



Optical and Vision Evaluation Procedure

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1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. The purpose of this standard is to evaluate the optical performance of the glazing systems (windshield, and backlite or liftgate glass) when installed in a vehicle. The ultimate goal is to identify boundary samples to be returned to the supplier for future reference as minimally-acceptable sets of glass. Additionally, the evaluation should be used to identify any concerns with the optical performance of the glass so that they can be corrected before Start of Regular Production (SORP).

Further, the secondary purpose for this test procedure is to help improve the quality of each evaluation and to improve the consistency between evaluations across the whole Fixed Glass organization (all programs and all suppliers). Finally, by developing a comprehensive and global procedure that can be followed on every new program, this test procedure should help ensure that the quality of optics is acceptable for every windshield and backlite before the first Saleable vehicle leaves the Production Line.

Samples will also be used during production to help identify improvements the supplier may be required to do for continuous improvement.

1.2 Applicability. This test procedure is applicable for all new program glazing systems, when a current product is re-sourced to a new supplier, or when a significant design or tooling change (impacting optical performance of the glazing system) occurs.

1.3 Remarks. The Optical and Vision Evaluation Procedure should serve as another step in the validation process for glazing systems. These parts should have already been deemed acceptable as a result of grid-board evaluations. This document is the GM Worldwide Glazing Testing Standard. Its purpose is to establish a common test methodology for glazing systems to ensure that a high quality world class system is consistently developed and produced. This is a living document and any suggestions or revisions will be reviewed and/or updated annually by the Fixed Glass Global Subsystem Leadership Team (GSSLT).

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

DIN 52336	FMVSS 205	UN R43
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2.2 GM Standards/Specifications.

GMW3059	GMW3136	GMW3600
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2.3 Additional References.

Note: The supplier shall work with the responsible GM engineer to comprehend these requirements.

- CG180 5-Phase Document (ID).
- GM Security Guidelines (ID). <https://gmweb.gm.com/HR/Security/Pages/FutureGuide.aspx>.
- GM1829 Analysis Development and Validation Plan and Report (ADVP&R).
- Program specific Component Technical Specification (CTS).
- Subsystem Technical Specifications (SSTS).

(ID) = This document is limited to internal use within General Motors and shall not be accessed outside this company. Contact the GM Lead Engineer for further instructions.

3 Resources

3.1 Facilities. Milford Proving Ground (MPG) "12 Mile Road" or equivalent. An equivalent road (test facility) is one which provides each of the following features, necessary for ensuring observers can adequately evaluate the test samples. Appendix C (Figure C1 thru Figure C6) provides pictures of MPG 12 Mile Road, which can be used to determine if the testing site in question provides all the necessary visual cues.

- Straight, approximately 0.75 km long section of road with little-to-no traffic.
- The section of road should also consist of a wide area or an adjacent parking lot area where the vehicle may be turned around and driven in small, repetitive circles without impacting road safety or other drivers/traffic.

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This area or another similar area will also be necessary for sample staging, for swapping samples onto the vehicle, and for serving as a waiting area for test drivers/evaluators.

- Clear, unobstructed surroundings for approximately 0.5 km, necessary since any large, nearby objects will hinder the test personnel's ability to observe glass distortion and to properly evaluate the samples.
- Beyond the unobstructed surroundings, there should be vertically-shaped and horizontally-shaped objects, such as tall trees, buildings, light posts, guard rails, fences, or other static features for use as image references to help detect distortion. The best reference objects are those that have regularly-patterned features (e.g., guard rail (horizontal beams) and their (vertical) posts).
- The facility and test location must provide the appropriate level of vehicle security (see 4.1.1).

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Tape – strong-enough to adhere the window to the vehicle (duct tape has historically worked well for this purpose).

3.2.2 Permanent marker – used for signing and indicating Boundary Samples at End of Test (EOT).

3.2.3 Window cleaning supplies.

3.2.4 Spacers or method of spacing the glass in design position, off of the bond flange.

3.2.5 Windshield holding fixture.

3.2.6 Digital Camera.

3.2.7 Chairs (2).

3.2.8 Data Sheets. Common data (Program, Model Year, Supplier, etc.,) should be input before creating the copies for the observers.

