Oscillograph or computer system capable of permanently recording r force-displacement plots.

(C) BREAK-AWAY TEST PROCEDURE

(1) The inside mirror assembly shall be examined for possible modes of failure to be utilized in the breakaway test. Describe on Data Sheet 5, and photograph these positions that differ from the general positions.

(2) Mount the attachment plate to a firmly supported rigid plate as shown in Figure 8. The plate will be positioned in a plane that is within ± 1 of the angle of the windshield (at the mirror attach location) relative to a horizontal plane.

(3) In conjunction with the COTR, select seven (7) directions for application of the 400 n (90 lb) load. The load directions including

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the possible failure modes selected from the examination of the mirror assembly will be selected to ensure that the mirror support is evaluated in the most critical mode. If selected directions provide no advantage to the evaluation of compliance, the following general load directions will be used:

[a] 0 / 90 — vertical angle is 0
horizontal angle is 90
through the centerline
of the support shaft

[b] 45 / 90 — vertical angle is 45
horizontal angle is 90

[c] -45 / 90 — vertical angle is -45
horizontal angle is 90

[d] 45 / 45 — vertical angle is 45
horizontal angle is 45

[e] -45 / 45 — vertical angle is -45
horizontal angle is 45

[f] 45 / -45 — vertical angle is 45
horizontal angle is -45

[g] -45/-45 — vertical angle is -45
horizontal angle is -45

NOTE: For reference, when the centerline of the ram has a horizontal angle of 90 it parallels with the vehicle's longitudinal center line.

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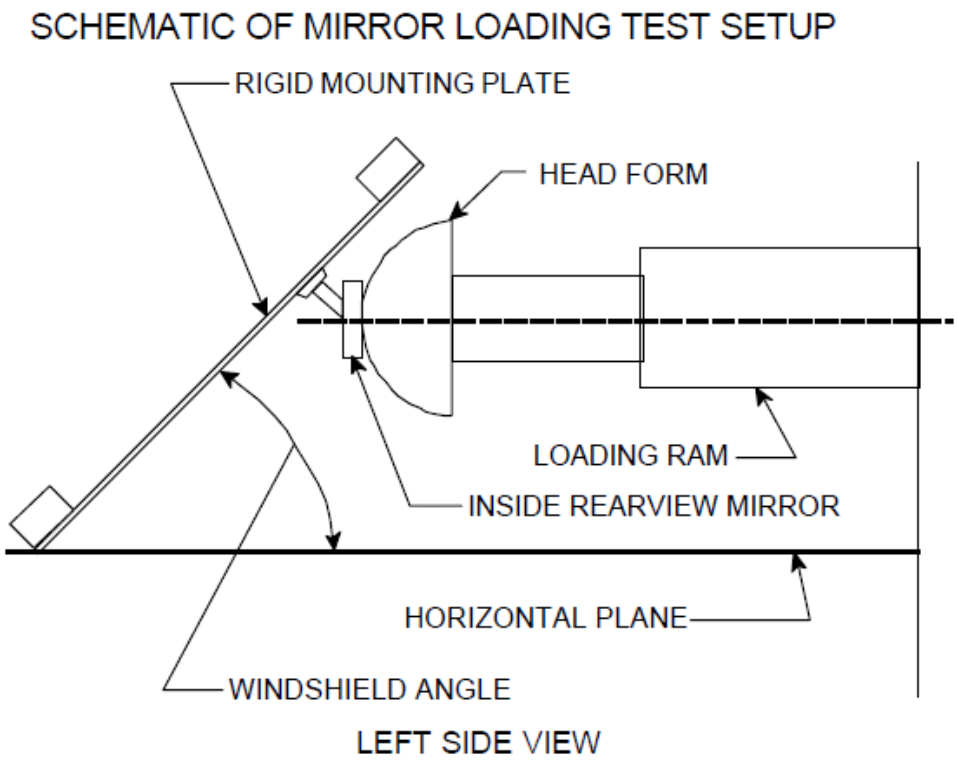

FIGURE 7

(4) For each of the 7 selected load directions, apply the load as follows:

[a] Tilt the mirror such that the reflective surface is in a vertical plane perpendicular to the horizontal plane as shown in **FIGURE 7.** Note that the mirror is not tested in vehicle.

[b] Position the loading ram with the ram centerline in the required direction and place the head form in contact with the reflective surface at the center of the mirror as shown in **FIGURES 8 and 9.**

[c] Actuate the ram to apply load to the mirror at a rate not to exceed 5.08 cm (2 inches) per minute. Test force is not to exceed 534 n (120 pounds) in the event of a failure i.e. mirror does not break-away. Record the displacement and force as the load is applied.

[d] Display displacement vs time and force vs time, on an oscillograph or computer system. Place the input of the displacement and force time histories to an X-Y plotter for evaluation and reporting purposes as shown in **FIGURE 10**.

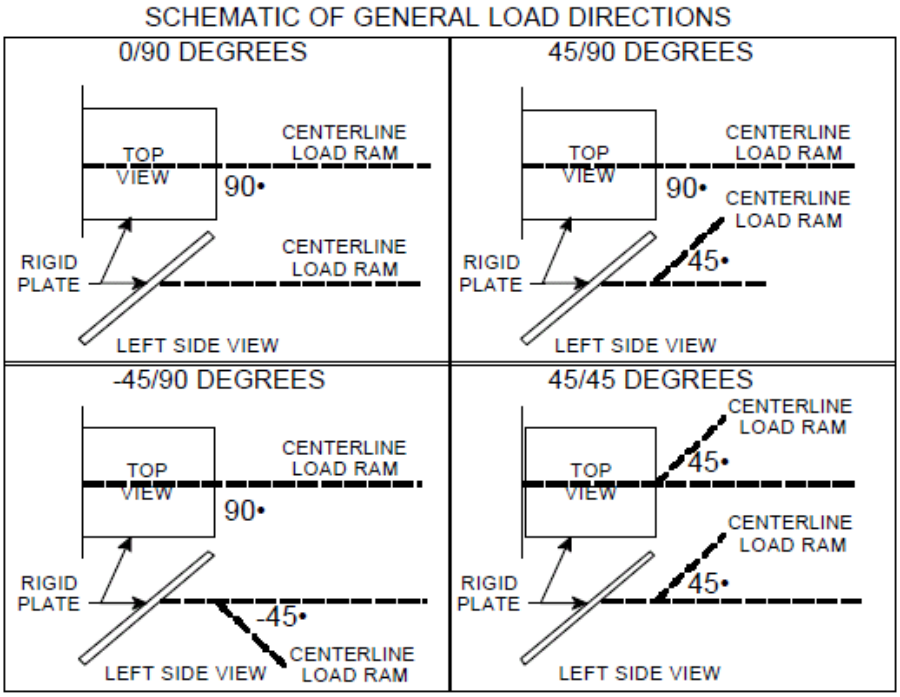

FIGURE 8

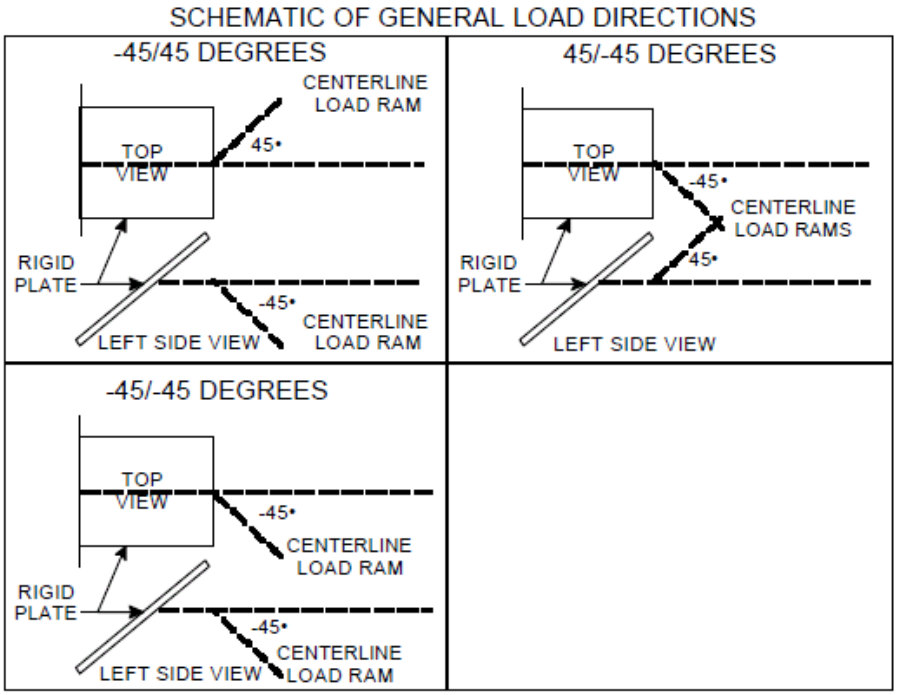

FIGURE 9

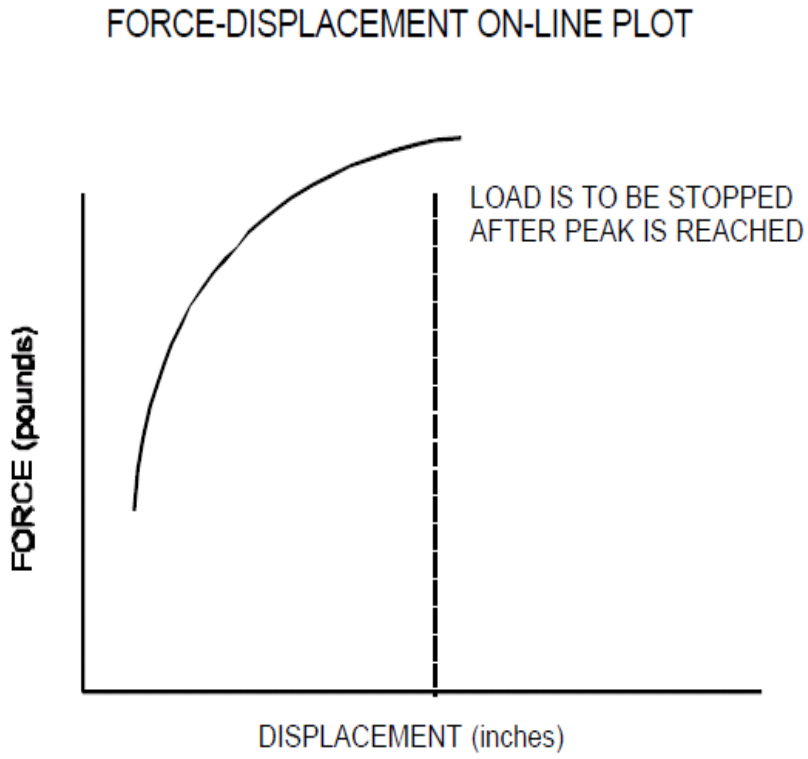

FIGURE 10

[e] Continue to apply the load until a decrease in force with further displacement is noted or until the 400 N (90 pounds) force is exceeded (up to 534N) without the mounting deflecting, collapsing or breaking away.

7. **UNIT MAGNIFICATION AND CONVEX MIRROR TESTS: ALL MIRRORS, ALL VEHICLES**

Record results on Data Sheet 6.

(A) REQUIREMENTS FOR PASSENGER CARS (S5.3 and S5.4)

The driver's side rearview mirror and the inside rearview mirror shall be unit magnification. If the field-of-view requirements are not met with the inside rearview mirror then the passenger's side rearview mirror is required. It can be either unit magnification or convex.

If the passenger's side mirror is convex, the average radius of curvature shall be not less than 889 mm (35 inches) and not more than 1651 millimeters (65 inches) and shall not deviate from the average by more

than plus or minus 12.5 percent. The convex mirror shall have permanently and indelibly marked at the lower edge of the mirror's reflective surface in letters not less than 4.8 mm (3/16 inch) nor more than 6.4 mm (0.25 inch) high the words, "**Objects in Mirror Are Closer Than They Appear**."

(B) SUGGESTED TEST EQUIPMENT

A 3-point linear spherometer with two outer fixed legs 38 mm (1.5 inches apart and one inner movable leg at the mid-point. The spherometer should have a dial indicator with a scale that can be read accurately to 0.0025mm (0.0001 inches), with the zero reading being a flat surface.
NOTE: English units are necessary to enable use of Table 1.

(C) RADIUS OF CURVATURE TEST PROCEDURE (S12.)

Steps (A) thru (F) apply to convex mirrors. Only steps (A) and (B) apply to unit magnification mirrors.

(1) Visually inspect mirror for any discontinuities.

(2) Using a 3-point linear spherometer measure the radius of curvature at the 10 test points indicated in **FIGURE 11**. The 10 test positions consist of two positions at right angles to each other at each of five locations. The locations are at the center of the mirror, at the left and right ends of a horizontal line that bisects the mirror and at the top and bottom ends of
a vertical line that bisects the mirror. None of the readings are within a 6.4 mm (0.25 inch) border on the edge of the image display. At each position, hold the spherometer perpendicular to the mirror surface and record the reading on the dial indicator to the nearest 0.0025 mm (0.0001 inch).

(3) Convert the dial reading data for each of the 10 test positions to radius of curvature measurements in millimeters using Table 1 of this procedure. Consider the changes as linear for dial readings that fall between two numbers in Table 1.

NOTE: If dial indicator is graduated in metric units, all the radius of curvature values in Table 1 are invalid.

(4) Calculate the average radius of curvature by adding the 10 radius of curvature measurements and dividing by 10.

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(5) Determine the numerical difference between the average radius of curvature and each of the 10 individual radius of curvature measurements in (C) above.

(6) Calculate the greatest percentage deviation by dividing the greatest numerical difference determined in (E) by the average radius of curvature and multiply by 100.

(7) Inspect the convex mirror on the lower edge of the mirror's reflective surface for the words, "**Objects in Mirror Are Closer Than They Appear**."

(8) Measure the height of the words on the convex mirror with a finely graduated ruler.

(9) Record results of both flat and convex mirror tests on Data Sheet 6.

LOCATION OF TEN CONVEX MIRROR TESTING POSITIONS

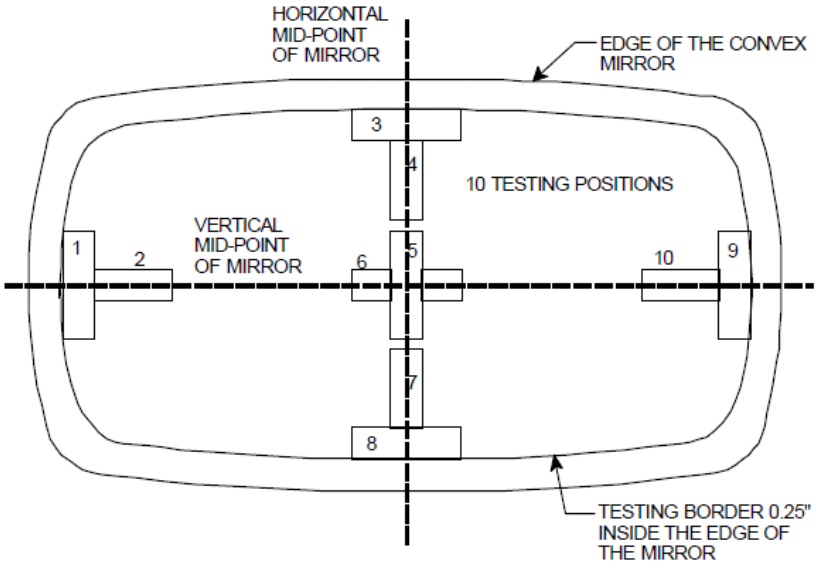

FIGURE 11

TABLE I
CONVERSION TABLE FROM SPHEROMETER DIAL

READING TO RADIUS OF CURVATURE

Dial Reading (inches)	Radius of Curvature (inches)	Radius of curvature (mm)
.00330	85.2	2164.1
.00350	80.4	2042.9
.00374	75.2	1910.1
.00402	70.0	1778.0
.00416	67.6	1717.0
.00432	65.1	1653.5
.00450	62.5	1587.5
.00468	60.1	1526.5
.00476	59.1	1501.1
.00484	58.1	1475.7
.00492	57.2	1452.9
.00502	56.0	1422.4
.00512	54.9	1394.5
.00522	53.9	1369.1
.00536	52.5	1333.5
.00544	51.7	1313.2
.00554	50.8	1290.3
.00566	49.7	1262.4
.00580	48.5	1231.9
.00592	47.5	1206.5
.00606	46.4	1178.6
.00622	45.2	1148.1
.00636	44.2	1122.7
.00654	43.0	1092.2
.00668	42.1	1069.3
.00686	41.0	1041.4
.00694	40.5	1028.7
.00720	39.1	993.1
.00740	38.0	965.2
.00760	37.0	939.8
.00780	36.1	916.9
.00802	35.1	891.5

Dial Reading (inches)	Radius of Curvature (inches)	Radius of curvature (mm)
.00822	34.2	868.7
.00850	33.1	840.7
.00878	32.0	812.8
.00906	31.0	787.4
.00922	30.5	774.7
.00938	30.0	762.0
.00960	29.3	744.2
.00980	28.7	729.0
.01004	28.0	711.2
.01022	27.5	698.5
.01042	27.0	685.8
.01060	26.5	673.1
.01080	26.0	660.4
.01110	25.3	642.6
.01130	24.9	632.5
.01170	24.0	609.6
.01200	23.4	594.4
.01240	22.7	576.6
.01280	22.0	558.8
.01310	21.5	546.1
.01360	20.7	525.8
.01400	20.1	510.5
.01430	19.7	500.4
.01480	19.0	482.6
.01540	18.3	464.8
.01570	17.9	454.7
.01610	17.5	444.5
.01650	17.1	434.3

Dial Reading (inches)	Radius of Curvature (inches)	Radius of curvature (mm)
.01700	16.6	421.6
.01750	16.1	408.9
.01800	15.6	396.2
.01860	15.1	383.5
.01910	14.7	373.4
.01980	14.2	360.7
.02040	13.8	350.5
.02100	13.4	340.4
.02160	13.0	330.2
.02250	12.5	317.5
.02340	12.0	304.8
.02450	11.5	292.1
.02560	11.0	279.4
.02680	10.5	266.7
.02810	10.0	254.0
.02960	9.5	241.3
.03130	9.0	228.6
.03310	8.5	215.9

8. Multipurpose passenger vehicles, trucks and buses (other than school buses) with a GVWR greater than 4,536

Record results summary on Data Sheet 8.

(A) REQUIREMENTS

(S6.1) Each multipurpose passenger vehicle, truck and bus, other than a school bus, with a GVWR of 4,536 kg or less shall have either:

(1) Mirrors conforming to the passenger car requirements, or

(2) Outside mirrors of unit magnification, each with not less than 126 sq cm (19.5 sq in) of reflective surface, installed with stable supports on both sides of the vehicle, located so as to provide the driver a view to the rear along both sides of the vehicle, and

adjustable in both the horizontal and vertical directions to view the rearward scene.
(S7.1 and S8.1) Each MPV, truck and bus, other than a school bus, with a GVWR of more than 4,536 kg shall have outside mirrors of unit magnification, each with not less than 323 sq cm (50 sq in) of reflective surface, installed with stable supports on both sides of the vehicle. The mirrors shall be located so as to provide the driver a view to the rear along both sides of the vehicle and shall be adjustable both in the horizontal and vertical directions to view the rearward scene.

(B) PROCEDURE

Consult the COTR for concurrence in application of the passenger car mirror test procedures or the alternative steps which follow:

(1) Inspect mirror installations on the vehicle. Record the results on Data Sheet 1.

(2) Perform the Mounting Adequacy and Adjustability Test. Record the results on Data Sheet 2.

(3) Perform the Reflectance Test. Record the results on Data Sheet 4.

