



Air Induction Duct Performance and Durability Test

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. Demonstrate the durability of a flexible air duct assembly (low pressure side for turbocharger applications) in the air induction system. This test subjects the duct to the full range of temperature and relative movement in the underhood environment from -35 °C to the Excursion Temperature based on Location (ETL) degrees Celsius, specified in the Subsystem Technical Specification (SSTS) Normal Operating Temperature Section.

1.2 Applicability. This standard covers the structural testing of air ducts assemblies intended to allow relative motion between engine air flow components. Ducts can be made by a blow molding or injection molding process with thermoplastic or elastomeric materials. The duct assemblies in this testing procedure shall include the flexible convoluted duct, the hard plastic duct, turbo elbow or adapter duct, resonators, and others.

2 References

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

2.1 External Standards/Specifications.

ASTM D1171	ISO 1431-1	ISO 17025	SAE J200
ASTM D2000	ISO 1817	ISO/TS 16949	

2.2 GM Standards/Specifications.

GMW16955

2.3 Additional References.

- GMPT-6-023-B
- IRM 903
- Rubber Manufacturers Association (RMA) Incorporated, Washington, DC (www.rma.org)
- Subsystem Technical Specification (SSTS)

3 Resources

3.1 Facilities. All tests must be run by an ISO/TS 16949 or ISO 17025 approved laboratory and be able to maintain an ambient room temperature of 23 °C ± 5 °C.

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 Temperature controlled chamber (reference Appendix A, Figure A1) capable of cycling from -40 °C to ETL (°C) at a programmed rate and capable of holding a specified temperature ± 2 °C for a minimum of 3 h. The test chamber may be fitted with an observation window, so that test pieces may be examined without opening the chamber and interrupting the test.

Note: The test equipment must be able to test a minimum of two (2) pieces simultaneously for duct durability testing.

3.2.2 Vacuum measuring equipment capable of a minimum of 640 mm of water (6.28 kPa), and readable to within 2 mm of water (0.02 kPa), or any other pressure/vacuum measuring device capable of the same specifications.

3.2.3 Fixture to hold test ducts in the in-vehicle position and in-vehicle orientation. Aluminum or stainless steel is suitable materials for the fixture.

Note: In-vehicle position: Duct assembly end to end, X, Y, Z coordinates relative to each other; must match in-vehicle design math data.

Note: In-vehicle orientation: Duct assembly orientation on fixture must match in-vehicle orientation relative to the duct assembly's position in the engine compartment.

3.3 Test Vehicle/Test Piece.

3.3.1 Samples. All samples shall be dimensionally correct and dimensional measurements shall be recorded on Data Sheet B1, Appendix B, and supplied with the evaluation report.

3.3.1.1 Critical Dimensions.

3.3.1.1.1 Material thickness at:

- Convolute peaks
- Convolute valleys
- Convolute walls

3.3.1.1.2 Ends of duct under clamps.

3.3.1.1.3 Walls at various points along duct length.

- Inside diameter at ends of duct at mating part
- Inside diameter of any ports (Positive Crankcase Ventilation (PCV), Secondary Air Induction (SAI), etc.)
- Height of sealing bead(s)

3.4 Test Time.

Calendar time: 27 days

Test hours: 620 hours

Coordination hours: 16 hours

3.5 Test Required Information. Pictures of each testing item setup and results must be provided in the evaluation report.

3.6 Personnel/Skills. A person trained to perform the procedures in Section 4.

4 Procedure

4.1 Preparation.

4.1.1 Preparation, Visual Inspection. No duct will have these conditions (4.1.1.1 thru 4.1.1.4) prior to testing.

4.1.1.1 Pin holes, surface irregularities, surface porosity, or other deformations that would cause functional failure.

4.1.1.2 Stress cracks.

4.1.1.3 Distortion that would not permit proper assembly, meet dimensional requirements or lead to functional failure.

4.1.1.4 Flash beyond print or Rubber Manufacturers Association (RMA) limits.

4.2 Conditions.

4.2.1 Environmental Conditions. Refer to each test section for the temperature, humidity, and pressure requirements.

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. This section contains the procedures, equipment and requirements for air ducts. The test procedure consists of Sequences A and B. Table 1 and Table 2 show test items and quantity for the two sequences. The logic flow diagrams show the proper test order sequence (reference Appendix A, Figure A2 and Figure A3).