3.3 Test Vehicle/Test Piece.

3.3.1 One to three drivable test vehicles.

3.3.2 Vehicles are to be reserved in advance with the appropriate option content. For example, ensure that a Heads Up Display (HUD) vehicle is available if the HUD system is to be evaluated.

3.3.3 Test parts shall be from production equipment.

3.3.4 Each sample should be assigned a sample number for documentation purposes.

3.3.5 Samples will be selected by the supplier and should exhibit optical properties representative of the normal range of the process.

3.3.6 If the program offers HUD, 5 additional samples of HUD glass will be required at a minimum, and the test vehicle should have the HUD option (UV6).

3.3.7 Backlites shall require a minimum of 3 samples.

3.3.8 Quantity of samples produced during the run shall be agreed to by System Management Team (SMT) and Supplier Quality Engineer (SQE) prior to selecting samples.

3.3.9 Windshield samples shall be pulled from beginning, middle, and end of glass run.

3.3.10 Perform Innomess Test on samples and make data available for review prior to ride.

3.3.11 Supplier must perform the objective Zebra Board Projector Test prior to the optics ride. The results (measurements and pictures) shall be submitted to GM prior to the Optics Ride and the supplier is to have the results available at the Optics Ride.

3.3.12 All samples are to have objective data (example in Table 1 – see GMW3136 for current values) and this data is to be sent to the DE prior to the ride.

Note: Samples from the previous Optics Ride shall be available for review – Design Validation (DV) parts for Product Validation (PV) Optics Ride, PV1 parts for PV2 Optics Ride.

Table 1: Objective Data Required

Sichtfeld	D _{absolut} in mdpt	ROC in mdpt
A	≤ 75	≤ 100
B	≤ 110	≤ 125
C	≤ 150	≤ 150

mdpt = Millidiopter

Note: Samples from the previous Optics Ride shall be available for review – DV parts for PV optics Ride, PV1 parts for PV2 Optics Ride.

Note: The supplier must ensure that there will be replacement glazing available to return the vehicle to the as received state. Take proper care to ensure that the correct option/variant content glazing is properly replaced.

3.3.13 If necessary, procure replacement molding(s) before Start of Test (SOT).

3.3.14 Material. The required material quality of the glazing are also designated by the relevant material specifications in the drawing.

3.3.15 All components/systems used in testing shall be within drawing specifications and have supporting data prior to start of test.

3.3.16 ALL test samples **MUST** be conditioned per 4.1.1.

3.3.17 All test samples and materials must be compliant to GMW3059 to enter a GM facility.

3.4 Test Time.

Calendar time: 1 d to 2 d (during daylight hours)

Test time: Up to 8 h (day 2)

Coordination time: 4 h (day 1)

Note: The 1st optics ride is required to be complete by Product/Process Validation (PPV) Material Required Date (MRD). This evaluation can be done at the local supplier's facility on a test fixture or buck.

Note: the supplier is to have approved optics ride prior to the second build block of SALEABLE MV vehicles.

3.5 Test Required Information.

3.5.1 GM Validation is to be notified of test failures within a 24 h period of occurrence.

3.5.2 Supplier to develop a 5-Phase Document (CG180) for all test failures.

3.5.3 Final Test Report **shall** be in the format from Appendix F (Data Sheet F1 shows an example).

3.5.4 Product Security. Security protocol for the test vehicle must be followed per GM Security Guidelines.

3.5.5 Subjective Rating Scale for quantifying the degree of image distortion perceived in each sample of glass (see Appendix A and Table A1).

3.5.6 Program/vehicle-related information, such as model year, glass vendor, thickness of glass, windshield angle, etc., shall be documented. (See Data Sheet B1, Data Sheet B2 and Figure B1 in Appendix B for windshields, Data Sheet J1, Data Sheet J2 and Figure J1 in Appendix J for rear windows and Data Sheet K1, Data Sheet K2 and Figure K1 in Appendix K for lift gate windows).