(4) Perform items (A and B) of the Unit Magnification/Convex Mirror Test procedure to verify that the mirrors are unit magnification. Record the results on Data Sheet 6.

(5) Measure the surface area of each outside rearview mirror on both sides of the vehicle. Record the results on Data Sheet 7.

(6) Verify driver view to the rear along both sides of the vehicle. Record the results on Data Sheet 7.

(7) Use Data Sheet 8 for summary of test data

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9. MOTORCYCLES

Record results summary on Data Sheet 9.

A. REQUIREMENTS (S10)

Each motorcycle shall have either a mirror of unit magnification with not less than 8065 mm2 of reflective surface, or a convex mirror with not less than 6450 mm2 of reflective surface and an average radius of curvature not less than 508 mm and not greater than 1524mm, installed with a stable support, and mounted so that the horizontal center of the reflective surface is at least 279 mm outward of the longitudinal centerline of the motorcycle. The mirror shall be adjustable by tilting in both the horizontal and vertical directions.

B. PROCEDURE

1. Record the number of mirrors on the vehicle

2. Inspect mirror installations on the vehicle. Record the results on Data Sheet 1.

3. Perform the Mounting Adequacy and Adjustability Test. Record the results on Data Sheet 2.

4. Perform the Reflectance Test. Record the results on Data Sheet 4.

5. Perform items (A and B) of the Unit Magnification/Convex Mirror Test procedure to determine mirror radius of curvature. Record the results on Data Sheet 6.

6. Measure the surface area of each outside rearview mirror on both sides of the vehicle. Record the results on Data Sheet 7.

7. Measure the distance from the centerline of the mirror reflective surface to the longitudinal centerline of the motorcycle.

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13.B REARVIEW IMAGE TESTING

Passenger cars, multipurpose passenger vehicles, trucks, buses, school buses and low speed vehicles with a GVWR of 4536kg or less shall be subjected to testing in the order below

NOTE:
Parenthesis e.g. (S5.5.1) refer to Sections in Standard PART 49 CFR 571, FMVSS 111

1.. Inspection

2. Field-of-View Test (S5.5.1 – pass. cars, S6.2.1 – MPV, LSV, trucks, buses and school bus)

3. Test Object Image Size (S5.5.2, S6.2.2)

4. Response Time (S5.5.3, S6.2.3)

5. Linger time (S5.5.4, S6.2.4)

6. Deactivation (S5.5.5, S6.2.5)

7. Default View (S5.5.6, S6.2.6)

8. Durability (S5.5.7, S6.2.7)

   A. Corrosion Conditioning
      1. Field –Of-View Test (repeat 2 above)
      2. Test Object Image Size Test (repeat 3 above)

   B. Humidity Conditioning
      1. Field –Of-View Test (repeat 2 above)
      2. Test Object Image Size Test (repeat 3 above)

   C. Temperature Conditioning
      1. Field –Of-View Test (repeat 2 above)
      2. Test Object Image Size Test (repeat 3 above)

NOTE:

Vehicles manufactured on or after September 1, 2016 and before September 1, 2017. Except as provided in S15.4 of the standard, for passenger cars, multipurpose passenger vehicles, trucks, buses, and low-speed vehicles with a GVWR of 4,536 kg or less, manufactured by a manufacturer on or after September 1, 2016, and before September 1, 2017, the number of such

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vehicles complying with S5.5.1 or S6.2.1 shall be not less than 10 percent of the manufacturer's—

(a) production of such vehicles during that period; or

(b) Average annual production of such vehicles manufactured in the three previous production years multiplied by two-thirds.

Vehicles manufactured on or after September 1, 2017 and before May 1, 2018. Except as provided in S15.4 of the standard, for passenger cars, multipurpose passenger vehicles, trucks, buses, and low-speed vehicles with a GVWR of 4,536 kg or less, manufactured by a manufacturer on or after September 1, 2017, and before May 1, 2018, the number of such vehicles complying with S5.5.1 or S6.2.1 shall be not less than 40 percent of the manufacturer's-

(a) production of such vehicles during that period; or

(b) Average annual production of such vehicles manufactured in the three previous production years multiplied by two-thirds

NOTE: During the phase in period, the only requirement that must be met is Field-of-View.

1. INSPECTION

Record results on Data Sheet 10.

A. Reinstall driver seat to manufacturer specifications if removed for the rear view mirror testing in Section 13A above. Remove vehicle support jacks if previously used to stabilize vehicle.

B. Inspect the Rearview image display and the installation and mounting of the outside rearview camera. Note any evidence of defects or imperfections for the display or camera which could influence the test.

C. Verify that the rear visual image is detected by a single source e.g one camera, and that the image is displayed at one location.

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D. Identify the location of the inside visual display (located within the interior rearview mirror, center console, etc.) If the visual surface is not directly accessible e.g. visual display is behind a curved, clear sheet of plastic, this should be noted. This protective surface may need to be removed so that the ruler for image size testing can be placed as close to the visual display surface as possible to promote measurement accuracy.

E. Record, if identifiable, the display manufacturer and model.

F. Document the rearview display dimensions for height, width, and diagonal. Measure the tilt angle of the display with reference to ground.

G. Record if display is part of a multifunction display.

H. Verify that the interior display meets the manufacturer's specification as described in the Vehicle Owner's Manual.

I. Activate the Rearview image camera system by starting the vehicle engine and placing the transmission gear selector into reverse. Note if any driver adjustments can be made to the visual display for contrast, brightness, or resolution. Compliance to Field-of-view and image size testing utilizes the initial (or default after each ignition cycle) view that appears after the vehicle's starting system is activated and the vehicle is placed into reverse. Modification made by the operator to the display during a backing event such as brightness lowered to non-visible condition, must not inhibit the display with complying with the standard during subsequent backing events.

J. By inspection and review of owner' manual, can the driver disable the Rearview image camera system prior to or after activation?

K. Document if the interior display mounting is adjustable i.e. rotation, telescoping, etc.

L. Document if display is recessed and if so, record how raised, and time required.

M. Indicate if transmission gear selector is lever type, rotational, or pushbutton.

N. Is the transmission gear selector recessed and not functional until fully raised? If so, indicate method to raise and time required.

O. Start and stop the engine and place into reverse multiple times and record whether the Rearview image appears in any gear position other than reverse.

P. Document the Rearview image default appearance.

Q. Determine and record if the system automatically generates an overlay on the visual display of the Rearview image such as path projection, wire grid, messages, etc. Identify if the overlay varies based on steering wheel input.

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R. Determine and record if the default Rearview image can be modified by the driver once displayed by the addition of overlays, wide angle view, bird's eye view, turn off, path projection, messages, etc. and how is it accomplished.

S. Measure the height from the ground surface to the center point of the rearview image lens.

T. Measure the lateral position of the center point of the rearview image lens with respect to the vehicle centerline.

U. Measure the angle in degrees of the plane of the rearview image lens with reference to the ground.

V. Determine if any part of the vehicle body extends rearward of the camera X-axis lens plane.

W. Note if vehicle is NOT equipped with a rear bumper.

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2. FIELD-OF-VIEW (S5.5.1, S6.2.1, S14.) -(only requirement during phase-in period)

Record results on Data Sheet 11 (include photo documentation in final report)

For passenger cars, multipurpose passenger vehicles, low-speed vehicles, trucks, buses and school buses with a GVWR of 4,536 kg or less manufactured on or after September 1, 2016, but not later than May 1, 2018, a percentage of each manufacturer's production, as specified in S15 of the standard, shall display a Rearview image meeting the requirements of S5.5.1 and/or S6.2.1 (Field-of-View only)

Requirement:

When tested in accordance with the procedures in S14.1, the Rearview image shall display:

A. a minimum of a 150-mm wide portion along the circumference of each test object located at positions F and G as shown below.(This criterion is the average breadth of an 18-month-old child's head)

B. the full width and height of each test object located at positions A through E as shown below. (this criterion equates to the driver being able to see the entire body of an 18-month-old child)

NOTE:
Overlays generated automatically in the default Rearview image at the beginning of the backing event cannot cover any of the required portions of the test objects. This coverage prohibition does not apply to manually activated overlays by the driver after a complying default view.

Procedure: .

1. Park the vehicle in the test area centered on grid as described in section 12 (Pre-test requirements). Parking brake should be set and wheels chocked as appropriate for the test being conducted.

2. Lighting (S14.1.1)

   A. Place a photo receptor at the center of the vehicle roof and on the top surface of Cylinder B. As per section 12, verify that the ambient illumination is evenly distributed from above and is at an intensity of between 7000 lux and 10,000 lux. Record the intensity level measured at the two locations.

3. Vehicle conditions (S14.1.2):

   A. Tires (S14.1.2.1)
   Set the tires to the vehicle manufacturers recommended cold inflation pressure (S14.1.2.1)

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B. Fuel tank loading (S14.1.2.2)
The fuel tank is full.

C. Vehicle Load (S14.1.2.3)
Load the vehicle to simulate the weight of the driver and four passengers or the designated occupant capacity, if less. The weight of each occupant (68 kg) is represented by 45 kg resting on the seat pan and 23 kg resting on the vehicle floorboard placed in the driver's designated seating position and any other available designated seating positions. If more than 5 designated seating positions are available (van, large SUV etc.) the 4 passenger weights may be placed in any passenger seat.

NOTE:
If J826 Manikin device is used in this procedure as a driver surrogate to determine eye-point positions and to act as a camera platform, may have a weight greater than the 68 kg specified (approximately 77 kg). If possible, remove manikin weighted disks to reduce weight to 68 kg. If unable to do so, contact the COTR for further guidance.

D. Rear hatch and trunk lids (S14.1.2.4):
Rear hatches or trunk lids are closed and latched in their normal vehicle operating condition.

E. If the vehicle head restraints obstruct a camera or video camera view of the display , especially if placed rearward of the driver to document test, the head restraints may be adjusted or removed prior to testing. (not cited in FMVSS 111)

F. If the visual display contrast, brightness, or resolution can be adjusted by the driver, the requirements for the Rearview image must be met <u>at all points</u> within the adjustment range.

4. <u>Driver's seat positioning (S14.1.2.5)</u>

A. Adjust the driver's seat to the midpoint of the longitudinal adjustment range. If the seat cannot be adjusted to the midpoint of the longitudinal adjustment range, the closest adjustment position to the rear of the midpoint shall be used (S14.1.2.5.1). Record on data sheet 11, then

B. Adjust the driver's seat to the lowest point of all vertical adjustment ranges present (S14.1.2.4.2).

NOTE:
If the seat cushion has tilt option, set the seat front and rear tilt to the midpoint of the tilt angle.

C. Per the standard, "using the three dimensional SAE Standard J826- JUL95 (incorporated by reference, see 571.5) manikin, adjust the driver's seat back angle

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at the vertical portion of the H-point machine's torso weight hanger to 25 degrees" as shown in **FIGURE 12**. If this adjustment setting is not available, adjust the seat-back angle to the positional detent setting closest to 25 degrees in the direction of the manufacturer's nominal design riding position (S14.1.2.4.3).

NOTE:
The COTR will, if available, provide to the testing laboratory a ***manufacturer supplied*** nominal seat back angle for a 50th percentile male driver which will result in a 25 degree torso weight hanger value for a seated manikin. The Laboratory shall adjust the seat back angle to this provided value, and install the manikin according to the steps described within J286. The FMVSS 208 manikin positioning procedure, which is also based on J286, is provided in APPENDIX 1 for reference purposes. Once manikin is set, if necessary, slowly adjust seat back until the hanger angle is at 25 degrees from vertical. With the manikin in this fixed position, determination of the test reference point can then proceed as described below .If manufacturer initial seat back angle is not provided, the laboratory must adjust seat back to obtain the required 25 degree specification.

NOTE:
The manikin per J826 for this procedure utilizes 95th percentile legs. If unable to position these legs due to length interference, the length of the lower leg and thigh segments of the H-point machine can be adjusted to match FMVSS 216a specifications at 414 and 401 millimeters respectively, instead of the values specified in SAE J826 Table one – 459 mm and 456mm. If leg/knee bolster interference occurs, leg removal with placement of the legs on the seat pan for correct weight may be required for proper manikin positioning. Contact the COTR for guidance.

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Figure 12. Measurement of the H-point manikin machine torso weight hanger angle at 22.8 degrees. Adjust to 25 degrees from vertical.

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Test Object (S14.1.3)

Each test object is a right circular cylinder that is 0.8 m high and 0.3 m in external diameter as shown **i**n **FIGURE 13**. There are seven test objects, designated A-G which are to be marked as follows:

A. Test objects A, B, C, D, and E are marked with a horizontal band encompassing the uppermost 150 mm of the side of the cylinder.

B. Test objects F and G are marked on the side with a solid vertical stripe of 150 mm width extending from the top to the bottom of each cylinder.

C. Both the horizontal band and vertical stripe shall be of a color that contrasts with both the rest of the cylinder and the test surface.

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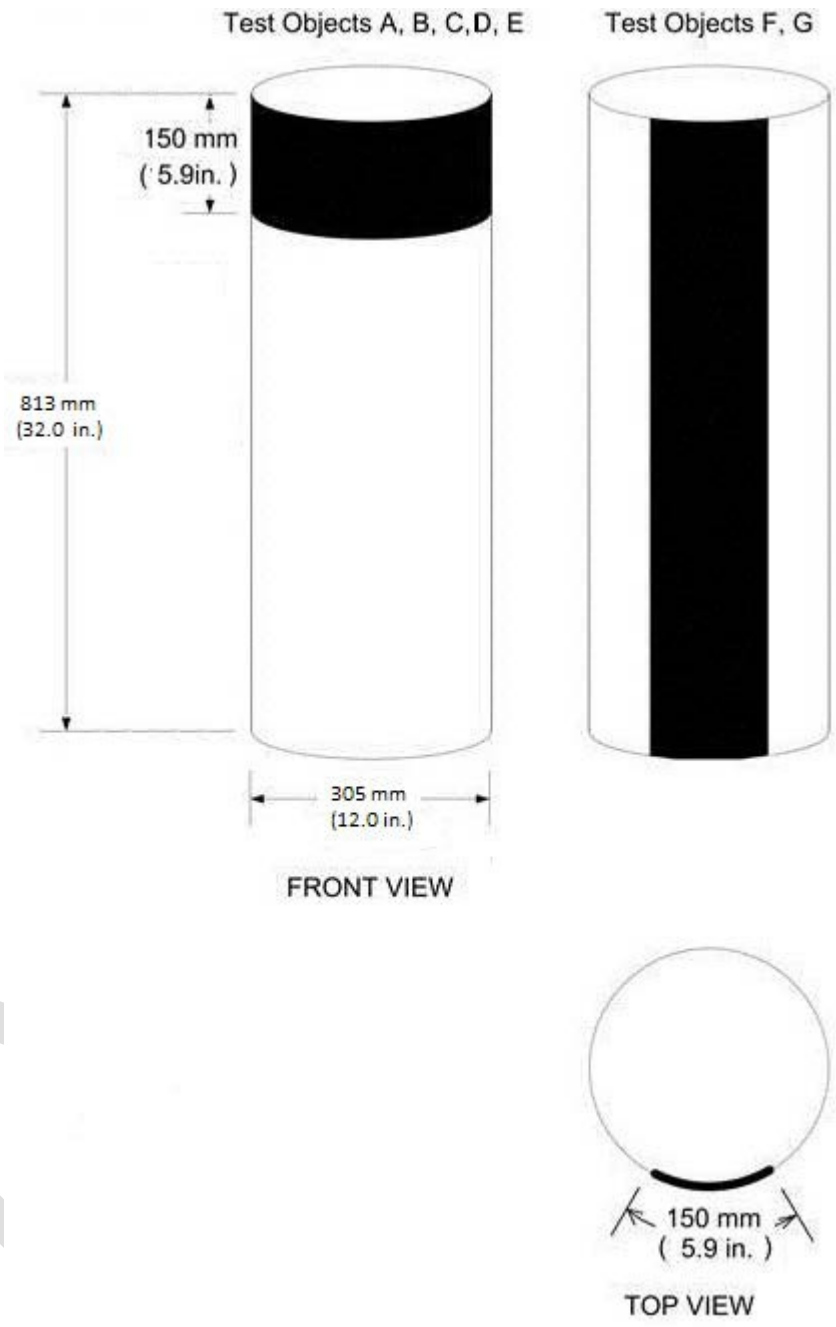
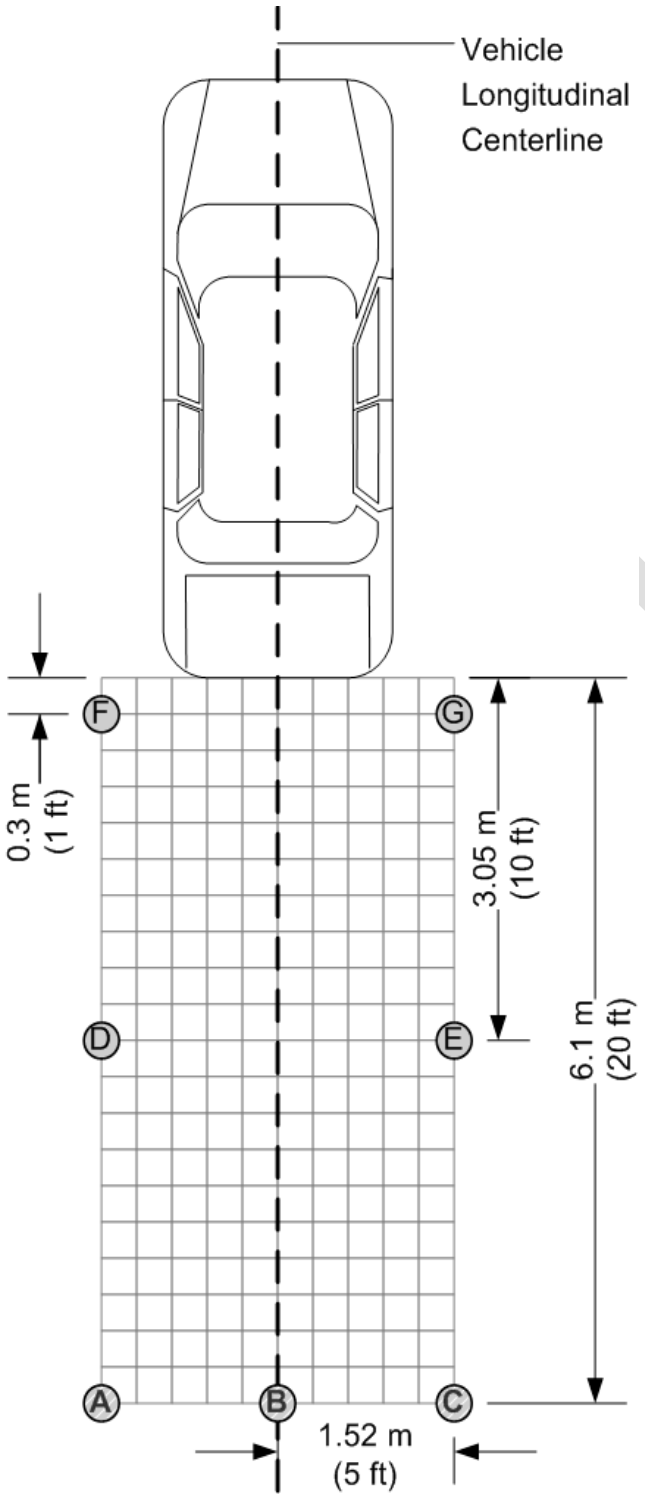


FIGURE 13. Test Object Dimensions and Markings (Note: standard specifies 800 mm height and 300 mm diameter. (note: - 5.9 inches equates to approximate diameter of a child's head at 18 months of age.)

FIGURE 14 – CYLINDER TEST OBJECT LOCATIONS



5. Test object locations and orientation(S14.1.4)

   A. Place the test objects at locations specified in S14.1.4 and illustrated in **FIGURE 14**. Measure the distances shown in the figure from a test object to another test object or another object from the cylindrical center (axis) of the test object as viewed from above. Each test object is oriented so that its axis is vertical.

