



Display Glare, Reflection and Washout Evaluation

1 Scope

Note: Nothing in this standard supersedes 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 procedure is to evaluate the readability of displays under various daytime lighting conditions: low and high ambient lighting, direct and indirect sun rays. These conditions can cause reflections and washout which can adversely affect readability of the displays. The displays include, but are not limited to center stack displays (navigation, radio, HVAC), instrument clusters, Driver Information Center (DIC), Heads-Up Displays (HUD), rear seat entertainment, etc.

1.2 Foreword. This procedure involves the use of a very powerful light source which could damage eyes. Avoid exposure and/or wear sunglasses to avoid discomfort.

1.3 Applicability. This procedure should be applied to all GM vehicle programs. Procedure can also be used on competitive vehicles for benchmarking or "reverse engineering" purposes.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15327

2.3 Additional References.

Global Technical Memory Best Practice 109735: Cluster Lens Reflection.

3 Resources

3.1 Facilities. This procedure should be done in an indoor room with ambient lighting adequate for

an office environment. The room needs to be equipped as specified in 3.2.

3.2 Equipment. It is the responsibility of the technician and/or the performance engineer to ensure that all instrumentation is verified for correct operation to the manufacturer's specifications and has been calibrated to traceable standards before the testing can be conducted. Equivalent equipment may be substituted in place of the equipment listed below.

3.2.1 Sun-Gun Lamp. Metal halide day lamp capable of 100 000 lux, 5600°K color temperature, Flicker Free (greater than 10 000 images/second) capable of required illumination over a 245 mm spot area (such as ARRISUN12+).

3.2.2 Mounting Fixture for Lamp. The lamp should be mounted on a fixture capable of shining the lamp through all windows (front, left and right side, and rear) while aiming the beam at the display in question. Fixture should allow the lamp to be aimed in all directions necessary to execute this procedure.

3.2.3 Lux Meter. Lux meter to measure illuminance on display surface.

3.2.4 Digital Camera. Digital camera to capture issues.

3.2.5 Previous Issues List and Action Items.

3.2.6 Contrast Ratio Measurement Device. A device capable of measuring contrast ratio (spectroradiometer, spectrometer, chromameter, photometer, etc.).

3.2.7 White Surface. A white surface illuminated by the light source that can be used to simulate clouds.

3.2.8 White Clothing. White shirts and white pants are required for the evaluators.

3.3 Test Vehicle/Test Piece. Tests should be conducted with vehicles/mock-ups equipped with production design intent components mounted in production intent interiors (when available). Any deviations from this should be noted on the evaluation form. The test property should have the lightest interior trim color. If this is not possible, the trim should be covered in material to simulate this color and gloss.

The reviews shall use the intended display technologies and are to be positioned in the correct vehicle space for the evaluation.

3.4 Test Time.

Calendar time: 1 to 2 days

Test hours: 8 hours

Coordination hours: 8 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. A performance engineer evaluator experienced in display evaluation and in the usage of the above equipment is required to complete this test procedure.

4 Procedure

4.1 Preparation.

4.1.1 The displays are to be positioned correctly in vehicle space and are to be determined to be operating at the intended parameters (brightness and contrast). If adjustable, the brightness should be set to the maximum value and the contrast should be set at the midpoint value or as deemed appropriate (document values when recording results). The evaluator's seating position is also to be in the correct spatial relationship to the displays. This procedure can also be used to determine placement and orientation of the display for reflection avoidance.

4.1.2 The light source shall be capable of being roved around the vehicle windows with the beam **aimed** at the display being evaluated. Each display evaluation will require separate scans.

4.1.3 The performance engineer will receive data from display supplier or the design engineer indicating the performance of the display relative to the requirements in GMW15327.

4.1.4 The displays should be powered up and driven as they would be in a normal vehicle installation.

4.2 Conditions.

4.2.1 Environmental Conditions. Simulate daytime ambient lighting with direct sun reflection, indirect sun reflection (haze), white shirt reflections, low ambient readability, and sky reflections.

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.

4.3 Instructions.

4.3.1 Direct Sun Reflection. A mirror is placed on the subject display to determine the specular line for direct sun reflections. If the display is positioned such that direct sun reflections are not possible (this should be the case if designed according to Best Practices), then proceed to 4.3.2. If the display is positioned such that direct sun reflections are possible, then position the light source so that it is visible in the mirror (center of the display) and aim the light source so that the rays will shine into the observer's eyes (the observer should be looking into the "**barrel**" of the light source).

4.3.1.1 Turn on the light source and measure the illuminance at the surface of the display. Dim the source or move it along the ray vector until 45 000 lux is achieved. Do not stare at the display if it becomes uncomfortable as eye damage may result.

4.3.1.2 Perform subjective evaluation and determine readability of display. Move your head around to simulate different size occupants and their positions.