3.6 Personnel/Skills.

3.6.1 A technician is typically required to assist in glass installation and general test road driving, directions, etc.

3.6.2 An attempt should be made to acquire observers of various heights (one person under 1626 mm, another between 1626 mm and 1829 mm, and another over 1829 mm tall).

3.6.3 At a minimum, the observers recruited for this evaluation should consist of the responsible Validation Engineer (VE), the Designing Engineer (DE), the Supplier Quality Engineer (SQE), and the Supplier-Integrated Design Engineer (SI DE). At least one of these people must have had previous experience in participating in this evaluation procedure.

4 Procedure

4.1 Preparation.

4.1.1 Read the proper requirement from the SSTs.

4.1.2 Thoroughly Read this GMW and any other associated GMWs.

4.1.3 Ensure that proper Personal Protection Equipment (PPE) is used during set up and testing.

4.1.4 Ensure that the materials are in compliance to GMW3059 and any regulatory requirements for country of sales.

4.1.5 Confirm Product Security Protocol for the vehicle tested by contacting the Vehicle Performance Manager (VPM). (Vehicles requiring camouflage, etc., must be carefully secured throughout the testing procedure so that no lapse in vehicle security occurs.)

4.1.6 Prior to evaluation, generally the day before the test, the Subsystem Validation Engineer (SVE) should coordinate cutting the glass out of the test vehicle(s).

4.1.7 Mark each test sample with an identifying sequence.

4.1.8 Photograph the Monogram on each piece of glass for test report.

4.1.9 Review Figure G1 "Process and Responsibilities for Parts and their Approvals" in Appendix G.

4.1.10 Ensure that an appropriate quantity of data sheets are available.

4.1.11 Ensure that the ISRA/AGC scans are available for review.

4.2 Conditions.

4.2.1 **Environmental Conditions.** Testing shall be performed during daylight hours in dry weather. If the program offers a HUD system, then the testing shall be performed during daylight and in the evening hours in dry weather.

4.2.2 **Test Conditions.** Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2.2.1 No preconditioning is required for this procedure.

4.3 Instructions.

4.3.1 Static Evaluation/Pre Optics Ride Evaluation.

4.3.1.1 **Purpose:** To ensure that the production glass tooling has been properly tuned to produce a quality part and to reduce the potential of not meeting requirements during the Optics Ride.

4.3.1.2 Test Equipment.

- Holding fixture.
- Light source.
- Zebra Board.

4.3.1.3 Test Samples.

- Windshields – 5 minimum.
- HUD Windshields – 5 minimum.
- Rear Windows – 3 minimum.

4.3.1.4 Test Preparation. See 4.1.

4.3.1.4.1 Refer to GMW3136 sections on Zebra Test.

4.3.1.5 Test Procedure.

4.3.1.5.1 Ensure that all PPE is being used by the team.

4.3.1.5.2 Run the Zebra Test from GMW3136 prior to the static evaluation to identify candidates for the static evaluation.

4.3.1.5.3 Provide ISRA/AGC scans.

4.3.1.5.4 Arrange pretest review with GM and supplier – ensure authorized evaluators are notified.

Note: Optics review shall be conducted only with approved observers.

4.3.1.5.5 Place the Windshield in a holding fixture at proper vehicle orientation.

4.3.1.5.6 Place the fixture in a parking lot where multiple vehicles can be seen as well as vertical poles (telephone poles or light posts). There should also be horizontal lines such as electrical or telephone lines.

4.3.1.5.7 Place two chairs where the front occupants would be in vehicle position.

4.3.1.5.8 Place 2 chairs where the rear occupants would be in vehicle position.

4.3.1.5.9 Observers shall be seated in the chairs and conduct a review of the fixed objects – vertical poles, horizontal lines and vehicles.

4.3.1.5.10 Document any potential for distortion or roll over effects while moving the head from side to side and up and down.