   B. Place test objects F and G so that their centers are in a transverse vertical plane that is 0.3 m to the rear of a transverse vertical plane tangent to the rearmost surface of the rear bumper.

      NOTE:
      For vehicles without a bumper, test objects F and G are positioned 0.3 m to the rearmost surface of the vehicle.

   C. Place test objects D and E so that their centers are in a transverse vertical plane that is 3.05 m to the rear of a transverse vertical plane tangent to the rearmost surface of the rear bumper.

   D. Place test objects A, B and C so that their centers are in a transverse vertical plane that is 6.1 m to the rear of a transverse vertical plane tangent to the rearmost surface of the rear bumper.

   E. Place test object B so that its center is in a longitudinal vertical plane passing through the vehicle's longitudinal centerline.

   F. Place test objects C, E, and G so that their centers are in a longitudinal vertical plane located 1.52 m, measured laterally and horizontally, to the right of the vehicle longitudinal center line.

   G. Place test objects A, D, and F so that their centers are in a longitudinal vertical plane located 1.52 m, measured laterally and horizontally, to the left of the vehicle longitudinal center line.

      NOTE:
      Test objects F and G can be rotated so that the vertical 150 mm marking is visible in the Rearview image display.

6. Test Reference Point (S14.1.5)

   A. The test reference point is intended to simulate the location of a 50^{th} percentile male driver's eyes when looking at the Rearview image visual display. This procedure is performed having already established the fixed position of the H-point manikin as described above. In order to establish this reference point as

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shown in section B below, a fixture to hold the camera is required. The fixture can be fabricated and mounted in place of the manikin neck and should have multiple points of adjustment such that it can be adjusted to lock and hold the camera in a specific position that corresponds to the required eye points. **FIGURE 15** below, is an example of a camera mounting system which identifies three views and coordinates (M_f, I, J H). Where applicable, after use of the H-point device, the camera can be positioned and held at the required location using an interior scaffolding or a robotic type arm extending from outside the vehicle.

B. To obtain the test reference point, use the following procedure:

1. Locate the center of the forward-looking eye midpoint (M_f) illustrated in **FIGURES 16 and 17** so that it is 635 mm vertically above the **H** point and 96 mm aft of the H point (H).

2. Next, locate the head/neck joint center (J) illustrated in **FIGURES 16 and 17** so that it is located 100 mm rearward of M_f and 588 mm vertically above the H point.

3. Draw an imaginary horizontal line between M_f and a point vertically above J, defined as J_2.

4. Rotate the imaginary line about J_2 in the direction of the Rearview image until the straight-line distance between M_f and the center of the visual display used to present the Rearview image reaches the shortest possible value.

5. Define this new, rotated location of M_f to be $\mathbf{M_r}$ (eye midpoint rotated).

6. Rotate the camera upward/downward about a horizontal axis through point M_r to simulate eye movement up or down to cause the line of sight to intersect with the center of the Rearview image display..

NOTE:
The ***manufacturer*** may at the request of NHTSA, provide coordinates for M_r (eye midpoint rotated) measured from a vehicle reference body point. For convenience, these coordinates may be used to position camera if COTR approval is provided. They also can be used for reference purposes to compare test laboratory installed Manikin derived M_r versus manufacturer data.

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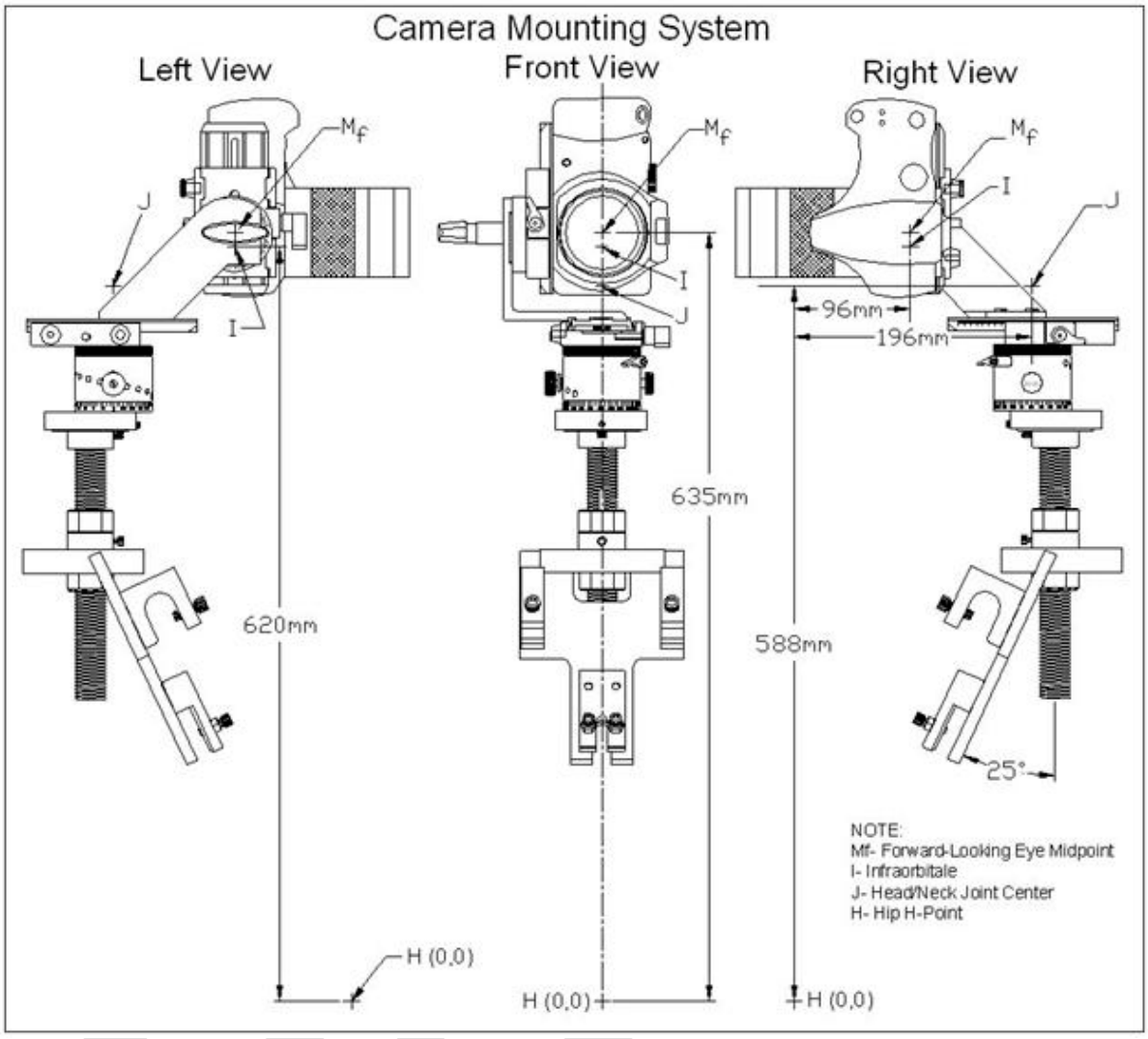

FIGURE 15. Camera Mounting System. Three Views, with Coordinates (Mf, I, J, H)

NOTE:
Camera mount and positioning is specific to the camera charged coupled device (CCD).

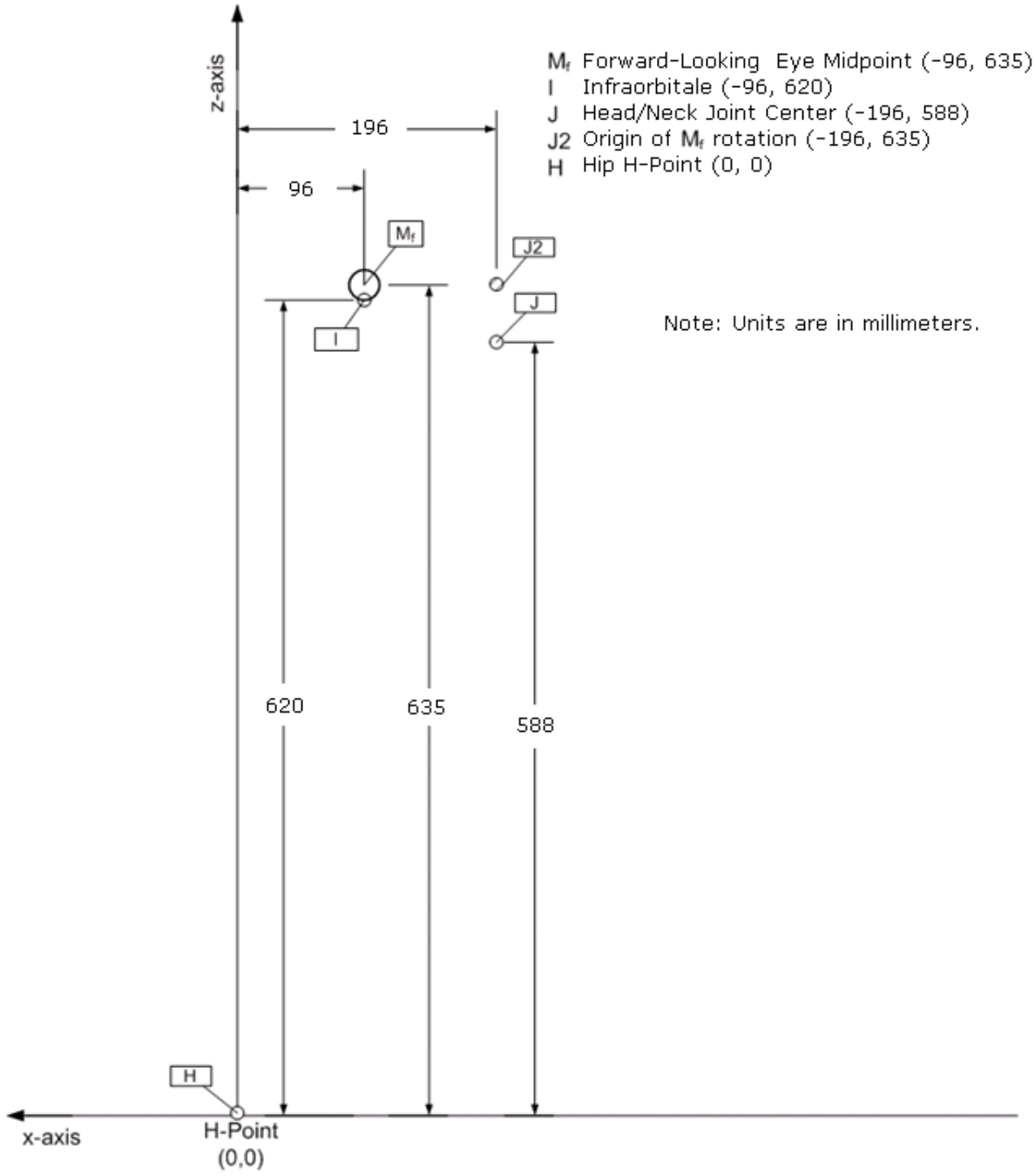

FIGURE 16: EYE MIDPOINT LOCATION (M_f) IN THE MID-SAGITTAL PLANE WITH RESPECT TO H POINT FOR FORWARD-LOOKING 50TH PERCENTILE MALE DRIVER SEATED WITH 25 DEGREE SEAT BACK ANGLE

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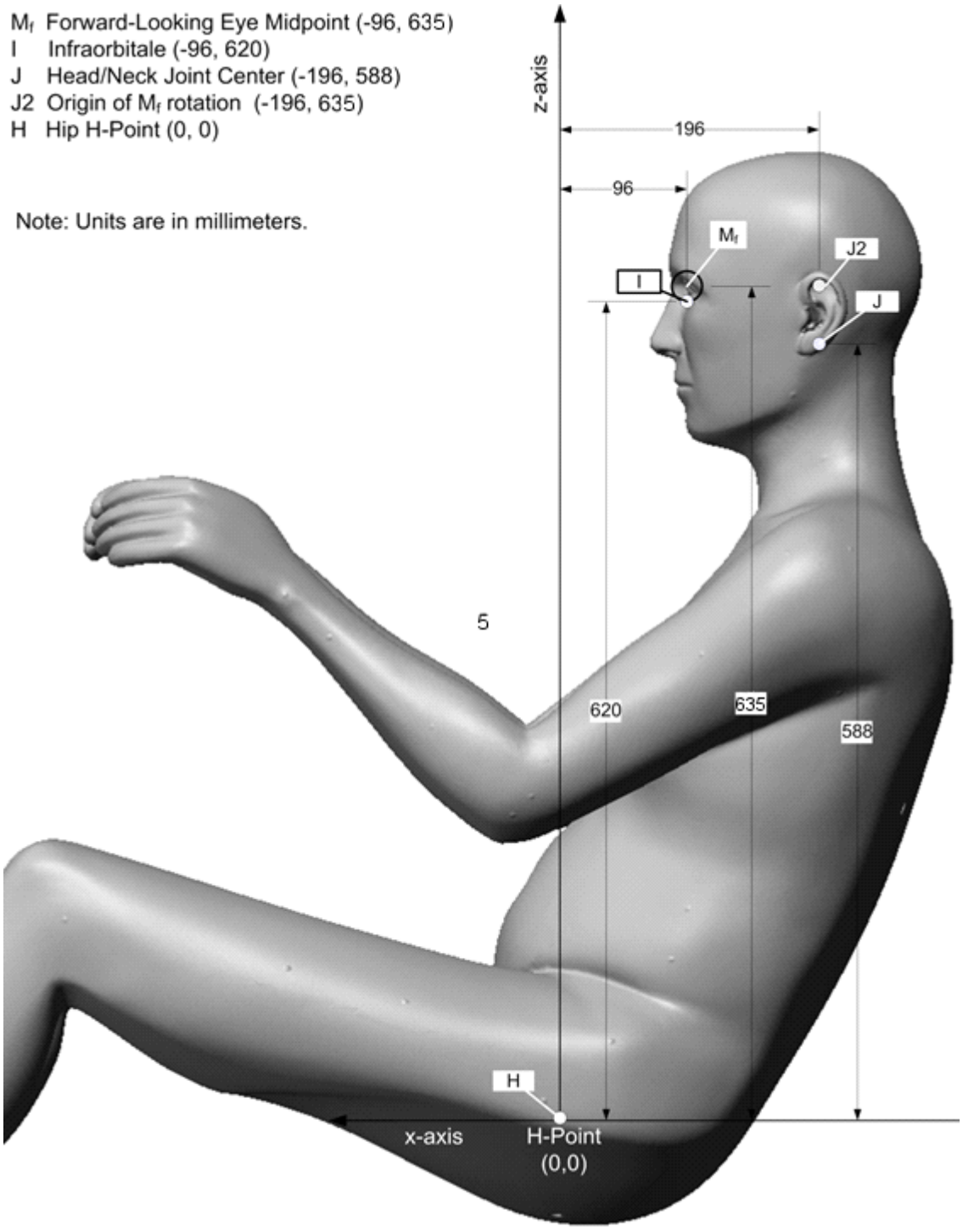

FIGURE 17 - Coordinates of the forward-Looking Eye Midpoint (MF) and Joint Center (J) of Head/Neck rotation of a 50th percentile male driver with respect to the H-Point in the Sagittal body plane..

FIGURE 18 – Camera & Mounting fixture on Neck of H-Point Machine

FIGURE 19 - Photos of the Image Quality Assessment Camera Fixture Installed in Test Vehicles

8. Display adjustment (S14.1.6)

If the display is mounted with a rotational adjustment mechanism, adjust the display such that the surface of the display is normal to the imaginary line traveling through M_r and J_2 or as near to normal as the display adjustment will allow. Indicate on data sheet 11 any adjustments made.

9. Steering Wheel Adjustment (S14.1.7)

A. Adjust the steering wheel to the position where the longitudinal centerline of all vehicle tires are parallel to the longitudinal centerline of the vehicle.

B. The test cylinders may be rotated about their axis in order to facilitate the measurement of the 150 mm width requirements for targets F and G.

C. Start the vehicle engine with the parking brake actuated, and place the vehicle in reverse gear. Secure vehicle so that it remains stationary.

10. Measurement procedure (S14.1.8)

A. Using a 35 mm or larger format still camera, video camera, or digital equivalent such that the center of the camera's image plane is located at M_r and the camera lens is directed at the center of the display's Rearview image. (view as shown in **FIGURES 18 & 19**)

B. Affix a precision quality ruler at the base of the Rearview image in an orientation parallel with a transverse cylinder centerline. Ruler should have a matte finish so as not to cause reflections when taking the data photograph. If the vehicle head restraints obstruct the camera's view of the display, they may be adjusted or removed. (Ruler in frame to be used for test object size below – not necessary for field-of-view compliance determination.)

NOTE:
To assist in test object size verification in next section, a comparison chart with a bar width indicating three minutes of arc can be placed adjacent to the rear image display screen and included in the still camera photograph.

C. Photograph the image of the visual display with the ruler included in the frame and the Rearview image displayed (Include in final report similar to **FIGURES 20 & 21**.

D. Utilizing the photograph of the Rearview image, verify and record on Data Sheet 11 that:

1. a minimum of a 150-mm wide portion along the circumference of each

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test object located at positions **F** and **G** in **FIGURE 13** is visible, and

2. the full width and height of each test object located at positions A through E in **FIGURE 14** is visible.

FIGURE 20 - Visual display with 7 test objects shown.
(note: cylinders D and E missing 150 mm band)

FIGURE 21 – Visual display with reference ruler in place. Note wire frame grid overlay does not obscure test object visibility. (note: cylinders D and E missing 150 mm band)

3. TEST OBJECT SIZE (S5.5.2, S6.2.2)

Record results on Data Sheet 12 (include photo documentation in final report)

Requirement:

When the Rearview image is measured in accordance with the procedures in S14.1, the calculated visual angle subtended by the horizontal width of:

a. all three test objects located at positions A, B, and C in Figure 13 shall average not less than **5** minutes of arc; and

b. each individual test object (A, B, and C) shall not be less than **3** minutes of arc.

This test serves to ensure that a minimum image quality is present, and that the test objects appear large enough for an average driver to quickly determine their presence and nature.

Procedure:

1. Extract photographic data (S14.1.8.1)

   a. Using the photograph for Field-of-View determination from above, measure the apparent length of a 50 mm delineated section of the in-photo ruler, along the ruler's edge, closest to the Rearview image and at a point near the horizontal center of the Rearview image.

   b. Using the photograph, measure the horizontal width of the colored band at the upper portion of each of the three test objects located at positions A, B, and C in **FIGURE14**.

   c. Define the measured horizontal widths of the colored bands of the three test objects as d_a, d_b, and d_c.

2. Obtain scaling factor (S14.1.8.2)

   a. Using the apparent length of the 50 mm portion of the ruler as it appears in the photograph, divide this apparent length by 50 mm to obtain a scaling factor. Define this scaling factor as s_{scale}.

3. Determine viewing distance (S14.1.8.3)

   a. Determine the actual distance from the rotated eye midpoint location (M_r) to the center of the Rearview image. Define this viewing distance as a_{eye}
   FIGURE 22 provides a plan view of the camera image plane relative to the video display. As the eye midpoint on the image plane on the centerline of the camera is

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within the camera body, the distance $_{aeye}$ is calculated using the Pythagorean Theorem.

NOTE:
COTR will provide to laboratory the a_{eye} value if available, from ***manufacturer*** for comparative purposes.

4. Calculate visual angle subtended by test objects (S14.1.8.4)

.

a. Use the following equation to calculate the subtended visual angles:

$$\theta_i = 60 \sin^{-1}\left(\frac{d_i}{a_{eye}s_{scale}}\right)$$

where *i* can take on the value of either *test object A*, *B*, or *C*, and arcsine is calculated in units of degrees.

