



Random Incidence Sound Absorption Evaluation Test Procedure

1 Introduction

Absorption coefficient shall be measured based on ISO 354 (Standard Test Method for Sound Absorption in a Reverberation Room). This standard shall be referenced for more detailed information corresponding to the following procedure. As an alternative, absorption measured per ASTM C423 is acceptable. (Note that sample size and room volume specified in ASTM C423 are acceptable as well). In addition, with GM approval, RIETER Alpha Cabin measurements shall be accepted with up-to-date calibration and maintenance documentation provided and suitable demonstration of correlation to the above standard measurement procedure results. Although the Alpha Cabin results may be acceptable, in order to compare to GM requirements, the Alpha Cabin test data shall first be corrected to ISO 354/ASTM C423 equivalent levels.

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. To determine the random incidence sound absorption of acoustic components.

1.2 Applicability. This test is applicable to all components which are relied upon to provide sound absorption, i.e., seats, floor trim, roof trim, rear window trim panels, luggage trim, engine absorption and any other material added to the vehicle for sound absorption purposes.

1.3 Remarks. This test procedure is used in the development and validation of components and subsystems.

2 References

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

2.1 External Standards/Specifications.

ASTM C423

ASTM E795

DIN 50014

ISO 354

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- SAE International-Paper 2005-01-2284
- SAE International-Paper 931266
- Subsystem Technical Specification (SSTS)

3 Resources

3.1 Facilities. As specified in ISO 354, a reverberation room with a volume of at least 150 m³, recommended 200 m³ or greater, shall be used. If a smaller reverberation room is used, verify that the required absorptive area per ISO 354 is achieved. If a reverberation room is not available, an Alpha Cabin shall be used per GM approval. See Appendix A for Alpha Cabin procedure deviations.

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. Wholly contained in ISO 354.

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3.3 Test Vehicle/Test Piece.

3.3.1 Flat Stock Material. At least 10 m² of flat stock material shall be measured. If the component has multiple thicknesses, typically three (3) thicknesses are evaluated; one (1) full loft, one (1) full compression and one (1) 50% of full compression for transition areas.

If the material when used in the vehicle has an air gap behind it, this space shall be comprehended as follows: test one (1) sample with no air gap and at least three (3) samples with respective air gaps to span available packaging. If program packaging is unknown, default air gaps shall be 5 mm, 10 mm, 15 mm and 20 mm.

If the roof trim has absorption material placed between the roof trim and sheet metal, test the sample with and without the material.

3.3.2 Buck. Edges shall be treated as in vehicle to eliminate any edge/flanking/non-representative air gap spacing effects of the molded part.

Holes shall be sealed with noise control patching material.

At least 10 m² of material shall be measured. This can be achieved with multiple parts (no more than six (6)). To account for part variation, for each test a random sample shall be chosen from a population that is 50% larger than the number of parts being measured. A minimum of three (3) tests shall be measured.

3.3.2.1 Hood Liner. To verify the fully formed part performance, the molded part shall be tested in plaster cast (or equivalent) bucks representative of the design intent sheet metal.

3.3.2.2. Front of Dash Mat. To verify the fully formed part performance, the molded part shall be tested in plaster cast (or equivalent) bucks representative of the design intent sheet metal.

3.3.2.3 Roof Trim. To verify the fully formed part performance, the molded part shall be tested in plaster cast (or equivalent) bucks representative of the design intent sheet metal. Edges shall be treated so that sides are sealed while front and rear are exposed.

If the roof trim has absorption material placed between the roof trim and sheet metal, include that material in the sample being tested.

3.3.2.4 Floor Trim/Rear Compartment Floor Trim. To verify the fully formed part performance, the molded part shall be tested in plaster cast (or equivalent) bucks representative of the design intent sheet metal.

3.3.3 Seats. To characterize the absorption of a single occupant free-standing seat, four (4) single occupant seats or two (2) bench seats shall be tested. For built-in seats, two (2) back and two (2) bottom cushions shall be tested.

3.4 Test Time.

Calendar time: (includes 24 h for material conditioning) 3 to 5 days

Test hours: 4 to 10 hours

Coordination hours: 2 to 4 hours

3.5 Test Required Information. For free-standing seats, the design intent seat spacing is required.

For variable thickness piece parts for which representative flat stock is being tested, each representative thickness and the associated fraction of the total part area shall be reported.

3.6 Personnel/Skills. Operators shall be appropriately trained in the operating procedures and safety precautions.

4 Procedure

4.1 Preparation. Wholly contained in ISO 354.

4.1.1 Test Specimen Preparation. Prior to any material, buck or seat testing, an empty room measurement shall be performed.

The empty room measurement shall be made with the empty bucks to allow for the effect of the bucks on the room acoustics.

4.1.1.1 Flat Stock. For any flat stock material it is important that sound be prevented from entering the specimen by any path other than through the front surface. For this reason, the sides of the specimen shall be closed out with non-absorptive material, e.g., wood or equivalent. See ASTM E795 for specific sealing details. If the material

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is being evaluated with an air gap, the perimeter of the specimen and air gap shall be closed out per ASTM E795. If multiple pieces of material are being used to obtain the required area, ensure that the seams and any gaps between the pieces are also being treated.

4.1.1.2 Bucks. Place the bucks randomly in the room such that no two (2) bucks are touching. If plaster cast bucks are not being used, edges of the bucks shall be sealed such that sound is prevented from entering the bucks by any path other than through the front surface.

4.1.1.3 Seats. For free-standing seats, place four (4) single occupant or two (2) bench free-standing seats upright in the room with spacing similar to that seen in a vehicle.

For built-in seats, place two (2) back and two (2) bottom cushions in the room similar to that seen in a vehicle. The seat backs shall be laying on the floor alongside the seat bottom cushions and both cushions shall be closed out to the floor.

Any headrests shall be in a full down position.

4.2 Conditions. Wholly contained in ISO 354.

4.2.1 Environmental Conditions. Changes in temperature and relative humidity during the course of a measurement can have a large effect on the measured reverberation time, especially at high frequencies and at low relative humidities.

Measurements should be performed in the empty room and in the room containing the test specimen with a change in relative humidity in the room shall be at least 30% with a maximum of 90% and the temperature shall be at least 15 °C.

The test specimen should be allowed to reach equilibrium with respect to temperature and relative humidity in the room before testing is performed.

Measurements

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. Wholly contained in ISO 354.

5 Data

5.1 Calculations. The computerized measurement system controls the excitation and calculates the reverberation times as a function of frequency.

For flat stock materials and bucks, calculate the absorption coefficient by using the following equation:

$$\alpha = 0.161 \cdot \left(\frac{V}{A} \right) \cdot \left(\frac{1}{T60_{sample}} - \frac{1}{T60_{empty}} \right)$$

Where:

V is the volume of the reverberation room (m³).

A is the surface area of the test sample (m²).

T60_{sample} is the reverberation time measurement with the test sample in the room.

T60_{empty} is the empty room reverberation time measurement.

For seats, calculate the total absorption in metric sabins (m²) by using the following equation:

$$\alpha A = 0.161 \cdot V \cdot \left(\frac{1}{T60_{sample}} - \frac{1}{T60_{empty}} \right)$$

Where:

αA is the total absorption (m²).

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