4.3.1.5.11 As a team determine if the glazing samples are acceptable to do the optics review at the proving grounds.

4.3.1.5.12 Each panel approved for optics evaluation shall be numbered and signed by GM SQE, DE, SVE and supplier representative.

4.3.1.6 Acceptance Criteria.

4.3.1.6.1 Must meet program Specific requirements.

4.3.1.6.2 Agreement of Team to proceed to vehicle test.

4.3.2 Windshield Glazing Evaluation.

4.3.2.1 Purpose. To ensure that the entire range of windshields produced meet customer expectations.

4.3.2.2 Test Equipment.

4.3.2.3 Test Samples. Five Window Samples - Minimum.

4.3.2.4 Test Preparation. See 4.1.

4.3.2.4.1 Take the test vehicle to the 12 Mile Road (or similar).

4.3.2.4.2 Layout the glazing to be prepped for installation into the test vehicle.

4.3.2.4.3 Install one of the glass samples into the window opening, using tape to adhere it instead of bonding it in with urethane.

4.3.2.4.4 Clean the inside of the glass with GM approved glass cleaner.

4.3.2.4.5 Clean the outside of glazing with GM approved cleaners at the test track.

4.3.2.5 Test Conditions.

4.3.2.5.1 No preconditioning is required for this procedure.

4.3.2.6 Test Procedure.

4.3.2.6.1 Ensure that appropriate PPE is being used.

4.3.2.6.2 Ensure the test route is free and clear for use.

4.3.2.6.3 Start the test with a minimum of 2 occupants.

4.3.2.6.4 From both front seat positions and rear seat positions, evaluate the optical performance of each of the zones defined on the attached data sheet in Appendix B, I and K by using the provided rating scale. Sketch the areas exhibiting distortion, etc., and record the ratings for each zone as required.

4.3.2.6.5 Use the same driving route for each sample of glass to consistently evaluate the optical performance of each as described in the following.

4.3.2.6.6 Vehicle speed should not exceed 24 km/h on straightaways and no more than 8 km/h while driving in circles.

4.3.2.6.7 All samples are to be evaluated in one testing session (one day).

4.3.2.6.8 Look for areas of the glazing systems that distort the targets. A good technique for evaluating distortion is to focus on road lines, guard rails, tree lines, utility poles, etc., and watch for “apparent motion” or shape changes of these fixed objects while moving one’s head or driving along the road. Observers are to view the glass from different positions, moving their heads up and down and left-to-right. Some examples of what might be observed are:

- Parallel lines no longer appear parallel.
- Straight lines no longer appear straight.
- Objects become thinner, thicker, shorter, taller, etc.

4.3.2.6.9 The other passenger(s) should be used to document (scribe) the evaluators' observations during the evaluation.

4.3.2.6.10 Each pair of observers should be allowed ample time to review each of the samples and should switch evaluating positions as necessary.

4.3.2.6.11 Each evaluator shall complete, sign, and date the data sheets.

4.3.2.6.12 After each glass sample is evaluated, remove and tape in another sample.

4.3.2.6.13 After all samples have been evaluated, the team must select at least two (2) samples as the boundary samples (see 5.2).

4.3.2.6.14 Using the permanent marker/paint pen, the SI DE, GM DE, SQE, and VE shall initial, date, and appropriately identify each boundary sample selected by writing in the blackout area of the glass.

4.3.2.6.15 The supplier shall take ownership of the identified boundary samples, quantify and document the distortion using a grid board, photograph and store the samples in a safe place within their assembly plant as reference, and submit a copy of the grid board data and photographs to the GM VE.

4.3.2.6.16 The HUD option samples and windshields which demonstrate borderline results during the static UN R43 Box Test (see Appendix D Figure D1 thru Figure D3 for examples) are to be evaluated using 4.3.1 through 4.3.12 and must also be evaluated for night time double imaging. Double Image (DI) evaluation is to be done while driving the vehicle after dark, using point light sources such as tail lamps of vehicles, headlamps of oncoming vehicles, traffic signals, roadway and parking lot lighting. DI will cause a point source light to exhibit a primary image of the light source and a lower intensity secondary image separated from the primary image. The rating is to be based on the presence of a secondary image and the distance of separation of the primary to secondary image, with increasing separation reducing the subjective rating.