5. Record results of photographic extraction on Data Sheet 12, verifying that:

a. all three test objects located at positions A, B, and C in Figure 15 average not less than **5 minutes of arc**; and

b. each individual test object (A, B, and C) are not be less than **3 minutes of arc**.

NOTE:

Photo editing software which provides zoom and pan functions, rotations, and a high resolution X-Y coordinate system may be used to measure the apparent size of the cylinders.

FIGURE 23 shows close-up of display with red arrows depicting chosen measurement points.

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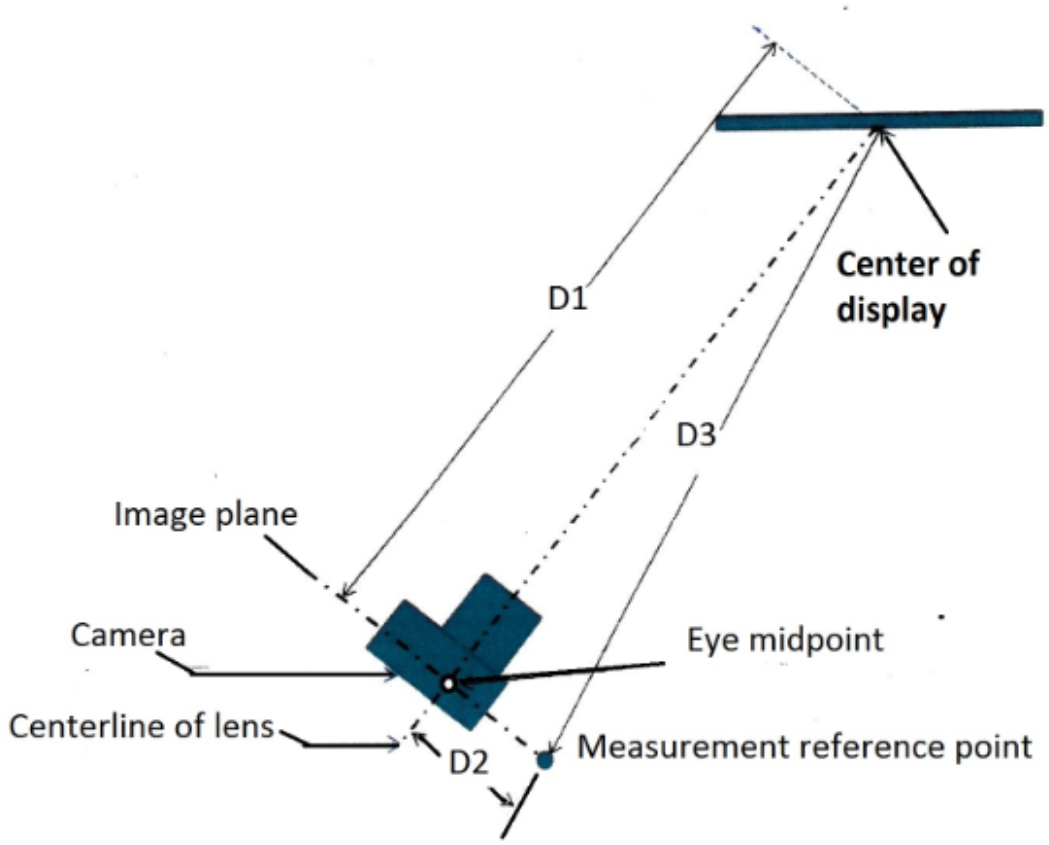
FIGURE 22 - Plan View of Camera Image Plane Relative to Video Display



D1 = Aeye = distance from focal plane to center of display
D2 = offset of reference to centerline of camera lens
D3 = measured distance from reference point to center of display

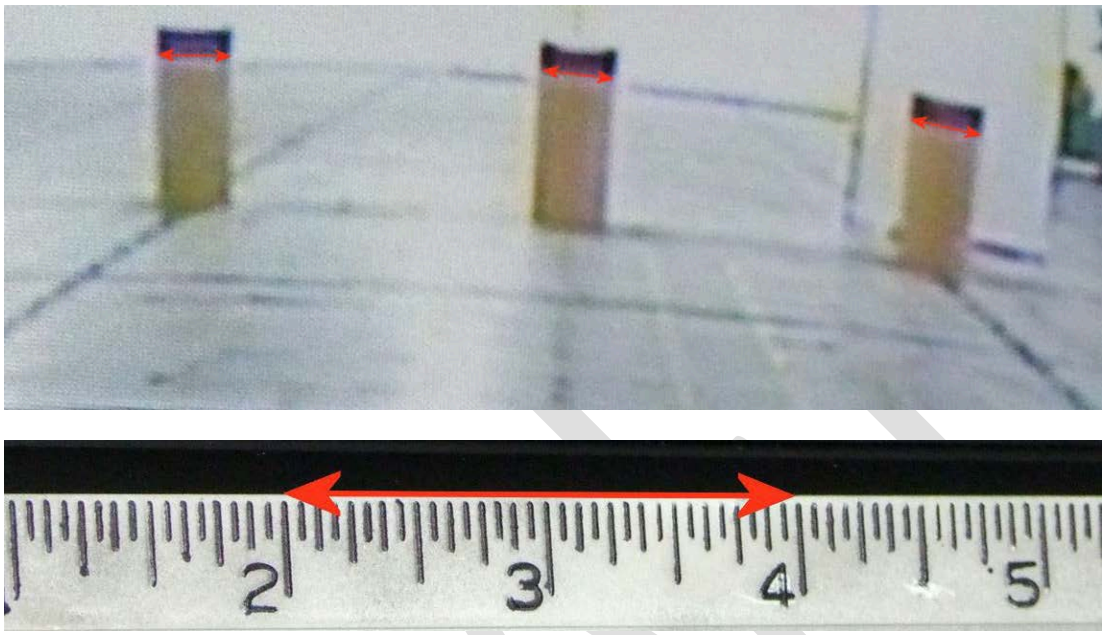


FIGURE 23 – Close-Up View Portions of Display with Red Arrows Depicting Chosen Measurement Points.

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4. REARVIEW IMAGE RESPONSE TIME (S5.5.3, S6.2.3, S14.2)

Record results on Data Sheet 13.

Requirement:

The Rearview image meeting the requirements of S5.5.1 and S5.5.2 (S6.2.1 and S6.2.2), when tested in accordance with S14.2, shall be displayed within **2.0 seconds** of the start of a backing event (transmission gear selector placed into reverse).

Procedure:

1. Prior to the start of a backing event, the vehicle condition is established using the following procedure:

    a. The driver's door will be opened to any width and

    b. Close the driver's door

    c. Activate the starting system using the key. The vehicle engine will be started (for automatic transmission equipped vehicles, the engine is to be started with the shift lever in PARK. For manual transmission equipped vehicles, the engine is to be started with the shift lever in any position other than reverse), and

    d. Select the vehicle's reverse direction (the start of the backing event) at any time **not less than 4 seconds and not more than 6 seconds** after the driver's door is opened. Driver door open is defined as when the edge of the driver's door opposite the door's hinge is no longer flush with the exterior body panel. (Brake application may be required for gear selector movement).

    NOTE:
    If vehicle cannot be placed in the reverse gear position within the 6 second time frame due to design constraints, (e.g shifter is recessed with vehicle off, and raises when vehicle started - can only function when fully up requiring additional time) contact COTR and perform testing as close to the 6 seconds as possible.

2. Immediately prior to commencing the a thru c actions above, all components of the rear visibility system must be in the lowest power resting state. Contact COTR for ***manufacturer*** recommendations for determination of this state. Record what constitutes lowest power resting state.

3. Position vehicle on test area as described in Section 12 (pre-test requirements) which allows for unobstructed forward and rearward vehicle travel.

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4. Verify that the temperature inside the vehicle during this test is at any temperature between 15 and 25 degrees C (59 to 77 F). Record the value.

5. Verify that the vehicle's battery power level is within the nominal operating range for the type of vehicle being tested.

NOTE:
The following steps 6 thru 9, provide one method for the laboratory to determine timing for door opening, door closed, engine started, transmission gear selector placed in reverse, and Rearview image displayed. The timing of these events (triggers), should be input into a continuous time recorder.

6. Tap into the driver door opening/lighting switch, or install another time trigger such as a trip switch, contact switch, or break wire at the door edge/B-pillar intersection, to identify at what point the door is opened (T_0).

7. Tap into automotive ignition or component which energizes when engine is started and input signal to the continuous timing device (T_1).

8. Tap into the rear backup lamps signal wiring for a time zero trigger source/ indicator, to identify at what point the vehicle transmission gear selector is placed into reverse. Verify with video or an observer, the time delay, if any, between the gear selector in reverse and the rear backing lights activated. If there is limited to no time delay this light activation can be used to determine when the gear selector is placed in reverse. An alternative to this is to mount a contact switch at the transmission shift lever which outputs a voltage signal when selector is placed in reverse(T_2).

9. To identify when the Rearview image is displayed on the interior visual display, a photo-receptor with software image recognition on the display (which can distinguish between the default splash screen display and the required Rearview image) can be utilized (T_3). If video camera is used as described below for determination of image display time, camera may require manual adjustment setting mode. If automatic mode, the aperature at time of image display may respond from closed to full open then back to an intermediate steady-state position. This "focusing" time lag in automatic mode may reduce the accuracy for event timing.

   An alternative to the above steps, is to have an observer using a hand held trigger, depress the device as the events occur. The data can be collected on a continuous recorder and analyzed.

   Another option for the laboratory to obtain the required data, is to incorporate a video recording system as described in step 10 below:

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10. Mount a digital video camera rearward of the driver such that the timing of the driver door opening, door closing, engine start, transmission shifting into reverse, and the rear view image display activation are visible. Video should have timing marks to allow for frame-by-frame analysis. A known video frame rate can be used to establish timing of events. Placement of a timing device in the video image field e.g. digital meter mounted on vehicle dash, can also be considered for timing determination. Video with sound is another option allowing test observers to announce when the critical events occur. Analysis of the video can then be used to determine event timing .More than one video camera can be used to obtain required data. For instance video of driver door, rear image display screen, shifter, and reverse lights can be simultaneously viewed and synchronized for event timing. The laboratory is at liberty to instrument the vehicle as necessary to obtain the required data, but with the approval of the COTR.

11. For conditions a,b,c, and d below, record on Data Sheet 13, timing of door opening (T_0), door closed, (T_1), engine started (T_2), gear selector into reverse (T_3), and time elapsed from gear selector into reverse to when Rearview image is displayed (T_4). For all conditions, verify image displayed within 2 seconds of transmission gear selector placed into reverse.

    NOTE: Brake pedal may have to be depressed to shift gear selector.

    a. With the elapsed time from door opening, door closed, engine started, and gear selector placed into reverse, as close to but <u>not less than 4 seconds</u>. Repeat 5 times.

    b. With the elapsed time from door opening, door closed, engine started, and gear selector placed into reverse, anytime between <u>4 and 6 seconds.</u> Repeat 5 times.

    c. With the elapsed time from door opening, door closed, engine started, and gear selector placed into reverse, as <u>close to 6 seconds as possible</u>. Repeat 5 times.

    d. The above three tests can be repeated with the vehicle in any expected operational condition such as engine cold.

    e. For <u>INFORMATION</u> purposes only, repeat testing with an elapsed time greater than 6 seconds.

    NOTE:
    During the 4 to 6 second time interval after door opening, there are no specifications for when the sequence of events for door closure, engine activated and reverse gear selected must occur e.g. time between engine activation and gear selector to reverse.

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5. LINGER TIME (S5.5.4, S6.2.4)

Record results on Data Sheet 14.

Requirement:

Linger time (S5.5.4)

The Rearview image meeting the requirements of S5.5.1 and S5.5.2 (S6.2.1 and S6.2.2) shall not be displayed after the backing event has ended.

Procedure:

This test is conducted to verify that the Rearview image is not displayed after the end of the backing event (as selected by manufacturer).

Obtain from the COTR which of the following or combination thereof, was selected by the ***manufacturer*** as to what constitutes the end of the vehicle backing event:

- A forward speed of 10 mph
- A forward distance of 10 meters traveled, or
- A forward motion of continuous duration of 10 seconds.

NOTE:
The manufacturer may elect to automatically extinguish the Rearview image at any time after the transmission gear selector is moved out of reverse but prior to the end of the backing event. The driver can deactivate the rear view image at any time after the start of the backing event.

NOTE:
Indicate if driver has option as to when image is extinguished, e.g. switch to allow 10 meters traveled (maximum 10) or transmission lever out of reverse. Describe how functions e.g defaults to original setting after completion of backing event .

1. Instrument the vehicle with a data acquisition system and optical fifth wheel, GPS system or equivalent, in order to determine forward vehicle speed, forward distance travelled, and time of continuous forward motion. A time zero needs to be established for when and where the vehicle first begins forward motion.

2. Alternatives to the above instrumentation can be considered by the laboratory similar to those described in the Response Time section above including video and voice delineation. The laboratory is at liberty to instrument the vehicle as necessary to obtain this required data, but with the approval of the COTR. .

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3. Position the vehicle in an area of sufficient size to allow for vehicle travel in the forward and reverse directions. A floor grid with defined distances marked is recommended.

4. To verify that the Rearview image display is not displayed after the end of the backing event (as defined by the manufacturer), proceed as follows:

    a. Place the vehicle transmission selector into reverse gear and travel rearward for a short distance. Stop and hold vehicle in this position. Rearview image must be displayed. Place the vehicle transmission selector into a forward gear and slowly travel forward. Record vehicle **speed** at which the Rearview image is extinguished. Repeat 5 times.

    b. Place the vehicle transmission selector into reverse gear and travel rearward for a short distance. Stop and hold vehicle in this position. Rearview image must be displayed. Place the vehicle transmission selector into a forward gear and a slowly travel forward. Record **distance** vehicle has traveled from the point at which the gear selector is placed in a forward gear to the point at which the Rearview image is extinguished. Repeat 5 times.

    c. Place the vehicle transmission selector into reverse gear and travel rearward for a short distance. Stop and hold vehicle in this position. Rearview image must be displayed. Place the vehicle transmission selector into a forward gear and slowly travel **continuously** forward. Record time elapsed from when gear selector was placed into a forward gear and motion started, to the time the Rearview image is extinguished. Repeat 5 times.

Rearview image **must not** be present after the vehicle speed reaches 10 mph, or after traveling forward 10 meters, or after time elapsed for continuous forward motion of 10 seconds..

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6. DEACTIVATION (S5.5.5, S6.2.5)

Record results on Data Sheet 15.

Requirement:

Deactivation (S5.5.5, S6.2.5)

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The Rearview image meeting the requirements of S5.5.1 and S5.5.2 (S6.2.1 and S6.2.2) shall remain visible during the backing event until either:

- the driver modifies the view, or
- the vehicle direction selector is removed from the reverse position.

This test is conducted to verify that once the backing event is initiated (transmission selector into reverse gear), the Rearview image **cannot** be extinguished by any means other than driver intervention which includes the vehicle direction selector being removed from the reverse position. Rearview image must extinguish by end of backing event.

Procedure:

1. Place vehicle transmission selector into **reverse gear**. Rearview image must be displayed, With vehicle maintained in reverse, depress any provided driver activated switch/button/touch screen (other than gear selector) which allows the displayed Rearview image to be extinguished or modified **.** Verify its functionality. Document and include applicable Owner's Manual pages which describe method for extinguishing or modification. Include if any, what view is displayed e.g. overlays, bird's eye, etc. Repeat 3 times.

2. Place vehicle transmission selector into **reverse gear**. Rearview image must be displayed. Then place transmission gear selector into a **neutral or forward gear.** If image remains activated, depress any provided driver activated switch/button/touch screen which allows the displayed Rearview image to be extinguished or modified prior to termination of the backing event**.** Verify its functionality. Document and include applicable Owner's Manual pages which describe method for extinguishing or modification. Include what view is displayed e.g. overlays, bird's eye, etc. Repeat 3 times.

3. Place vehicle transmission selector into **reverse gear.**. Rearview image must be displayed, With vehicle maintained in reverse, determine if there is any vehicle conditions **absent driver action** in which the required Rearview image can be modified or extinguished (not permissible).

4. Verify that there is no means by driver or otherwise to deactivate the rear view image from activating **prior to** the start of the backing event i.e. driver cannot disable the rear visibility system except during the backing event.

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7. DEFAULT VIEW (S5.5.6, S6.2.6)

Record results on Data Sheet 16.

Requirement:

The rear visibility system must default to the Rearview image meeting the requirements of S5.5.1 and S5.5.2 (S6.2.1 and S6.2.2) at the beginning of each backing event regardless of any modification to the field of view the driver has previously selected.

NOTE: If display has driver controlled features such as object detection overlays, path prediction, warning statements, birds eye view, and screen contrast, brightness, resolution etc, the test uses the initial (or default after each ignition cycle) view that appears after the vehicle's starting system is activated and the vehicle is placed into reverse. This default view must comply with the Rearview image requirements.

Procedure:

1. Start the vehicle, initiate and complete a backing event. Turn off the vehicle and remove the ignition key. Verify that for subsequent startup and backing events, Rearview image is displayed. Repeat 5 times.

2. Start the vehicle, initiate and complete a backing event. With engine still running complete consecutive backing events and verify that for subsequent backing events, Rearview image is displayed. Repeat 5 times.

3. Start the vehicle, and initiate a backing event. During but prior to the end of the backing event, extinguish or modify the Rearview image by any means provided to the driver. Indicate if modification is made prior to or after gear selection is out of reverse. Identify resulting image – warning message, distance markers, vehicle trajectory, wide angle view, bird's eye etc. Turn off the vehicle, restart, and initiate a backing event Verify that the required default Rearview image is displayed and complies with all applicable requirements. Repeat 5 times.

4. Start the vehicle, and initiate a backing event. During but prior to the end of the backing event, extinguish or modify the Rearview image by any means provided to the driver. Indicate if modification is made prior to or after gear selection is out of reverse. With engine still operating, initiate another backing event. Verify that the required default Rearview image is displayed and complies with all applicable requirements. Repeat 5 times.

5. From Deactivation testing results above, determine if there is a means to deactivate or modify the required Rearview image **prior to** the start of the backing event and that altered condition remains once the backing event starts (not permissible – i.e. Rearview image must always appear at the start of backing event regardless of actions taken prior to backing event.)

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6. Note if default view includes an automatic overlay and if the overlay obscures any of the test object cylinders.

7. Note if the driver can manually add overlays and if so describe.

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8. DURABILITY (S5.5.7, S6.2.7)

Record results on Data Sheet 17.

Requirement:

Durability (S5.5.7,S6.2.7)

The rearview system shall meet:

A. The field of view requirements of S5.5.1 (S6.2.1) and

B. Test Object Image Size requirements of S5.5.2 (S6.2.2) after **each** durability test specified in S14.3.1, S14.3.2, and S14.3

This testing is a component level test to environmentally condition (corrosion, humidity, and temperature) the external portion of the rearview imaging system (usually the camera) which is exposed to the elements and then to determine that the system remains functional and continues to comply with the field-of-view and test object image size requirements without degradation in image quality.

Procedure:

1. Prior to testing, verify that the camera and rearview system is functional.

2. Note the model and manufacturer of camera, if available.

3. Consult with COTR to determine if environmental test fixture is obtainable from the manufacturer for use in OVSC testing..

4. Prior to removal of camera and associated electrical attachments from the vehicle, measure the angle of the camera lens plane with reference to ground, the camera lens center position from the ground, and the lateral position on vehicle.

5. Photograph and examine the sealing method that the camera is affixed to the vehicle, and document on data sheet e.g. camera screwed to vertical portion of trunk with gasket material at interface.