Note: Test Sequences A and B shall be independently conducted.

Table 1: Test Sequence A

Test Number Sequence	Test Description	Number of New Ducts for Sequence A	Equipment Criteria
4.3.1.1	Leakage	Minimum 2	Durability Chamber
4.3.1.2	Heat Aging	From 4.3.1.1	Durability Chamber
4.3.1.3	Ozone Resistance	From 4.3.1.2	Ozone Chamber
4.3.1.4	Leakage	From 4.3.1.3	Durability Chamber
4.3.1.5	Durability	From 4.3.1.4	Durability Chamber
4.3.1.6	Leakage	From 4.3.1.5	Durability Chamber

Table 2: Test Sequence B

Test Number Sequence	Test Description	Number of New Ducts for Sequence B	Equipment Criteria
4.3.2.1	Push On	Minimum 3 (with Minimum Diameter)	Tensile Test Machine
4.3.2.2	Pull Off	Minimum 3 (with Maximum Diameter)	Tensile Test Machine
4.3.2.3	Convolute Flexibility	From 4.3.2.3	Tensile Test Machine
4.3.2.4	Drop Test	From 4.3.2.4	Not applicable
4.3.2.5	Leakage	From 4.3.2.5	Durability Chamber

4.3.1 Test Sequence A.

4.3.1.1 Leakage (Clean Air System Only). This test will help determine if any of the test samples have any deformation or abnormalities that may affect other test results. This test will be the baseline for any additional leakage tests in this procedure. Reference Appendix A, Figure A2.

4.3.1.1.1 Preparation. Mount the ducts using specified production hardware, assembly methods and procedures in the in-vehicle position and in-vehicle orientation, with any fasteners at the minimum dynamic torque specification. Mount onto mandrels that represent the mating part (air cleaner, Mass Air Flow Sensor (MAFS), throttle body, turbocharger compressor inlet, etc.) with the minimum outside diameter and any retention barb at its minimum height. One of the mandrels shall have a port to introduce vacuum. Any PCV, SAI, etc., ports shall have the design intent mating part installed with the open ends sealed.

4.3.1.1.2 Conditions.

4.3.1.1.2.1 Environmental Conditions. The temperature of the samples must be stabilized at $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ for a minimum of 1 h before starting the test.

4.3.1.1.3 Instructions. Introduce a vacuum into the duct at a sufficient rate to maintain 130 mm of water (1.28 kPa). After the vacuum has stabilized at 130 mm of water (1.28 kPa), turn/seal off the vacuum source.

4.3.1.1.4 Requirements. The duct shall not leak in excess of 2.0 mm of water (0.02 kPa) for 60 s. If there is a leak in excess of 2.0 mm (0.02 kPa), then check connections with leak detection fluid and fix any leaks.

4.3.1.2 Heat Aging. The material of new parts may not be fully cured or stabilized. Heat aging is done to condition the parts before testing.

4.3.1.2.1 Preparation. Use duct assemblies which have been leakage tested per 4.3.1.1.

4.3.1.2.2 Conditions.

4.3.1.2.2.1 Environmental Conditions. Test temperature $100\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

4.3.1.2.3 Instructions. Place duct assemblies into a temperature chamber that has been stabilized at $100\text{ }^{\circ}\text{C} \pm 2.0\text{ }^{\circ}\text{C}$. Soak duct assemblies at $100\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ for 48 h. Let duct assemblies cool down to room temperature before conducting ozone test.

4.3.1.3 Ozone Effect. The materials of the duct assemblies will be exposed to atmospheric ozone during the life of the vehicle. Ozone exposure may adversely affect duct material properties.

4.3.1.3.1 Preparation. Use duct assemblies which have been heat aged per 4.3.1.2. Elastomer based parts, including Thermo Plastic Elastomer (TPE), Thermo Plastic Olefin (TPO), Thermo Plastic Vulcanizate (TPV), etc., and any combined material parts (soft-hard-soft) shall be tested. Plastic based (polypropylene, etc.) parts may be exempted from this test, based on the recommendation of GM Materials Engineering.