4.3.2.6.17 Once all testing is complete and the boundary samples selected, reinstall one of the remaining samples per standard, window service installation procedures.

4.3.2.7 Acceptance Criteria.

4.3.2.7.1 Must meet the program specific requirements.

4.3.2.7.2 Boundary samples for use during normal glazing production.

4.3.2.7.3 Note: Before opening the packaging with the test samples, make sure the supplier has an opportunity to review how the parts were shipped. The supplier shall inspect the package for damage and other concerns.

4.3.2.7.4 Note: When transporting the extra glazing materials to the track, be cautious to prevent glass breakage by ensuring that the glass has appropriate separators to prevent contact and breakage.

4.3.2.7.5 Note: Glass must not be bonded into the opening.

4.3.2.7.6 Note: Ensure that the tape does not cover any of the Day Light Opening (DLO). Ensure the glazing is secure to the body and will not cause a safety issue during the drive.

4.3.3 Rear Window and Liftgate Glazing Evaluation Procedure.

4.3.3.1 Purpose: To evaluate the rear window for objectionable distortion.

4.3.3.2 Test Equipment. See 3.2.

4.3.3.3 Test Samples. 3 minimum.

4.3.3.4 Test Preparation. See 4.1.

4.3.3.5 Test Conditions. No preconditioning is required for this procedure.

4.3.3.6 Procedure.

4.3.3.6.1 Ensure proper PPE is being used.

4.3.3.6.2 Repeat 4.3.2.6.1 through 4.3.2.6.15.

4.3.3.6.3 Locate a building similar to that depicted in Figure H1 in Appendix H.

4.3.3.6.4 Do an evaluation with the observers.

4.3.3.6.5 Document all observations.

4.3.3.7 Acceptance Criteria.

4.3.3.7.1 Must meet program specific requirements from SSTs.

4.3.3.7.2 Must meet ALL observer's expectations.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. General Motors Validation is to be notified of test failures within a 24 h period of occurrence. Test samples shall have no objectionable discoloration from the cigarette smoke. Test samples are to remain fully functional and in compliance with Federal Regulations. Check program specific CTS/SSTS for other requirements.

Test reports with supplier letterhead are to be generated by supplier performing test and electronically distributed to GM Validation. All test reports are to be in the English language.

5.2.1 The minimum acceptable rating for windshields and backlites is seven (7). The goal of this evaluation should be to identify at least two (2) samples of glass at this level to serve as the "Boundary Samples" (representing the minimum level of acceptance for these parts).

5.2.2 "Shimmer" or "puddling" (image that is unstable, wavy, distorted, etc.) along the edge of the blackout is caused by the heat differential in the glass during its manufacture. This heat differential (caused by a "heat-sinking" effect from the paint) prevents the glass from bending/forming in the same manner as the bulk of the glass. This is the ultimate cause of distortion near the blackout. This type of distortion should not extend more than 10 mm into the DLO from the edge of the blackout. One way to minimize this defect is to implement (or increase the size of) a dot-matrix blackout pattern in that area, thus decreasing the heat-sink effect. Another way to minimize this effect is to change the type of blackout (frit) and/or to change the operating temperatures for curing the frit.

5.2.3 Apparent, faint vertical (or horizontal) lines of distortion in the glass are generally a result of the float process and (depending on the severity) may be acceptable, especially since these lines are a characteristic of all floated-glass products. However, if the severity of the lines is too severe, resulting in an unacceptable level of distortion, then corrective action must be taken by the supplier. **Note:** Glass installation angle aggravates the perceived level of distortion.

5.3 Test Documentation.

5.3.1 The VE shall collect and summarize all data from each of the participants.

5.3.2 The SQE shall maintain the data sheets and publish results summary within the GM document management system. The SVE/SQE are to use the checklist in Appendix E to ensure all steps have been taken.