6. Remove the camera and any other portion of the Rearview image system which is exposed to the elements. Carefully detach the camera and undo any electrical connections. (Typical as shown in **FIGURE 24**)

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FIGURE 24 – Typical camera and associated connector and wiring removed from vehicle.

7. Position the camera in an environmental test fixture as defined in Section 10 and repeated here:
   Environmental test fixture - means a device designed to support the external components of the rear visibility system for testing purposes, using any factory seal which would be used during normal vehicle operation, in a manner that
   simulates the on-vehicle component orientation during normal vehicle operation, and prevents the exposure of any test conditions to portions of the external component which are not exposed to the outside of the motor vehicle.
   Use of manufacturer supplied test fixture is recommended, if available.

8. The portions of the camera not exposed to the elements (usually rear) can be inserted into a cutout portion of a plexi-glass enclosure utilizing the same gasket or sealing method as on the test vehicle. Connectors can be protected and sealed in air tight containers or bags, and if necessary, coated with removable silicon or plastic-dip in the terminal area temporarily. Document and photograph the procedures taken prior to the start of the durability testing to ensure that the cameras and associated wirring are mounted in weatherproof enclosures in a manner and orientation that simulates their original equipment (OE) installation against the vehicle body. (See **FIGURES 25, 26, and 27** for sample installation)

FIGURE 25 – Sample plexi-glass environmental enclosure with camera installed.

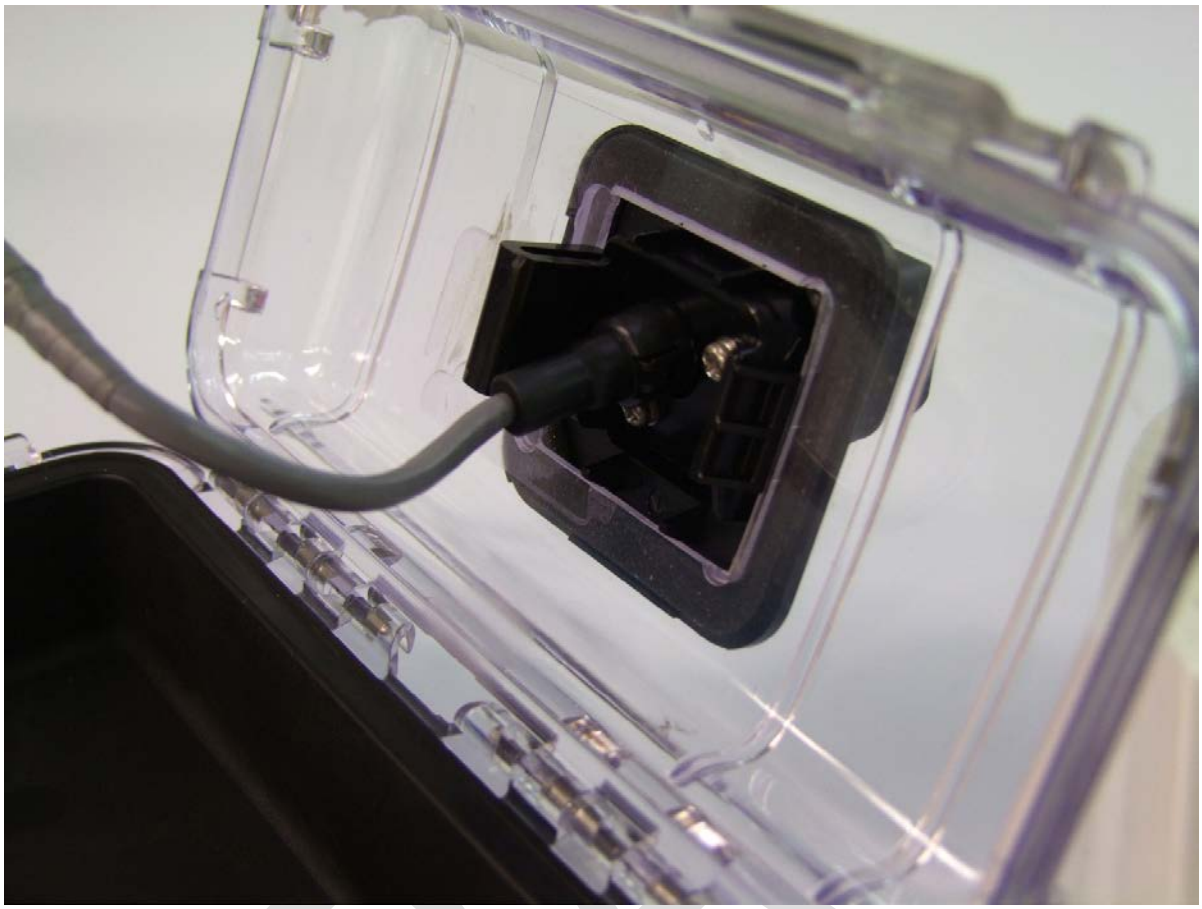

FIGURE 26– Plexi-glass enclosure from the interior showing camera mounting seal.

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FIGURE 27 – Camera removed from vehicle showing OEM compressible water-tight foam seal on perimeter which would be against vehicle body..

9. Proceed with the Durability/environmental testing as described below with the applicable rear view system components installed in the environmental test fixture:

   NOTE:
   After exposure to <u>each</u> of the three environmental conditions, the rear visibility system is as stated below, to be removed from test fixture, reinstalled onto the vehicle and compliance tested for rear-view-image and test object image size. However, **with approval of COTR**, to facilitate the testing, after both corrosion and humidity cycling, the conditioned rear visibility components do not have to be re-installed on the vehicle and tested to field-of-view and image size if there is a means to power up the system to verify that it continues to be operational i.e. bench tested. After the Temperature conditioning, the camera must be reinstalled on the vehicle and the rear visibility system field-of-view and test object image size tested. If the outcome of this abbreviated testing results in a failure, the conditioning procedures may need to be repeated to the specific requirement of the standard with a newly purchased camera system.

10. <u>Corrosion Conditioning (S14.3.1)</u>

    The external components are subjected to two 24-hour corrosion test cycles. In each corrosion test cycle, the external components are subjected to a salt spray (fog) test in accordance with ASTM B117-73, <u>Method of Salt Spray (Fog) Testing</u> (incorporated by reference, see § 571.5) for a period of 24 hours. Allow 1 hour to elapse without spray between the two test cycles.

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After completion of the corrosion conditioning, photograph the camera, associated wiring, and any other rear image system components environmentally exposed and record any visual anomalies such as corrosion, lens deterioration, water droplets in the camera lens, or wiring/connector deterioration.

A. Disassemble camera from the environmental test fixture, and reinstall the camera and associated wiring back on the subject test vehicle. The installed rearview system should be positioned and affixed as close to the original configuration as possible. Consult COTR if camera reinstallation alignment requires manufacturer specifications. NOTE: The camera exterior lens can be gently wiped clean with a soft cloth to remove surface moisture and particles (equivalent to that found on the vehicle during normal operational use) which may have been deposited during the environmental conditioning.

B. Start vehicle engine and perform fore and aft vehicle travel to verify that the camera and Rearview image system is operational.

C. Proceed with post durability verification field-of-view and test object image size testing as described in Compliance Test Execution Sections 2 and 3.

D. Remove the camera and associated wiring from the vehicle and install back into the environmental test fixture as described above. Proceed with the Humidity conditioning as shown below (allow the rear visibility camera system to stabilize at room temperature for a minimum of one hour after the end of corrosion conditioning and before the start of humidity conditioning).

E. Document in final report before and after durability image as shown in **FIGURE 28**.

11. Humidity Conditioning (S14.3.2)

The external components are subjected to 24 consecutive 3-hour humidity test cycles. In each humidity test cycle, external components are subjected to a temperature of 100°+7°-0º F (38º+4º-0° C) with a relative humidity of not less than 90% for a period of 2 hours. After a period not to exceed 5 minutes, the external components are subjected to a temperature of 32° +5° -0° F (0° +3° -0° C) and a humidity of not more than 40% for 1 hour. Allow no more than 5 minutes to elapse between each test cycle.

A. After completion of the Humidity conditioning, photograph the camera, associated wiring, and any other rear image system components environmentally exposed and record any visual anomalies such as corrosion, lens deterioration, water droplets in the camera lens, or wiring/connector deterioration.

B. Disassemble camera from the environmental test fixture, and reinstall the camera

and associated wiring back on the subject test vehicle. The installed rearview system should be positioned and affixed as close to the original configuration as possible. Consult COTR if camera reinstallation alignment requires manufacturer specifications.. NOTE: The camera exterior lens can be gently wiped clean with a soft cloth to remove surface moisture and particles (equivalent to that found on the vehicle during normal operational use) which may have been deposited during the environmental conditioning.

C. Start vehicle engine and perform fore and aft vehicle travel to verify that the camera and Rearview image system is operational.

D. Proceed with post durability verification field-of-view and test object image size testing as described in Compliance Test Execution Sections 2 and 3.

F. Remove the camera and associated wiring from the vehicle and install back into the environmental test fixture as described above. Proceed with the Temperature conditioning as shown below (allow the rear visibility camera system to stabilize at room temperature for a minimum of one hour after the end of humidity conditioning and before the start of temperature conditioning).

G. Document in final report before and after durability image as shown in **FIGURE 28**.

12. Temperature Conditioning.(S14.3.3)

The external components are subjected to 4 consecutive 2-hour temperature test cycles. In each temperature test cycle, the external components are first subjected to a temperature of 176° ± 5° F (80° ± 3° C) for a period of one hour. After a period not to exceed 5 minutes, the external components are subjected to a temperature of 32° +5° -0° F (0° +3° -0° C) for 1 hour. Allow no more than 5 minutes to elapse between each test cycle.

A. After completion of the Temperature conditioning, photograph the camera, associated wiring, and any other rear image system components environmentally exposed and record any visual anomalies such as corrosion, lens deterioration, water droplets in the camera lens, or wiring/connector deterioration.

B. Disassemble camera from the environmental test fixture, and reinstall the camera and associated wiring back on the subject test vehicle. The installed rearview system should be positioned and affixed as close to the original configuration as possible. Consult COTR if camera reinstallation alignment requires manufacturer specifications.. NOTE: The camera exterior lens can be gently wiped clean with a soft cloth to remove surface moisture and particles (equivalent to that found on the vehicle during normal operational use) which may have been deposited during the environmental conditioning.

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C. Start vehicle engine and perform fore and aft vehicle travel to verify that the camera and Rearview image system is operational.

D. Proceed with post durability verification field-of-view and test object image size testing as described in Compliance Test Execution Sections 2 and 3.

E. Document in final report before and after durability image as shown in **FIGURE 28.**

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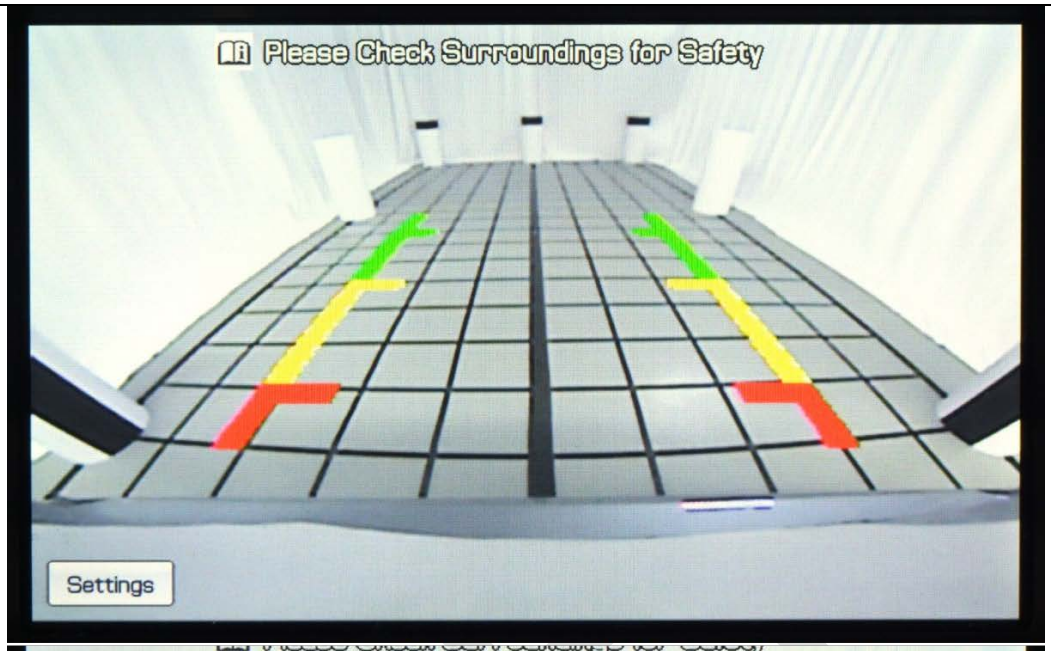
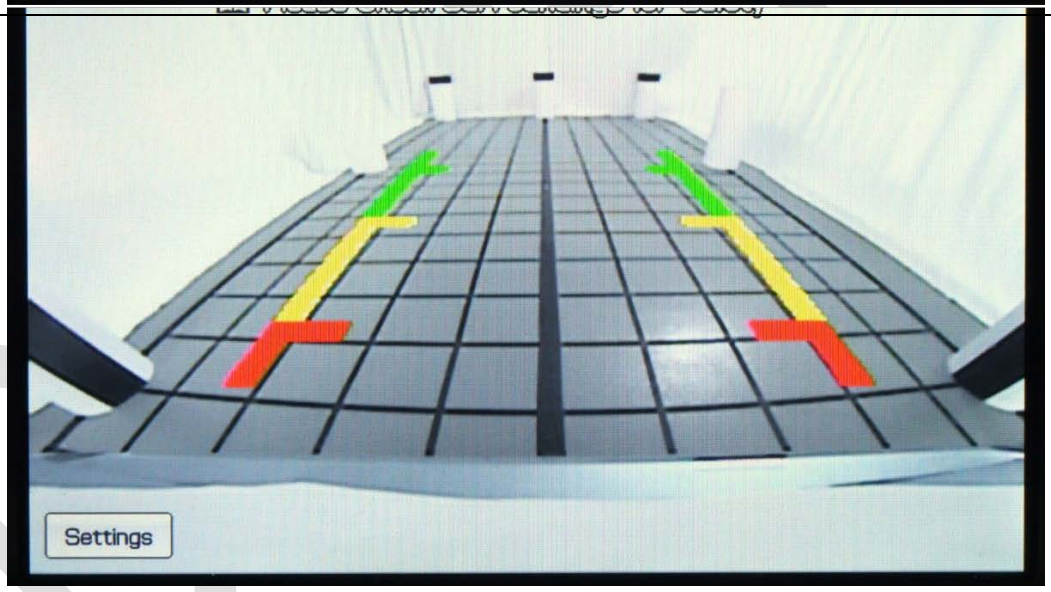
Comparison Image	
Rearview Image After Durability Exposure	

Figure 28. Sample report documentation photographs of visual image before and after durability testing. NOTE: The cylinders required field-of-view is not obscured by the wire overlay. D and E should have 150 mm band)

14. POST TEST REQUIREMENTS

After the required tests are completed, the contractor shall:

A. Verify all instrumentation, data sheets and photographs

B. Complete the Vehicle Condition report form including a word description of its post test condition

C. Copy applicable pages of the vehicle Owner's Manual for attachment to the final test report

D. Move the test vehicle to a secure area

E. Place all original records in a secure and organized file awaiting test data disposition.

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15. REPORTS

15.1 MONTHLY STATUS REPORTS

The contractor shall submit a monthly Test Status Report and a Vehicle Status Report to the COTR. The Vehicle Status Report shall be submitted until all vehicles or items of equipment are disposed of. Samples of the required Monthly Status Reports are contained in the Report Forms section.

15.2 APPARENT NONCOMPLIANCE

Any indication of a test failure shall be communicated by telephone to the COTR within 24 hours with written notification mailed within 48 hours (Saturdays and Sundays excluded). A Notice of Test Failure (see report forms section) with a copy of the particular compliance test data sheet(s) and preliminary data plot(s) shall be included. In the event of a test failure, a post test calibration check of some critically sensitive test equipment and instrumentation is required for verification of accuracy. The calibration shall be performed without additional costs to the OVSC.

15.3 FINAL TEST REPORTS

15.3.1 COPIES

In the case of a test failure, 7 copies of the Final Test Report shall be submitted to the COTR for acceptance within three weeks of test completion. The Final Test Report format to be used by all contractors can be found in the "Report Section".

Where there has been no indication of a test failure, 3 copies of each Final Test Report shall be submitted to the COTR within three weeks of test completion. Payment of contractor's invoices for completed compliance tests may be withheld until the Final Test Report is accepted by the COTR. Do NOT submit invoices before the COTR is provided copies of the Final Test Report.

Contractors are required to submit the first Final Test Report in draft form within two weeks after the compliance test is conducted. The contractor and the COTR will then be able to discuss the details of both test conduct and report content early in the compliance test program.

Contractors are required to PROOF READ all Final Test Reports before submittal to the COTR. The OVSC will not act as a report quality control office for contractors. Reports containing a significant number of errors

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will be returned to the contractor for correction, and a "hold" will be placed on invoice payment for the particular test.

15.3.2 REQUIREMENTS

The Final Test Report, associated documentation (including photographs) are relied upon as the chronicle of the compliance test. The Final Test Report will be released to the public domain after review and acceptance by the COTR. For these reasons, each final report must be a complete document capable of standing by itself.

The contractor should use DETAILED descriptions of all compliance test events. Any events that are not directly associated with the standard but are of technical interest should also be included. The contractor should include as much DETAIL as possible in the report.

Instructions for the preparation of the first three pages of the final test report are provided below for the purpose of standardization.

15.3.3 FIRST THREE PAGES

A. FRONT COVER

A heavy paperback cover (or transparency) shall be provided for the protection of the final report. The information required on the cover is as follows:

(1) Final Report Number such as 111ABCXX001 where –

111 is the FMVSS tested
ABC are the initials for the laboratory
XX is the last two numbers of the Fiscal Year of the test program

(2) Final Report Title and Subtitle such as

COMPLIANCE TESTING FOR FMVSS 111
Rear Visibility
* *
World Motors Corporation
20XX XYZ Motor Cars
NHTSA No. CX0901

(3) Contractor's Name and Address such as

COMPLIANCE TESTING LABORATORIES, INC.
4335 West Dearborn Street
Detroit, Michigan 48090

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NOTE: DOT SYMBOL WILL BE PLACED BETWEEN ITEMS (3) AND (4)

(4) Date of Final Report completion

(5) The words "FINAL REPORT"

(6) The sponsoring agency's name and address as follows

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance
Mail Code: NEF-220
1200 New Jersey Ave., SE
Washington, DC 20590

B. FIRST PAGE AFTER COVER PAGE

When a contract test laboratory is reporting, a disclaimer statement and an acceptance signature block for the COTR shall be provided as follows:

This publication is distributed by the National Highway Traffic Safety Administration in the interest of information exchange. Opinions, findings and conclusions expressed in this publication are those of the author(s) and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof.

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If trade or manufacturers' names or products are mentioned, it is only because they are considered essential to the object of the publication and should not be construed as an endorsement.

Prepared By:
_____

Approved By:
_____

Approval Date:
_____

FINAL REPORT ACCEPTANCE BY OVSC:

Accepted By:
_____

Acceptance Date:
_____

C. SECOND PAGE AFTER FRONT COVER

A completed Technical Report Documentation Page (Form DOT F1700.7) shall be completed for those items that are applicable with the other spaces left blank. Sample data for the applicable block numbers of the title page follows.