4.3.1.3.2 Conditions.

4.3.1.3.2.1 Environmental Conditions. Test temperature $38\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

4.3.1.3.3 Instructions.

4.3.1.3.3.1 Place the duct assemblies into a test chamber as specified in ISO 1431-1, introduce and maintain 100 parts per hundred million (pphm) ozone concentrations, stabilize the chamber at $38\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and soak for 336 h.

Use ISO 1431-1 (A100, B336, Y, Z1, Z2),

Where:

Z1 = Part must be mounted in the in-vehicle position and in-vehicle orientation with mandrels that represent the mating parts with the minimum outside diameter and any retention barb at its minimum height. Leave all ports open.

Z2 = Part must be elongated 20% along the main axis of convoluted sections of duct.

4.3.1.3.3.2 After 336 h of exposure, sample shall be removed from the chamber and permitted to cool to room temperature and then, while still on the fixture, shall be visually inspected for signs of cracking under 2x magnification.

4.3.1.3.4 Requirements. No cracking (rating zero (0) per ASTM D1171).

4.3.1.4 Leakage (Clean Air Systems Only). Repeat 4.3.1.1.

4.3.1.5 Durability. The purpose of this test is to determine the effect of engine/vehicle movement on the material, part design and hardware. The duct assemblies are tested independently and in combination with other support tests to simulate accumulated end use effects. The duct assemblies shall include the flexible convoluted duct, the hard plastic duct, turbo elbow or adapter duct, resonators, and others.

4.3.1.5.1 Preparation. Use duct assemblies which have completed Leakage per 4.3.1.1, Heat Aging per 4.3.1.2, Ozone Effect as required per 4.3.1.3, and have been Leakage tested per 4.3.1.4.

4.3.1.5.1.1 The duct assemblies with a PCV port connection must be preconditioned with oil/fuel exposure, since PCV oil/fuel mixture can flow into the duct assemblies. If there is no PCV port connection on the duct, go to 4.3.1.5.1.5. If there is no PCV oil/fuel mixture flowing into the duct assemblies (i.e. a check valve in PCV fresh air line), go to 4.3.1.5.1.5.

4.3.1.5.1.2 For all Regions Except GM Brazil (GMB). This section shall apply to both gasoline and diesel applications. Prepare a mixture (more than 50 mL) of oil combined with E85 fuel. Fifteen percent (15%) of mixture volume should be E85 fuel (GMPT-6-023-B), 85% of mixture volume should be IRM 903 or GMW16955 oil.

Note: If the vehicle is not designed to run E85 fuel, then ISO 1817, Liquid 2, shall be substituted for E85 fuel.

4.3.1.5.1.3 For GMB Region. Two test samples are required. Prepare two (2) mixtures (more than 50 mL for each) of oil and fuel. One with E25 fuel and the other with E100 fuel. Fifteen percent (15%) of mixture volume

should be fuel. The remaining 85% of mixture volume should be IRM 903 or GMW16955 oil. For the first test sample, use E25 fuel mixture; and for second test sample, use E100 fuel mixture.

4.3.1.5.1.4 Prepare mandrels that represent the mating parts (air cleaner, throttle body, turbocharger compressor inlet, etc.) and prepare plugs for PCV port. Any other ports except PCV port, shall have the design intent mating part installed with the open ends sealed.

4.3.1.5.1.4.1 Install a mandrel on one end of duct, and plug PCV port if equipped. Add 50 mL oil/fuel mixture to the duct open end, and cap open end with another mandrel. Reference Figure 1.

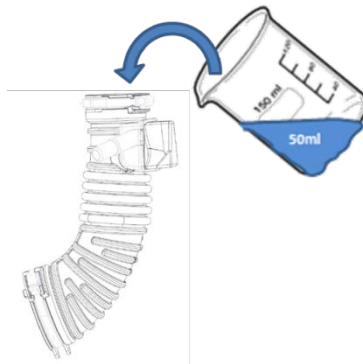


Figure 1: Add 50 mL Oil/Fuel Mixture into the Duct

4.3.1.5.1.4.2 Shake and roll duct to coat inside with uniform layer of oil/fuel mixture. Reference Figure 2.

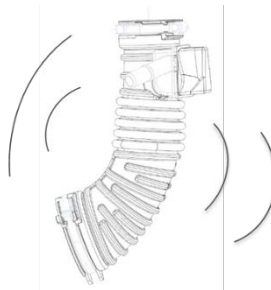


Figure 2: Shake and Roll the Duct