5.3.3 The SI DE and/or VE shall update any necessary program-related test documentation systems based on the results of the evaluation (e.g., Analysis, Development, and Validation Management System (ADVMS), Analysis, Development, Validation, Plan, and Report, (ADVP&R) etc.)

Samples of components or material released to this specification shall be tested for conformity with the requirements of this specification and approved by the responsible GM Department prior to the start of delivery of production level components or materials. Any change to the component or material e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release.

If not otherwise agreed to the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases a shorter test can be agreed to between the responsible GM Department and the supplier.

The supplier shall write evaluation reports to document the results of all their validation activities and shall make the test results and evaluation reports available to GM Engineers upon request. Refer to GMW3600.

5.3.4 Test Results. With reference to this general specification the test results shall be specified in a test report.

5.3.4.1 Test reports shall include all of the following:

- Test Engineer's Name and Contact Information.
- Test equipment.
- Serial numbers.
- Calibration information.
- Description of test material (including design revision, lot or batch, options, etc.)
- Test specification date, pertinent setup information, and photographs.

Evaluation reports should document the results of all their validation activities and shall be provided to GM Engineers upon request (see GMW3600). All reports are to be in the English language. Document all test results, parameters, and findings.

5.3.4.2 Photos. Photos of the test fixture, test setup and test sample shall be added to the test report.

5.3.4.3 Evaluation Reports. The supplier shall write evaluation reports to document the results of all validation activities and shall make the test results and evaluation reports available to GM engineers upon request. See GMW3600. All test reports are to be in English and available two (2) weeks after test completion.

5.3.4.4 Required Documentation. A 5 Phase Document for all test failures within 24 h period of occurrence. The following is also required for all test reports:

- Procedure number and section numbers on all test reports.
- Requirement being met and SSTS requirement number.
- Part traceability – include cavity number, serial number, tool number, engineering change level (ECL), etc., to specifically identify the part.
- All test parameters for environment and equipment.
- Any authorized deviations to the plan.
- Test setup shall be photographed.
- Road map as required.
- Dimensional data on the test part as required.

6 Safety

This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

In general, a risk assessment needs to be performed for every driving instruction prior to executing this standard. (**Note:** National law needs to be considered while performing a risk assessment.) The required rating of risk by exposure probability and possible violation will be done in a separate document. Every identified risk must be named inside the risk assessment for the relevant driving instruction in order to announce that risk to employees. Within the risk assessment, the vehicle equipment and different vehicle build stages have to be considered. After performing a risk assessment, non-acceptable risk needs to be mitigated by appropriate countermeasures. Here technical measures are preferred because these are independent from attendant circumstances. In case technical measures are not appropriate, organizational and/or personal measures will apply. This includes training, wearing of Personal Protection Equipment, or arrangement of idle time.

6.1 Safety Precautions.

6.1.1 Instrumentation and other test equipment must be securely mounted in accordance with proving grounds traffic safety guidelines for mounting and usage of in-vehicle instrumentation.

6.1.2 All running lights and vehicle safety features must be operational according to proving grounds rules for running lights and power windows. Exterior lights must not be obscured by styling add-ons, covers or camouflage packages. The horn may be disabled because of steer angle transducer installation.

6.1.3 A helmet is required in accordance with the regulations of the test facility. The vehicle should never be operated in a manner where the vehicle leaves the roadway or goes onto the shoulder for any reason.

6.1.4 Check for proper attachment of the steering wheel to the gear via the intermediate shaft. If it feels loose or abnormal, do not run the test until the parts are properly assembled according to the intended design.

6.1.5 Check to be certain that all wheel lugs are present and have the specified torque. Loose or missing wheel fasteners are to be replaced, installed or tightened before the test may begin.

6.1.6 The driver's seatbelt must be worn at all times during the test. Passengers accompanying the test operator must also be safely belted in the vehicle, preferably in the right rear seat.

Note: Passengers are allowed for observation or training purposes.

6.1.7 If a crossbar is used to hold the steering wheel angle transducer base plate, the passenger side airbag is to be disabled or disconnected.