Block 1 — REPORT NUMBER
111ABCXX001

Block 2 — GOVERNMENT ACCESSION NUMBER
Leave blank

Block 3 — RECIPIENT'S CATALOG NUMBER
Leave blank

Block 4 — TITLE AND SUBTITLE
Final Report of FMVSS 111 Compliance Testing of 20XX World XYZ Motor Cars, NHTSA No. CX0901

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Block 5 — REPORT DATE
Month Day, 20XX

Block 6 — PERFORMING ORGANIZATION CODE
ABC

Block 7 — AUTHOR(S)
John Smith, Project Manager
Bill Doe, Project Engineer

Block 8 — PERFORMING ORGANIZATION REPORT NUMBER
ABCDOTXXX001

Block 9 — PERFORMING ORGANIZATION NAME AND ADDRESS
ABC Laboratories
405 Main Street
Detroit, MI 48070

Block 10 — WORK UNIT NUMBER
Leave blank

Block 11 — CONTRACT OR GRANT NUMBER
DTNH22XXD12345

Block 12 — SPONSORING AGENCY NAME AND ADDRESS
U.S. Department of Transportation
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance
Mail Code: NVS-220
1200 New Jersey Ave., SE
Washington, DC 20590

Block 13 — TYPE OF REPORT AND PERIOD COVERED
Final Test Report
Month Day to Month Day, 20XX

Block 14 — SPONSORING AGENCY CODE
NVS-220

Block 15 — SUPPLEMENTARY NOTES
Leave blank

Block 16 — ABSTRACT

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Compliance tests were conducted on the subject 20XX World XYZ Motor Car in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP111XX for the determination of FMVSS 111 compliance. Test failures identified were as follows:

None

NOTE: Above wording must be shown with appropriate changes made for a particular compliance test. Any questions should be resolved with the COTR.

Block 17 — KEY WORDS
Compliance Testing
Safety Engineering
FMVSS 111

Block 18 — DISTRIBUTION STATEMENT
National Highway Traffic Safety Administration
Technical Information Services Division, NPO-411
1200 New Jersey Avenue SE (Room E12-100)
Washington DC 20590
e-mail: tis@nhtsa.dot.gov
FAX: 202-493-2833

Block 19 — SECURITY CLASSIFICATION OF REPORT
Unclassified

Block 20 — SECURITY CLASSIFICATION OF PAGE
Unclassified

Block 21 — NUMBER OF PAGES
Add appropriate number

Block 22 — PRICE
Leave blank

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15.3.4 TABLE OF CONTENTS

Final test report Table of Contents shall include the following:

Disclaimer Notice

Technical Report documentation Page

Table of contents

Introduction

Test Vehicle Information

Purpose of Compliance Test

Compliance Test Data Summary

Compliance Test Data Sheets

Notice of Possible Noncompliance (if applicable)

Photographs

Test Equipment List and Calibration Information

Copy of Manufacturer’s Sticker

Applicable pages from vehicle owner’s manual

Discussion of Data/ Contractor Comments (if applicable)

Procedure Modifications and Test Facility Description (if applicable)

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16. DATA SHEETS

15. REARVIEW MIRROR TESTING:

DATA SUMMARY SHEET
FMVSS 111 - REARVIEW MIRRORS

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

OUTSIDE DRIVER SIDE MIRROR

	PASS	FAIL	COMMENTS
STABLE SUPPORT			
DOES NOT PROTRUDE BEYOND VEHICLE BODY			
NOT OBSCURED BY UNWIPED PORTION OF WINDSHIELD			
ADJUSTABLE BY TILTING			
ADJUSTABLE FROM DRIVER SEAT			
FREE OF SHARP EDGES			
FIELD-OF-VIEW			
REFLECTANCE			
UNIT MAGNIFICATION			

INSIDE REARVIEW MIRROR

	PASS	FAIL	COMMENTS
STABLE SUPPORT			
ADJUSTABLE BY TILTING			
FIELD-OF-VIEW			
REFLECTANCE			
BREAK AWAY			
UNIT MAGNIFICATION			

FMVSS 111 DATA SUMMARY SHEET CONTINUED

OUTSIDE PASSENGER SIDE MIRROR (if required)

	PASS	FAIL	COMMENTS
STABLE SUPPORT			
ADJUSTABLE BY TILTING			
REFLECTANCE			
FREE OF SHARP EDGES			
UNIT MAGNIFICATION or			
CONVEX			

REMARKS:

DATA SHEET 1 (1 of 2)
VEHICLE INSPECTION AND IDENTIFICATION

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

TYPES OF REARVIEW MIRRORS (flat, spherical, etc.):

INSIDE REARVIEW: _____

DRIVER'S SIDE OUTSIDE: _____

PASSENGER'S SIDE OUTSIDE: _____

OTHER:

DESIGNATED SEATING CAPACITY: _____

PASSENGER CARS AND MPVs, TRUCKS, AND BUSES, OTHER THAN SCHOOL BUSES, WITH GVWR 4,536 KG (10,000 LB), USING OPTIONAL PASSENGER CAR REQUIREMENTS:

LOCATION AND DESCRIPTION OF MANUFACTURER PROVIDED REFERENCE POINT FOR EYE POINT MEASUREMENT:

LOCATION OF DRIVER SEATING REFERENCE POINT (SRP): _____

REMARKS:

COORDINATES (FROM MANUFACTURER REFERENCE POINT) OF DRIVER EYE POINTS:

	X	Y	Z
LEFT EYE			
RIGHT EYE			

RESULTS OF RECEIVING INSPECTION:
PASS _____
FAIL _____

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CONDITIONS:
GENERAL VEHICLE INFORMATION:

GVWR: _____ kg

FRONT GAWR: _____ kg

REAR GAWR: _____ kg

UNLOADED WEIGHT: _____ kg

CARGO WEIGHT: _____ kg

TOTAL RATED LOAD: _____ kg

BODY STYLE:_____

TRANSMISSSION:_____

ENGINE: _____

FRONT TIRE SIZE AND RECOMMENDED COLD INFLATION PRESSURE:

_____

REAR TIRE SIZE AND RECOMMENDED COLD INFLATION PRESSURE:

_____

DISPOSITION/ACTION/REMARKS:

RECORDED BY: _____ APPROVED BY: _____ DATE: _____

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DATA SHEET 2 (1 OF 2)
FMVSS 111 MOUNTING ADEQUACY TEST

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

MIRROR MOUNTING PROVIDES A STABLE SUPPORT:

	PASS	FAIL	CONDITIONAL
INSIDE REARVIEW MIRROR			
DRIVER'S SIDE OUTSIDE MIRROR			
PASS. SIDE OUTSIDE MIRROR			

CONDITIONS:
Driver outside mirror does not protrude farther that the widest part of the vehicle body except to the extent necessary to produce the required field-of-view (Pass/Fail)___

The driver side outside mirror is not obscured by the unwiped portion of the windshield (Pass/fail)___

OUTSIDE MIRRORS FREE OF SHARP POINTS OR EDGES (PASS/FAIL):_____

MIRROR IS ADJUSTABLE IN BOTH THE VERTICAL AND HORIZONTAL DIRECTIONS:

	PASS	FAIL	CONDITIONAL
INSIDE REARVIEW MIRROR			
DRIVER'S SIDE OUTSIDE MIRROR			
PASSENGER SIDE OUTSIDE MIRROR			

CONDITIONS:

DRIVER’S SIDE OUTSIDE MIRROR ADJUSTABLE FROM THE DRIVER’S SEATED POSITION (PASS/FAIL):_____

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DATA SHEET 2 (2 of 2)

ADJUSTMENT ANGLE	V+	V—	H+	H—
INSIDE REARVIEW MIRROR				
DRIVER'S SIDE OUTSIDE MIRROR				
PASS. SIDE OUTSIDE MIRROR				

CONDITIONS:

MPVs, TRUCKS AND BUSES, OTHER THAN SCHOOL BUSES, **NOT** CONFORMING TO PASSENGER CAR REQUIREMENTS

MIRROR PROVIDES A VIEW TO THE REAR ALONG BOTH SIDES OF THE VEHICLE:

	PASS	FAIL	CONDITIONAL
DRIVER'S SIDE OUTSIDE MIRROR			
PASS. SIDE OUTSIDE MIRROR			

CONDITIONS:

TEST RESULTS: PASS _____ FAIL _____

REMARKS:

RECORDED BY: _____ APPROVED BY: _____ DATE: _____

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DATA SHEET 3 (1 of 2)
FMVSS 111 FIELD-OF-VIEW TEST

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

INSIDE REARVIEW MIRROR (S5.1.1)

E Distance from center of mirror to projected eye point

A = Distance from rear of vehicle to projected eye point location =

X1 = Distance from rear of vehicle to field of view grid =

Z1 = Vertical distance to lowest point of field of view at distance X1

Z2 = Height of center of mirror =

X2 = Distance from rear of vehicle where the road surface is first visible:

$$X2 = [(Z2 \times X1) + (Z1 \times A)]/(Z2 - Z1) = \_\_\_\_\_ \text{(61 m maximum)}$$

YL, YR = Distance to driver's left or right of vehicle's centerline at the location of the field of view grid or markers

MONOCULAR DATA (ALR & ARL Are Angles)				
EYE LOCATION	YL	YR	ALR	ARL
LEFT EYE POINT	(YLL)	(YLR)		
RIGHT EYE POINT	(YRL)	(YRR)		

REMARKS:

DATA SHEET 3 (2 of 2)

CALCULATED HORIZONTAL AMBINOCULAR VIEW ANGLE (AB)

ALR = TAN [1YLR/(X1 + A)] ARL = TAN [1YRL/(X1 + A)]

ANGLE AB = ANGLE ALR + ANGLE ARL _____ (20 degrees minimum)

TEST RESULTS: PASS _____ ; FAIL _____;

DRIVER SIDE MIRROR (S5.2)

MIRROR OBSCURED BY UNWIPED PORTION OF WINDSHIELD? (Y/N):

HEIGHT OF TARGET DISC ON MIRROR:

DISTANCE OF TARGET DISC ON MIRROR FROM VEH. TANGENT PLANE:

TARGET DISC LOCATION RELATIVE TO VEH. TANGENT PLANE: Outboard
Inboard

ENTIRE TRIANGULAR TEST TARGET AREA ON SCREEN VISIBLE? (Y/N):

MIRROR PROTRUDES BEYOND VEH. TANGENT PLANE? (Y/N):

PROTRUSION REQUIRED TO MEET FIELD OF VIEW REQUIREMENTS? (Y/N):

TEST RESULTS: PASS _____ ; FAIL _____:

PASSENGER SIDE MIRROR (S5.3 or MFG. OPTION)

PASSENGER SIDE MIRROR TYPE (convex or unit magnification):

REMARKS:

RECORDED BY: _____ APPROVED BY: _____ DATE:_____

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DATA SHEET 4 (1of 4)

FMVSS 111 REFLECTANCE TEST – ALL MIRRORS

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

INSIDE MIRROR:

TYPE OF MIRROR:

2 POSITION PRISMATIC _____ ; ELECTROCHROMATIC_____

ELECTRO/MECHANICAL _____; LIQUID CRYSTAL _____

OTHER: (Specify) _____

DESCRIPTION OF TEST APPARATUS:

MIRROR DESCRIPTION:

VOLTAGE READING FROM CALIBRATION (Average Value):

VOLTAGE READING FROM LIGHT REFLECTED BY DAY MIRROR (Average Value):

REFLECTANCE (Day) = Voltage (Refl)/Voltage (Cal) = 0.___ x 100 = ___ percent
(Minimum Requirement = 35 percent)

VOLTAGE READING FROM CALIBRATION (Average Value) =

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DATA SHEET 4 (2 OF 4)

VOLTAGE READING FROM LIGHT REFLECTED BY NIGHT MIRROR (Average Value):

REFLECTANCE (Night) = Voltage (Refl)/Voltage (Cal) = 0.___ x 100 = ___ percent
(Minimum Requirement = 4 percent)

NOTE: If meter reading directly in percent is used, record only percent

INSIDE MIRROR WITH MULTIPLE REFLECTANCE LEVELS:

Does the mirror have a manual adjustment to achieve day mode operation?

YES _____ NO_____

If "NO" above, test for reflectance in the event of electrical failure:

VOLTAGE READING FROM CALIBRATION (Average Value) =

VOLTAGE READING FROM LIGHT REFLECTED BY ELECTRICALLY FAILED MIRROR (Average Value):

REFLECTANCE (Failed electrical, manually adjusted)
= Voltage (Refl)/Voltage (Cal) = 0.___ x 100 = ___ percent
(Minimum Requirement = 35 percent)

NOTE: If meter reading directly in percent is used, record only percent

OBSERVATIONS:

TEST RESULTS FOR INSIDE MIRROR:

PASS _____ FAIL _____

RECORDED BY: _____ APPROVED BY: _____ DATE:_____

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DATA SHEET 4 (3 OF 4)

DRIVER'S SIDE MIRROR:_____

DATE OF TEST:_____

TYPE OF MIRROR: UNIT MAGNIFICATION

OTHER (Specify):

MIRROR DESCRIPTION:

VOLTAGE READING FROM CALIBRATION (Average Value):

VOLTAGE READING FROM LIGHT REFLECTED BY MIRROR (Average Value):

REFLECTANCE = Voltage (Refl)/Voltage (Cal) = 0.___ x 100 = ___ percent
(Minimum Requirement = 35 percent)

NOTE: If meter reading directly in percent is used, record only percent

OBSERVATIONS:

TEST RESULTS FOR DRIVER SIDE MIRROR:

PASS _____ FAIL _____

REMARKS:

RECORDED BY: _____ APPROVED BY: _____ DATE: _____

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DATA SHEET 4 (4 OF 4)

PASSENGER'S SIDE MIRROR (if required):

DATE OF TEST:_____

TYPE OF MIRROR: UNIT MAGNIFICATION _____ CONVEX

OTHER (Specify):

DESCRIPTION OF TEST APPARATUS:

MIRROR DESCRIPTION:

VOLTAGE READING FROM CALIBRATION (Average Value):

VOLTAGE READING FROM LIGHT REFLECTED BY DAY MIRROR (Average Value):

REFLECTANCE (Day) = Voltage (Refl)/Voltage (Cal) = 0.___ x 100 = _____ percent
(Minimum Requirement = 35 percent)

NOTE: If meter reading directly in percent is used, record only percent

OBSERVATIONS:

TEST RESULTS FOR PASSENGER SIDE MIRROR:

PASS _____ FAIL_____

RECORDED BY: _____ APPROVED BY: _____ DATE:_____

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DATA SHEET 5
FMVSS 111 BREAKAWAY TEST - INSIDE REARVIEW MIRROR

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

MOUNTING OF MIRROR (INSIDE) DESCRIPTION:

(Requirement: the mirror shall deflect, collapse or break away when it is subjected to a force of 400 N or less)

TEST NO.	LOAD DIRECTION (Vertical/Horizontal)	MAXIMUM FORCE (N)	PASS	FAIL
1				
2				
3				
4				
5				
6				
7				

REMARKS:

FAILURE TYPE DESCRIPTION:

XY PLOTTER DATA I.D. NUMBER:

TEST RESULTS: PASS _____ FAIL _____

REMARKS:

RECORDED BY: _____ APPROVED BY: _____ DATE: _____

DATA SHEET 6 (1 of 3)
FMVSS 111 UNIT MAGNIFICATION AND CONVEX MIRROR TESTS

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

DESCRIPTION OF TEST APPARATUS:

DRIVER'S SIDE and INSIDE REARVIEW MIRRORS:

DRIVER SIDE MIRROR:

TEST POSITION	DIAL READINGS
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

INSIDE MIRROR:

TEST POSITION	DIAL READINGS
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

All dial indicator readings for unit magnification mirrors must be zero.

TEST RESULTS: PASS____ FAIL_____

DATA SHEET 6 (2 OF 3)

PASSENGER'S SIDE REARVIEW MIRROR:

CONVERSION DATA TABLE FROM SPHEROMETER DIAL READING TO RADIUS OF CURVATURE

TEST POSITION	DIAL READINGS (inches)	RADIUS OF CURVATURE (mm)	DEVIATION BETWEEN THE AVERAGE RADIUS OF CURVATURE AND THE TEST POSITION RADIUS OF CURVATURE (mm)	PERCENT DEVIATION FROM THE AVERAGE RADIUS OF CURVATURE
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Average Radius of Curvature - A summation of Column 3 divided by 10: _____(mm)			Greatest percent Deviation From the Average Radius of Curvature - From Column 5: %	

REMARKS:

DATA SHEET 6 (3 OF 3)

PASSENGER'S SIDE REARVIEW MIRROR

IF CONVEX, ARE THERE ANY DISCONTINUITIES IN THE SLOPE OF THE SURFACE OF THE MIRROR:

YES _____ NO _____

IF CONVEX, ARE THE WORDS, "**OBJECTS IN THE MIRROR ARE CLOSER THAN THEY APPEAR**" PRESENT?

YES _____ NO _____

IF CONVEX, MEASURE LETTER HEIGHT OF ABOVE WORDS: _____ mm

IF CONVEX, LETTERS ARE NOT LESS THAN 4.8 mm OR MORE THAN 6.4 mm HIGH
YES _____ NO _____ ____

IF CONVEX, THE AVERAGE RADIUS OF CURVATURE IS NOT LESS THAN 889 mm AND NOT MORE THAN 1651 mm:

YES _____ NO _____

IF CONVEX, THE GREATEST PERCENT DEVIATION FROM THE AVERAGE RADIUS OF CURVATURE IS ± 12.5 PERCENT:

YES _____ NO ____

IF UNIT MAGNIFICATION, ALL DIAL READINGS ARE ZERO +/_ 0.