4.3.1.3 Document with digital photos. Adjust the camera as needed to make sure that the photos capture the condition observed.

4.3.1.4 Measure contrast ratio if desired.

4.3.2 Direct Sun Impingement. Position the light source so that the center ray will impinge on the center of the display through the upper rear corner of the passenger window for fixed roof vehicles. The illuminance on the display should be 45 000 lux. For convertibles, the light source should be positioned at the rear of the vehicle along the centerline 30 degrees from the horizontal.

If any part of the vehicle blocks the direct rays, then increase the angle as sufficient and record this angle for future testing of this vehicle.

Note: This procedure is important for emissive displays even if a direct sun reflection is not possible. Vacuum fluorescent displays or negative mode Liquid Crystal Displays (LCD) can become unreadable under this condition even if reflections are not an issue. The haze test will not be as severe as non-specular direct impingement.

4.3.2.1 Perform subjective evaluation and determine readability of display. Move your head around to simulate different size occupants and their positions.

4.3.2.2 Document with digital photos. Adjust the camera as needed to make sure that the photos capture the condition observed.

4.3.2.3 Measure contrast ratio if desired.

4.3.3 Haze Condition.

4.3.3.1 Position the light source as described in 4.3.1 on the direct sun specular line or as close as possible to it.

4.3.3.2 Move the light source within a 10 degree cone so that rays just off the specular line impinge on the display.

4.3.3.3 Perform subjective evaluation and determine readability of display.

4.3.3.4 Document with digital photos or measure contrast ratio if desired. Adjust the camera as needed to make sure that the photos capture the condition observed.

4.3.4 Interior Reflections.

4.3.4.1 Using the mirror positioning technique described in 4.3.1, determine the part of the interior that is reflected in the display and position the light source in front of the vehicle so that 45 000 lux impinges on that part. If the reflection is of a person, the person should be wearing white clothes.

4.3.4.2 Perform subjective evaluation and determine readability of display.

4.3.4.3 Document with either digital photos or contrast ratio measurement. Adjust the camera as needed to make sure that the photos capture the condition observed.

Note: Highly reflective display surfaces will not perform well under this condition if they are aimed at the occupants or light colored glossy interior trim. The recommendation is to position the displays to reflect into the headliner, which is usually low gloss and never illuminated by the sun. For convertibles, anti-reflective coatings will be needed to perform well under this condition.

4.3.5 Low Ambient Daytime Condition. There should be 100 lux illuminance on the vehicle's instrument panel. There should be no light rays directly impinging on the display surface.

4.3.5.1 Perform evaluation and determine readability of display.

4.3.5.2 Document with digital photos. Adjust the camera as needed to make sure that the photos capture the condition observed.

Note: Reflective displays will not perform well in this condition unless they are backlit during daytime operating conditions. The recommended backlight intensity is 80 to 100 cd/m².

4.3.6 Sky Reflection

4.3.6.1 Using the mirror on the display to determine the reflection vector, place the white sheet in the position to be reflected off the displays

and aim the 45 000 lux light source at the white sheet.

4.3.6.2 Perform subjective evaluation and determine readability of display.

4.3.7 Reflections from "**bright-work**". Aim the 100 000 lux sun lamp on any bright-work inside the car to see if reflections will cause discomfort or distractions to the occupants. Note issues and document on comment sheet.

4.3.8 Other Conditions. Look for other conditions not specified above that may adversely affect display readability. Evaluate the display with polarized sunglasses. Move the 45 000 to 100 000 lux light source around all of the daylight openings and look for other phenomenon causing poor readability of the display.

4.3.8.1 Perform evaluation and determine readability of display.

5 Data

5.1 Calculations. See Appendix A for rating scale and Appendix B for worksheet that is to be used.

5.2 Interpretation of Results. This procedure is intended to determine lighting conditions which cause undesirable reflections on the displays. Once these conditions are determined, appropriate measures can be taken to resolve such issue(s).

5.3 Test Documentation. Subjective observations should be summarized on data sheet (Appendix B). Performance deficiencies should be captured on a separate spreadsheet (Issues Log) noting date of observation, owner of issue, action plans, and next action date. Issues Log must be maintained throughout the program to record actions and final resolution.

5.3.1 Review performance deficiencies along with actions taken with the Vehicle Performance Manager to determine which issues should be entered into the Problem Resolution Tracking System (PRTS+).

After each review, a report will be generated and sent to the director of Electrical Controls and Software.

Use issue description criteria under "**Issue Resolution Process for Performance Integration**" and closure code description wording under "**Reference Material - Lean Closure Code**" found on the PRTS+ website.

5.3.2 An Evaluation Report should be created prior to 100% Production Part Approval Process (PPAP) including the data sheet and issues log.

5.3.3 Distribute Evaluation Report to Vehicle Chief Engineer (VCE), Program Engineering Manager