YES_____ NO_____

TEST RESULTS:

PASS _____ FAIL _____

RECORDED BY: _____ APPROVED BY: _____ DATE: _____

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DATA SHEET 7
FMVSS 111 MIRROR REFLECTIVE SURFACE AREA TEST

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

DATA TABLE FOR SURFACE AREA

MIRRORS	AREA	REQUIREMENT MPVs, TRUCKS, BUSES (OTHER THAN SCHOOL), GVWR 4536 kg	REQUIREMENT MPVs, TRUCKS, BUSES (OTHER THAN SCHOOL), GVWR 4536 kg	PASS/ FAIL
Driver Outside		126 cm^2	323 cm^2	
Passenger Outside		126 cm^2	323 cm^2	

MIRRORS LOCATED SO AS TO PROVIDE DRIVER A VIEW TO THE REAR:
LEFT SIDE (Y/N):
RIGHT SIDE (Y/N):

TEST RESULTS: PASS _____ FAIL ____

REMARKS:

RECORDED BY: _____ APPROVED BY: _____ DATE: _____

DATA SHEET 8
FMVSS 111 TEST SUMMARY –
MPV'S, BUSES (NOT SCHOOL), AND TRUCKS
NOT TESTED TO PASSENGER CAR REQUIREMENTS

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

A. OUTSIDE DRIVER SIDE MIRROR

	PASS	FAIL	COMMENTS
STABLE SUPPORT			
ADJUSTABLE BY TILTING			
VIEW TO REAR			
SURFACE AREA			
REFLECTANCE			
UNIT MAGNIFICATION			

B. OUTSIDE PASSENGER SIDE MIRROR

	PASS	FAIL	COMMENTS
STABLE SUPPORT			
ADJUSTABLE BY TILTING			
VIEW TO REAR			
SURFACE AREA			
REFLECTANCE			
UNIT MAGNIFICATION			

RECORDED BY:_____ APPROVED BY:_____ DATE: _____

DATA SHEET 9
FMVSS 111 TEST SUMMARY –
MOTORCYCLES

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

A. OUTSIDE DRIVER SIDE MIRROR

	PASS	FAIL	COMMENTS
STABLE SUPPORT			
ADJUSTABLE BY TILTING			
SURFACE AREA			
REFLECTANCE			
UNIT or CONVEX MAGNIFICATION			

B. OUTSIDE PASSENGER SIDE MIRROR

	PASS	FAIL	COMMENTS
STABLE SUPPORT			
ADJUSTABLE BY TILTING			
SURFACE AREA			
REFLECTANCE			
UNIT or CONVEX MAGNIFICATION			

RECORDED BY:_____ APPROVED BY:_____ DATE: _____

REARVIEW IMAGE TESTING:

DATA SUMMARY SHEET
FMVSS 111 - REARVIEW IMAGE TESTING

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

	PASS	FAIL	COMMENTS
INSPECTION			
FIELD-OF-VIEW (S5.5.1, S6.2.1)			
TEST OBJECT IMAGE SIZE (S5.5.2, S6.2.2)			
RESPONSE TIME (S5.5.3, S6.2.3)			
LINGER TIME (S5.5.4, S6.2.4)			
DEACTIVATION (S5.5.5, S6.2.5)			
DEFAULT VIEW (S5.5.6, S6.2.6			
POST CORROSION DURABILITY (S5.5.7, S6.2.7)			
FIELD-OF-VIEW (S5.5.1, S6.2.1)			
TEST OBJECT IMAGE SIZE(S5.5.2, S6.2.2)			
POST HUMIDITY DURABILITY (S5.5.7, S6.2.7)			
FIELD-OF-VIEW (S5.5.1, S6.2.1)			
TEST OBJECT IMAGE SIZE(S5.5.2, S6.2.2)			
POST TEMPERATURE DURABILITY (S5.5.7, S6.2.7)			
FIELD-OF-VIEW (S5.5.1, S6.2.1)			
TEST OBJECT IMAGE SIZE(S5.5.2, S6.2.2)			

DATA SHEET 10 (1 of 2)
VEHICLE INSPECTION AND IDENTIFICATION

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

A. Reinstall Driver seat and remove vehicle stabilizing jack stands, if used previously_____ _

B. Identify any Defects or imperfections for visual display or camera_____

C. Visual image is detected by a single source (one camera) and is image is displayed at a single location_____

D. Location of inside visual display (within the interior rearview mirror, center console, etc.)_____

   Describe any protective screen/plastic or curved surface over the visual display?_____

   Specify if cover is removed to improve test measurement with ruler accuracy_____

E. Display Manufacturer/Model _____

F. Rearview display height, width, diagonal and reference to ground angle?_____

G. Display part of multi-function display?_____

H. Interior display meets manufacturer specification per Owner's Manual?_____

I. Describe any visual display adjustments for contrast, brightness, or resolution etc._____

J. Can the Rearview image be disabled by driver?_____ If yes, describe method _____

K. Interior display adjustable for rotation, angle, telescoping?_____

L. Is Interior display recessed ? ___ If so, how raised and time to do so_____

M. Transmission gear selector is lever type, rotational, or pushbutton _____

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DATA SHEET 10 (2 of 2)
VEHICLE INSPECTION AND IDENTIFICATION

N. Is transmission gear selector recessed and not functional until fully raised _____. If so, how raised and time to do so _____

O. Rearview image displayed in any gear position other than reverse_____?

P. Document Rearview image and default appearance. _____

Q. Default Rearview image automatically includes overlay, bird's eye view, path projection, messages, etc. Does overlay vary based on steering input_____

R. Can driver modify Rearview image once displayed (turn off, change view, add overlays, path projection, messages, etc.)_____ If so how accomplished _____

S. Height from ground to center point of rearview image lens_____

T. Lateral position of center point of rear camera measured from vehicle centerline_____

U. Angle in degrees of camera lens plane with reference to ground_____

V. Any vehicle body point which extends rearward of camera lens X-axis plane_____

W. Is the vehicle NOT equipped with a rear bumper _____

REMARKS:_____

TEST RESULTS: PASS_____ FAIL_____

RECORDED BY: _____ APPROVED BY: _____ DATE: _____

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DATA SHEET 11

FIELD-OF-VIEW (S5.5.1/S6.2.1) (1 of 2)

VEH. MY/MAKE/MODEL/BODY STYLE: _____

NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____

TEST LABORATORY: _____; CONTRACT NO.: _____

DATE OF TEST: _____

GENERAL VEHICLE INFORMATION:

GVWR:	_____	kg
FRONT GAWR:	_____	kg
REAR GAWR:	_____	kg
UNLOADED WEIGHT:	_____	kg
CARGO WEIGHT:	_____	kg
TOTAL RATED LOAD:	_____	kg

Measured Vehicle Interior Temperature_____

Measured Exterior Ambient Temperature_____

Measured Ambient Illumination LUX : Roof ____Top surface of Cylinder B ____ (Required 7000 to 10000 LUX)

Measured tire inflation pressure_____

Verify Fuel Tank is full:_____

Ballast added to vehicle for occupant load_____

Rear hatches or trunk lids closed and latched:_____

Driver seat longitudinal adjustable position – placed at mid-point of travel or closest adjustment to the rear of midpoint?_____

Driver seat adjusted to lowest point of vertical travel?_____

Driver seat cushion have tilting feature and set to mid-tilt?_____

Manufacturer supplied nominal seat back angle and/or seat back angle resulting in H-point machine torso weight hanger angle of 25 degrees_____

Driver seat back adjusted so that vertical portion of the H-point machine torso weight hanger is at 25 degrees?_____

Interior Display adjustment if equipped with rotational mounting adjustment?_____
Steering wheel adjustments made_____
If so equipped, visual display settings for contrast, brightness, and resolution_____

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DATA SHEET 11
FIELD-OF-VIEW (S5.5.1/S6.2.1) (2 of 2)
Coordinates measured from H-point_____, or fixed point on vehicle body_____ :

	X	Y	Z
H- Hip H-Point			
J - Head/Neck Joint Center			
J2 – Orgin of Mf rotation			
M_f Forward-Looking Eye Midpoint			
M_R – Eye Mid-point Rotated			
M_R – Eye Mid-point Rotated (If ***manufacture supplied***)			

Measured shortest straight-line distance between M_R and the Center of the display___ = (a_{eye})
Manufacturer supplied a_{eye} value _____

PHOTOGRAPHIC DATA EXTRACTION:

Field-of-View from photograph (S5.5.1):

1. Is a 150 mm wide portion along circumference visible for:
   Test Object F_____
   Test Object G _____
   YES___ Pass, NO____ Fail

2. The full width and height of test objects visible:
   Test Object A____
   Test Object B____
   Test Object C____
   Test Object D____
   Test Object E____
   YES___ Pass, NO____ Fail

Indicate if any test objects are obscured by a default overlay_____

[Include photographic documentation in final report]

REMARKS:_____
TEST RESULTS: PASS_____ FAIL_____
RECORDED BY: _____ APPROVED BY: _____ DATE: _____

DATA SHEET 12 (S5.5.2, S6.2.2)
TEST OBJECT IMAGE SIZE

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

Image Size from photograph (S5.5.2):

Apparent length of 50mm delineated section of the in-photo ruler_____

Horizontal width of the colored band on the upper portion of test objects:

Test Object A_____= DA
Test Object B_____=DB
Test Object C_____=DC

Scaling Factor:
Apparent Length/ 50mm = _____ S scale

Actual distance from the rotated eye midpoint location (Mr) to the center of the Rearview image = _____

Visual Angle subtended by test Objects:

For Test object:

Test Object A_____ arc min.
Test Object B_____ arc min.
Test Object C_____ arc min.

,

Each individual test object horizontal width not less than 3 minutes of arc?

YES___ Pass, NO____ Fail

Average for A,B,C, =_____
Not less than 5 minutes of arc YES___ Pass, NO____ Fail

Include data reduction for arc min determination if pixel measurements used.
[Include photographic documentation in final report]

REMARKS:_____
TEST RESULTS: PASS_____ FAIL_____
RECORDED BY: _____ APPROVED BY: _____ DATE: _____

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DATA SHEET 13 (1 of 3)
RESPONSE TIME (S5.5.3, S6.2.3)

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

Measured vehicle interior compartment Temperature_____ (Required 15 to 25 C)

Measured Exterior Ambient Temperature_____

Measured Ambient Illumination LUX @ Roof Center_____ Test Object B Surface_____(Required 7000 to 10000LUX)

Method used to establish rear visibility system is at **lowest** power resting state_____ (***manufacturer supplied*** information?)

Method used to establish time zero for door opening (interior light trigger, trip wire switch, video, etc.)_____

Method used to establish Engine started _____

Method used to establish time zero for gear selector in reverse (rear brake lights, video etc)_____

If rear brake lights utilized, indicate time lag from selector in reverse and rear backing lights activated _____

Method used to establish visual display activation (driver hand trigger, photo receptor, video, etc.)_____

Door opening, door closed engine started, transmission gear shift selector into reverse (Attempt as close to 4 seconds – but not less than)

ATTEMPT	Time interval from door opening, door closed, engine started, and vehicle selector into reverse position (t = 4 seconds)	Time interval from vehicle selector into reverse gear until Rearview image is displayed.	Complies if image display less than 2 seconds after gear selector into reverse
1			
2			
3			
4			
5			

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DATA SHEET 13 (2 of 3)
RESPONSE TIME (S5.5.3, S6.2.3)

Door opening, door closed, engine started, gear shift selector into reverse (Attempt for times from 4 to 6 seconds)

ATTEMPT	Time interval from door opening, door closed, engine started, and vehicle selector into reverse position ($4 \leq t \leq 6$ seconds)	Time interval from vehicle selector into reverse gear until Rearview image is displayed.	Complies if image display less than 2 seconds after gear selector into reverse
1			
2			
3			
4			
5			

Door opening, door closed, engine started, gear shift selector into reverse (Attempt for times equal to 6 seconds)

ATTEMPT	Time interval from door opening, door closed, engine started, and vehicle selector into reverse position ($t = 6$ seconds)	Time interval from vehicle selector into reverse gear until Rearview image is displayed.	Complies if image display less than 2 seconds after gear selector into reverse
1			
2			
3			
4			
5			

For **INFORMATION** purposes only - Door opening, door closed, engine started, gear shift selector into reverse (Attempt for times greater than 6 seconds)

ATTEMPT	Time interval from door opening, door closed, engine started, and vehicle selector into reverse position (time greater than 6 seconds)	Time interval from vehicle selector into reverse gear until Rearview image is displayed.	Complies if image display less than 2 seconds after gear selector into reverse
1			
2			
3			
4			
5			

DATA SHEET 13 (3 of 3)
RESPONSE TIME (S5.5.3, S6.2.3)

With vehicle at any operational state such as cold engine, repeat the four tables above.

OPTIONAL Data collection charts for above tests:

ATTEMPT	Door open Time = 0 (T_0)	Door Closed (T_1)	Engine Started (T_2)	Gear Selector into Reverse (T_3)	Required Image Displayed (T_4)	Response Time ($T_4 - T_3$)
1	0					
2	0					
3	0					
4	0					
5	0					

If response time determination utilizes video system frame counts, include that information in the final report similar to:

EVENT	Frame Count	Time (sec)
Door Open		
Door Closed		
Ignition activation		
Gear selector in reverse		
Rearview image displayed		

REMARKS:_____

TEST RESULTS: PASS_____ FAIL_____

RECORDED BY: _____ APPROVED BY: _____ DATE: _____

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DATA SHEET 14 (1 of 2)
LINGER TIME (S5.5.4, S6.2.4)

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

Measured Exterior Ambient Temp._____

Manufacturer Selection – COTR Supplied Information:

Indicate Termination of backing event or combinations thereof	
Forward Speed 10 mph	
Forward Distance 10 feet	
Forward Continuous Time Travel 10 Seconds	

Does driver have option to select when Rearview image is extinguished e.g. original setting – extinguished when vehicle out of reverse, or select when vehicle has travelled forward 10 meters, reached 10 mph , forward travel 10 seconds, or during interval prior to backing event termination? If so describe operation and how change made and if permanent or defaults to original setting after completion of backing event._____

Indicate method used by laboratory to determine vehicle speed, distance and time, and how events were triggered:
(GPS, Video, etc.)_____

For each of the following tests for speed, distance and time, place vehicle transmission selector into reverse gear, travel rearward for a short distance, stop the vehicle, shift gear selector to a forward position and travel forward:

SPEED-

Attempt	Rearview image is present with transmission in reverse gear Yes/no	Forward Vehicle Speed after transmission selector is moved to a forward gear at which time the Rearview image is extinguished
1		
2		
3		
4		
5		

DATA SHEET 14 (2 of 2)
LINGER TIME (S5.5.4, S6.2.4)

DISTANCE-

Attempt	Rearview image is present with transmission in reverse gear Yes/no	Forward Vehicle Distance travelled from the point at which the transmission selector is moved to a forward gear and Rearview image is extinguished
1		
2		
3		
4		
5		

TIME-

Attempt	Rearview image is present with transmission in reverse gear Yes/no	Continuous Forward Vehicle Movement Elapsed Time travelled from time at which the transmission selector is moved to a forward gear and the Rearview image is extinguished.
1		
2		
3		
4		
5		

If linger time determination utilizes video system frame counts, include that information in the final report .

COMPLIES if image extinguished ≤ 10 mph, or ≤ 10 meters travelled, or ≤ 10 seconds continuous forward travel:

YES_____ NO_____

REMARKS:_____

TEST RESULTS: PASS_____ FAIL_____

RECORDED BY: _____ APPROVED BY: _____ DATE: _____

DATA SHEET 15
DEACTIVATION (S5.5.5, S6.2.5)

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

With vehicle transmission selector placed and maintained in **reverse gear**, activate any provided driver actuated switch/button/touch screen to extinguish or modify the required Rearview image.

Attempt	Switch/Button Location	Image Extinguished or modified?	If applicable, describe modified view
1			
2			
3			

With vehicle transmission selector placed into a **neutral or forward** gear after reverse, activate any provided driver actuated switch/button/touch screen to extinguish or modify the Rearview image prior to end of backing event and describe and verify functionality (assuming gear out-of-reverse does not deactivate image)

Attempt	Switch/Button Location	Image Extinguished or modified?	If applicable, describe modified view
1			
2			
3			

Is the required Rearview image capable of being deactivated or modified **during** the backing event with the transmission selector in reverse and **absent** any driver action (excluding transmission selector into a position other than reverse?) Not permissible. If so describe._____

Is the required Rearview image capable of being disabled by the driver or otherwise **prior to** the start of the backing event? Not Permissible. If so describe. _____

REMARKS:_____

TEST RESULTS: PASS_____ FAIL_____

RECORDED BY: _____ APPROVED BY: _____ DATE: _____

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DATA SHEET 16 (1 of 2)
DEFAULT VIEW (S5.5.6, S6.2.6)

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

Is the required Rearview image capable of being deactivated or modified after initiation of the backing event:_____
If so, describe_____

To determine that rear visibility system defaults to required image under standard operating conditions, conduct test as shown below:

Attempt #	Engine off, ignition key out, vehicle then started and backing event initiated and completed. Motor turned off. Restart vehicle initiate another backing event.	Complies if defaults to required Rearview image each time.
1		
2		
3		
4		
5		

To determine that rear visibility system defaults to required image after consecutive backing events, conduct test as shown below:.

Attempt #	Engine on, backing event initiated and completed. Engine still running – start another backing event.:	Complies if defaults to required Rearview image each time.
1		
2		
3		
4		
5		

Note if the default display includes any automatic overlays and if so, does the overlay obscure any of the test object cylinders (not permissible)_____

Note if the driver can manually add overlays to the image and if so describe_____

DATA SHEET 16 (2 of 2)
DEFAULT VIEW (S5.5.6, S6.2.6)

To determine that rear visibility system defaults to required image after a previous modification was made to the Rearview image during the backing event, complete the following tests:

Attempt #	During backing event extinguish or modify the required Rearview image. Turn off engine and remove ignition key. Start vehicle and initiate another backing event.	Identify when driver action taken: Prior to or after transmission removed from reverse.	Identify resulting image: Off, warning message, distance markers, vehicle trajectory, wide angle view, etc.	Complies if defaults to required Rearview image.
1				
2				
3				
4				
5				

Attempt #	During backing event extinguish or modify required Rearview image. Engine still running, initiate another backing event.	Identify when driver action taken: Prior to or after transmission removed from reverse.	Identify resulting image: Off, warning message, distance markers, vehicle trajectory, wide angle view, etc.	Complies if defaults to required Rearview image.
1				
2				
3				
4				
5				

Is the required Rearview image capable of being deactivated or modified prior to initiation of the backing event and that altered condition remains once the backing event starts _____ (not permissible – at start of backing event rear image must be present regardless of actions taken prior to backing event.)

[INCLUDE PHOTOGRAPHIC DOCUMENTATION IN FINAL REPORT if applicable for default view, overlays if present etc.]

REMARKS:_____

TEST RESULTS: PASS_____ FAIL_____

RECORDED BY: _____ APPROVED BY: _____ DATE: _____

DATA SHEET 17 (1 of 2)
DURABILITY (S5.5.7, S6.2.7)

VEH. MY/MAKE/MODEL/BODY STYLE: _____
NHTSA NO.: _____; VEH. TYPE: _____; VIN: _____
TEST LABORATORY: _____; CONTRACT NO.: _____
DATE OF TEST: _____

Model, Manufacturer of camera(s)_____

Plane of rear Camera Lens Angle with reference to ground	
Vertical height from ground to center of camera lens	
Lateral position of camera lens center	
Number of connecting camera cables	
Number of camera cable connector pins	
Method of Camera attachment to Vehicle (screw, rivet, etc.)	
OEM sealant or gaskets used on vehicle for sealing camera to rear of vehicle	

Indicate if manufacturer supplied environmental test fixture was utilized_____

Describe method utilized to condition exposed portion of rearview image (camera inserted into plexi-glass box, silicon sealant, etc. _____

Describe how associated wiring, connectors, and any other exposed portions of the Rearview image system are prepared for conditioning _____

VISUAL OBSERVATION:

	Pre Durability Testing	POST Corrosion Exposure	POST Humidity Exposure	POST Temperature Exposure
Camera housing condition				
Camera Connector and wiring				
Camera lens Clarity				
Signs of lens Corrosion				
Signs of Lens Water intrusion				

Include **Pre and post durability test photos** of camera and associated rearview imaging system hardware after corrosion, after humidity and after temperature exposure.

DATA SHEET 17 (2 of 2)
DURABILITY (S5.5.7, S6.2.7)

Include photographs of camera installed on vehicle prior to and after durability conditioning.

POST CORROSION CONDITIONING

FIELD-OF-VIEW (S5.5.1/S6.2.1)

REPEAT USE OF DATA SHEET 11

POST CORROSION CONDITIONING

TEST OBJECT IMAGE SIZE (S5.5.2/S6.2.2)

REPEAT USE OF DATA SHEET 12

POST HUMIDITY CONDITIONING

FIELD-OF-VIEW (S5.5.1/S6.2.1)

REPEAT USE OF DATA SHEET 11

POST HUMIDITY CONDITIONING

TEST OBJECT IMAGE SIZE (S5.5.2/S6.2.2)

REPEAT USE OF DATA SHEET 12

POST TEMPERATURE CONDITIONING

FIELD-OF-VIEW (S5.5.1/S6.2.1)

REPEAT USE OF DATA SHEET 11

POST TEMPERATURE CONDITIONING

TEST OBJECT IMAGE SIZE (S5.5.2/S6.2.2)

REPEAT USE OF DATA SHEET 12

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17. FORMS

LABORATORY NOTICE OF TEST FAILURE TO OVSC

FMVSS NO.: 111 TEST DATE: _____

LABORATORY: _____

CONTRACT NO.: _____ DELV. ORDER NO.:____

LABORATORY PROJECT ENGINEER'S NAME: _____

TEST VEHICLE DESCRIPTION: _____

VEH. NHTSA NO.: _____ VIN: _____

VEHICLE MANUFACTURER:_____

TEST FAILURE DESCRIPTION:

FMVSS 111 REQUIREMENT, PARAGRAPH ____ :

NOTIFICATION TO NHTSA (COTR):

DATE: _____ BY: _____

REMARKS:

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MONTHLY **TEST STATUS** REPORT, FMVSS 111
DATE OF REPORT:

No.	VEHICLE NHTSA No., MAKE & MODEL	COMPLIANCE TEST DATE	PASS/ FAIL	DATE REPORT SUBMITTED	DATE INVOICE SUBMITTED	INVOICE PAYMENT DATE
1						
2						
3						
4						
5						
6						
7						
8						
9						

MONTHLY **VEHICLE STATUS** REPORT, FMVSS 111
DATE OF REPORT:

No.	VEHICLE NHTSA No., MAKE & MODEL	DATE OF DELIVERY	TEST COMPLETE DATE	VEHICLE SHIPMENT DATE	CONDITION OF VEHICLE
1					
2					
3					
4					
5					

Instrumentation and Calibration (12 Month Maximum Interval)

Test Equipment List and Calibration (example)

Rearview Mirror Testing

Equipment	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
Computer					
Interior Camera Mount Fixture					
A/D Interface					
Signal Conditioner					
Load cell					
Inclinometer					
Linear Potentiometer					
Precision Steel Scale					
35 mm Still Camera					
Reflectometer					
Spherometer					

Rearview image Testing

Equipment	Description	Model No.	Serial No.	Calibration Date	Calibration Due Date
Computer					
J826-1995 Manikin					
Camera to Manikin Bracket					
Light Intensity Meter					
Fifth wheel					
GPS					
A/D Interface					
Signal Conditioner					
Linear Potentiometer					
Precision Steel Scale					
35 mm Still Camera					
Video Camera (s)					
Corrosion Test Chamber					
Humidity Test Chamber					
Temperature Test Chamber					

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18. APPENDICES.

APPENDIX 1

H-Point Determination for 50th Percentile Male Dummy (Driver)

NHTSA No. _____ Test Date: _____

Laboratory: _____Test Technician(s): _____

__Driver Designated Seating Position

__1. Position the seat's adjustable lumbar supports so that the lumbar support is in its lowest, retracted or deflated adjustment position. (S8.1.3)

__N/A – No lumbar adjustment

__2. Position any adjustable parts of the seat that provide additional support so that they are in the lowest or most open adjustment position. (S16.2.10.2)

__ N/A – No additional support adjustment

__3. Use all the seat controls that have any affect on the fore-aft movement of the seat to move the seat cushion to the rearmost position. **Mark** this position. (8/31/95 legal interp to Hogan and Hartson)

__4. Use all the seat controls that have any affect on the fore-aft movement of the seat to move the seat cushion to the foremost position. **Mark** this position. (8/31/95 legal interp to Hogan and Hartson)

__5. **Mark** each fore-aft position so that there is a visual indication when the seat is at a particular position. For manual seats, **mark** each detent. For power seats, **mark** only the rearmost, middle, and foremost positions. Label three of the positions with the following: F for foremost, M for mid-position (if there is no mid-position, label the closest adjustment position to the rear of the mid-point), and R for rearmost. Determine the mid fore-aft seat position based on the foremost and rearmost positions determined in items 3 and 4. (8/31/95 legal interp to Hogan and Hartson)

__6. Move the seat to the mid position.

__7. While maintaining the mid position, move the seat to its lowest position. **Mark** the height position. For seats with adjustable seat cushions, use the manufacturer's recommended seat cushion angle for determining the lowest height position.

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__8. Visually **mark** the seat back angle, if adjustable, at the manufacturer's nominal design riding position for a **50th percentile adult male** in the manner specified by the manufacturer.
__ N/A – No seat back angle adjustment

__Previously marked during Data Sheet 14.1 go to 9

Manufacturer's design seat back angle _____

__9. Is the seat a bucket seat?

__Previously marked during data sheet 14.1. This form is complete.

__Yes, go to 10 and skip 11

__No, go to 11 and skip 10

__10. Bucket seats:

Locate and **mark** for future reference the longitudinal centerline of the seat cushion. The intersection of the vertical longitudinal plane that passes through the SgRP and the seat cushion upper surface determines the longitudinal centerline of a bucket seat cushion. (S10.4.1.2 and S16.3.1.10)

__11. Bench seats (complete ONLY the one that is applicable to the seat being marked):
11.1 Driver Seat

Locate and **mark** for future reference the longitudinal line on the seat cushion that marks the intersection of the vertical longitudinal plane through the centerline of the steering wheel and the seat cushion upper surface. (S10.4.1.1)

11.2 Passenger Seat (NA)

__12. Place a 910 mm^2 piece of muslin cotton cloth over the seat area. (The muslin cloth shall be comparable to 48 threads/in^2 and density of 2.85 lb/yd.) Tuck the muslin cloth in a sufficient amount to prevent hammocking of the material.

__13. Place the seat and back assembly of the H-Point machine at the centerline of the seat as determined in item 10 or 11.

__14. Install the lower leg, and foot segments.

__15. Set the length of the lower leg segment at 16.3 inches and the length of the thigh bar at 15.8 inches.

__16. Leg and foot placement

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__16.1 Driver Designated Seating Position

__16.1.1 Insert the pin so that the foot angle is never less than 87 degrees.

__16.1.2 Place the right foot on the undepressed accelerator pedal with the sole of the foot on the pedal and the heel as far forward as allowable. Do not place the heel on the toe board.

__16.1.3 Adjust the left leg to be the same distance from H-point machine centerline as the right leg.

__16.1.4 With the T-bar level, place the left foot on the toe board with the rearmost point of the heel resting on the floor pan as close as possible to the point of intersection of the planes described by the toe board and the floor pan and not on the wheel well projection. If the foot cannot be positioned on the toe board, set it on the floor pan.

__Foot on toe board

__Foot on floor pan

__16.2 Passenger Designated Seating Position (NA)

__17. Apply the lower leg weights.

__18. Apply the thigh weights.

__19. Tilt the back pan forward against the forward stop and draw the H-point machine away from the seatback using the T-bar.

__20. Repositioning the back pan

__20.1 Allow the H-point machine to slide rearward until a forward horizontal restraining load on the T-bar is no longer required due to the seat pan contacting the seat back.

__The seat pan does not slide rearward. Go to 20.2

__20.2 Slide the H-point machine rearward by a horizontal rearward load applied at the T-bar until the seat pan contacts the seat back.

__21. Apply a 10 kg load at the intersection of the hip angle quadrant and the T-bar housing along a line from the above intersection to a point just above the thigh bar housing.

__22. Again apply a 10 kg load at the intersection of the hip angle quadrant and the T-bar housing along a line from the above intersection to a point just above the thigh bar housing.

__23. Carefully return the back pan to the seat back.

__24. Install the right and left buttock weights.

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__25. Install the eight torso weights alternately the installation between right and left.

__26. Tilt the back pan forward until the stop is contacted.

__27. Rock the H-point from side to side over a 10degree arc (5 degrees to each side of the vertical centerline) for three complete cycles. Restrain the T-bar during rocking so that the seat pan does not change position. Minimize any inadvertent exterior loads applied in a vertical or fore-aft direction. The feet are free to move during this rocking motion.

__28. Without applying a forward or lateral load lift the right foot off the floor the minimum amount necessary until no additional forward foot movement is obtained.

__29. Lower the right foot until the heel is in contact with the floor pan and the ball of the foot is in contact with the floor, toe board, or undepressed accelerator pedal.

__30. Without applying a forward or lateral load lift the left foot off the floor the minimum amount necessary until no additional forward foot movement is obtained.

__31. Lower the left foot until the heel is in contact with the floor pan and the ball of the foot is in contact with the floor or toe board.

__32. Is the seat pan level?

__Yes. Go to 34

__No. Go to 33

__33. Apply a sufficient lateral load to the top of the seatback pan to level the H-point machine seat pan on the seat.

__34. Holding the T-bar to prevent the H-point from sliding forward on the seat cushion, return the seatback pan to the seatback.

__35. Holding the T-bar to prevent the H-point from sliding forward on the seat cushion, apply sufficient rearward force perpendicular to the back angle bar just above the torso weights to increase the hip angle 3 degrees. Minimize the exterior downward or side forces applied to the H-point machine. Release the force. Repeat this step until the hip angle readout is identical. Complete as many force applications as necessary and record the results in the following table:

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Force Application	Hip Angle
1	
2	
3	
4	
5	

__36. Is the H-point machine level?

__Yes, go to 37.

__No, relevel. Go back to item 26 and repeat using a new data sheet.

__37. Record the H-point location.

Describe and mark the measuring reference point. _____

x direction measurement _____

z direction measurement _____

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APPENDIX 2. A DERIVATION OF THE EQUATION USED TO CALCULATE THE SUBTENDED VISUAL ANGLE OF EACH TEST OBJECT

Assumption 1: The plane upon which the image is displayed (may be a mirror, a video display, or some other surface) is, at least locally, flat. (This works, even for convex mirrors, because the image being analyzed is small compared to the radius of curvature of the mirror, video display, or other surface.)

Assumption 2: The plane upon which the image is displayed (may be a mirror, a video display, or some other surface) is perpendicular to the driver's line of sight at some point. While this is not in general exactly true, the difference from perpendicularity has been typically small in systems that NHTSA has tested to date.

Figure 1 shows the geometry of the situation and defines the symbols used.

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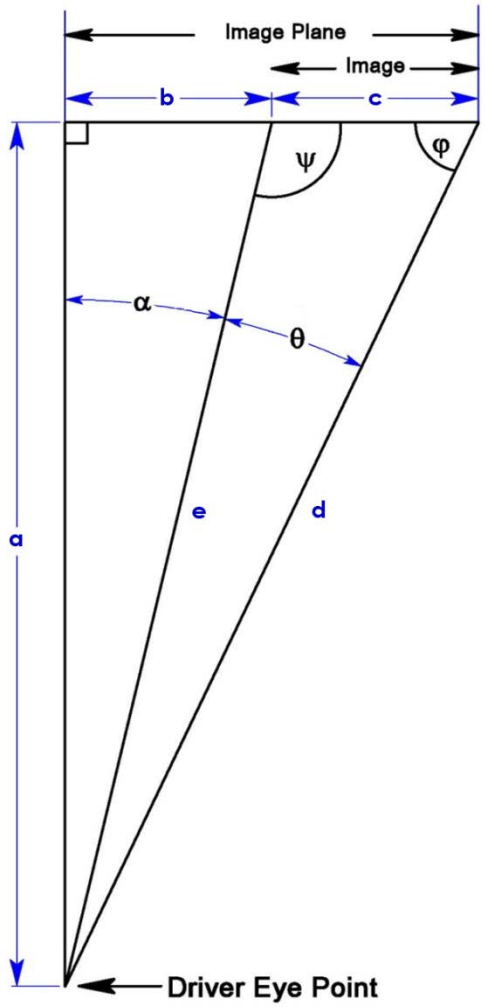

Figure 1. Geometry Used to Derived Subtended Visual Angle Equation

Definitions:

In the figure, c is the width of the actual image in the Image Plane, a is the perpendicular distance from the Driver's Eyepoint to the Image Plane, and Greek letters denote angles. The subtended visual angle that is to be determined is denoted by θ.

Case 1: One Edge of Image at Perpendicular Point

This is a special case in which one edge the image is at the point in the Image Plane that is intersected by the perpendicular line emanating from the Driver's Eyepoint. In the figure, this corresponds to the angle, α, and the distance, b, being zero. For this case, using the standard trigonometric definition of tangent,

$$\tan\theta = \frac{c}{a} \qquad (1)$$

Equation (1) can be rearranged to:

$$\theta = \tan^{-1}\frac{c}{a} \qquad (2)$$

Case 2: One Edge of Image Not at Perpendicular Point

This is a more general case in which an edge the image is no longer assumed to be at the point in the Image Plane that is intersected by the perpendicular line emanating from the Driver's Eyepoint. Then, from the Law of Sines, the following equation is true:

$$\frac{\sin\theta}{c} = \frac{\sin\Psi}{d} = \frac{\sin\varphi}{e} \qquad (3)$$

Where

$$e = \sqrt{b^2 + a^2} \qquad (4)$$

$$d = \sqrt{(c+b)^2 + a^2} \qquad (5)$$

$$\Psi = 90° + \alpha \qquad (6)$$

$$\alpha = \tan^{-1}\frac{b}{a} \qquad (7)$$

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$$\varphi = 90° - \alpha - \theta \qquad (8)$$

Using Equations (6) and (8), Equation (3) can be reduced to:

$$\frac{\sin\theta}{c} = \frac{\cos\alpha}{d} = \frac{\cos(\alpha + \theta)}{e} \qquad (9)$$

It is difficult to determine the exact point on the Image Plane that is precisely perpendicular to the line emanating from the Driver's Eyepoint. Therefore, it is practically impossible to accurately measure the distance e. To allow for an approximate solution of Equation (9), to additional assumptions will be made:

Assumption 3: The distance c is much smaller than the distance a. Therefore, the angle θ will be small (less than 1 degree for the situations being considered).

Assumption 4: The distance b is much smaller than the distance a. Therefore, the angle α will be small (less than 1 degree for the situations being considered).

Using Assumptions 3 and 4, the quantity $(b + c)$ is also much smaller than the distance d.

Assumptions 3 and 4 were used to simplify the $\cos\alpha/d$ term in Equation (9). Each part of this term was expanded in a MacLaurin series in powers of c/a and b/a and second order, or higher, terms deleted as too small to matter.

Start with simplifying Equation (5):

$$d = a\sqrt{1 + f^2} \qquad (10)$$

where

$$f = \frac{b + c}{a} \qquad (11)$$

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As stated above,

$$f \ll 1 \qquad (12)$$

To expand c in a MacLaurin series, the first two derivatives of c with respect to f need to be calculated and evaluated at $f = 0$

$$\frac{dd}{df} = \frac{fa}{\sqrt{1+f^2}} \qquad (13)$$

$$\left.\frac{dd}{df}\right|_{f=0} = 0 \qquad (14)$$

$$\frac{d^2d}{df^2} = \frac{a}{\sqrt{1+f^2}} - \frac{f^2a}{\sqrt{(1+f^2)^3}} \qquad (15)$$

$$\left.\frac{d^2d}{df^2}\right|_{f=0} = a \qquad (16)$$

$$d = a + \frac{a}{2} f^2 + \ Higher\ Order\ Terms \qquad (17)$$

Neglecting all terms of order f^2 or higher, compared to a, yields

$$d \cong a \qquad (18)$$

Next, simplify Equation (7) using the standard MacLaurin series expansion for arctangent:

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$$\alpha = \tan^{-1}\frac{b}{a} = \frac{b}{a} - \frac{1}{3}\left(\frac{e}{a}\right)^3 + Higher\ Order\ Terms \qquad (19)$$

Neglecting all terms of order $\left(b/a\right)^2$ or higher yields

$$\alpha \cong \frac{b}{a} \qquad (20)$$

Using the standard MacLaurin series expansion for cosine:

$$\cos\alpha = 1 - \frac{1}{2}\left(\frac{b}{a}\right)^2 + Higher\ Order\ Terms \qquad (21)$$

Neglecting all terms of order $\left(b/a\right)^2$ or higher yields

$$\cos\alpha \cong 1 \qquad (22)$$

The $\cos\alpha/d$ term in Equation (9) therefore can be simplified, based to the assumptions made, to $1/a$. The first two terms in Equation (9) have, therefore, been reduced to:

$$\frac{\sin\theta}{c} = \frac{1}{a} \qquad (23)$$

or

$$\theta = \sin^{-1}\frac{c}{a} \qquad (24)$$

Two equations, Equations (2) and (24), have now been developed for the subtended visual angle θ. Equation (2) is exact but only applies to the special case in which one edge the image is at the point in the Image Plane that is intersected by the perpendicular line emanating from the Driver's Eyepoint. Equation (24) applies to the more general case in which one edge the image

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is **not** at the point in the Image Plane that is intersected by the perpendicular line emanating from the Driver's Eyepoint, however, it relies on small angle approximations. Note that for small angles, both Equations (2) and (24) are identical since

$$\sin^{-1}\theta \cong \tan^{-1}\theta \cong \theta \qquad (25)$$

Therefore, both Equations (2) and (24) reduce, for small angles to:

$$\theta = \frac{10800}{\pi} \times \frac{c}{a} \qquad (26)$$

Where $10800 / \pi$ is the correct constant to convert $^{c}/_{a}$ into minutes of arc. Equation (26) provides a third equation for determining the subtended visual angle.

Each of Equations (2), (24), and (26) was used to calculate a subtended visual angle for a given $^{c}/_{a}$ value. The $^{c}/_{a}$ value used was 0.00145444053054153000. The resulting values of θ were 4.999994711511520 minutes of arc from Equation (2), 5.000000000000000 minutes of arc from Equation (24), and 4.999998237167900 minutes of arc from Equation (26).

The above calculations demonstrate two things:

1. For the angles of interest, there is a minimal difference in the subtended visual angle that was calculated with a maximum difference of 0.000005288488482 minutes of arc. This sixth decimal place difference is well beyond the accuracy of the procedures used to measure a and d. Therefore, from an accuracy point of view, it does not matter which of these equations is used.
2. Equation (24), which utilized the arcsine function, calculated the largest value of θ. Therefore, this is the equation that helps the most when trying to fare well in an image quality assessment based on a minimum subtended visual angle.

Based on the above discussion, the preferred equation for calculating the subtended visual angle is:

$$\theta = \sin^{-1}\frac{c}{a} \qquad (24)$$

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In the case where Assumption 2 is not true (the plane upon which the image is displayed is not perpendicular to the driver's line of sight, the subtended angle will be calculated based on the apparent size of the object in the plane in which the image is displayed. As the ultimate goal of measuring subtended angles is to determine how much area the reflected object occupies in the driver's field of view, the apparent size is the correct measurement. Define e as zero and the projection of α onto a plane perpendicular to the line of sight will be designated as α' (see Figure 28). In this case Equation 2 can be used:

$$\theta = \tan^{-1}\frac{c'}{a} \qquad (27)$$

Using the small angle approximation, Equation 27 becomes:

$$\theta = \sin^{-1}\frac{c'}{a} \qquad (28)$$

Which is the same as Equation 24 with α' substituting for α.

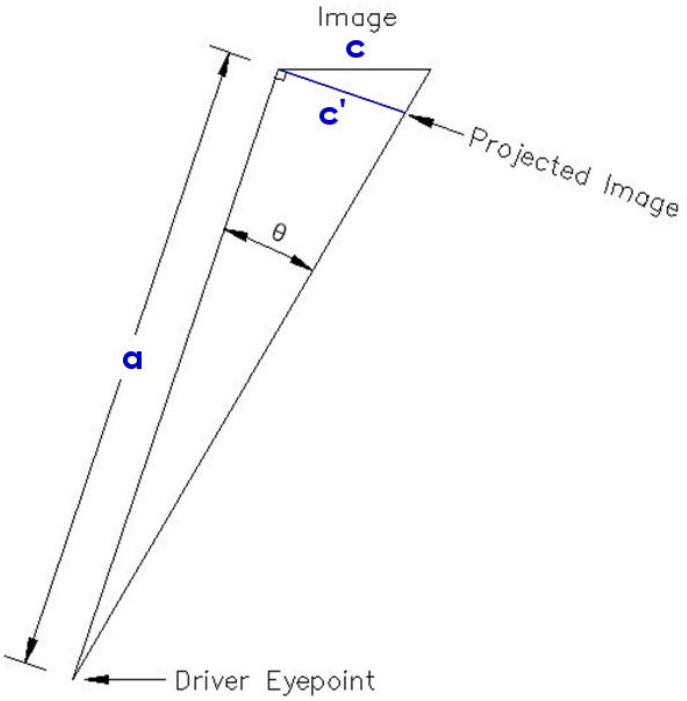

Figure 2. Calculation of Subtended Visual Angle for Case Where Plane in Which Image is Displayed is Not Perpendicular to Driver's Line of Sight

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